United Nations Development Programme
Country: Bangladesh

PROJECT DOCUMENT

Project Title:	Development of Sustainable Renewable Energy Power Generation (SREPGen)

UNDAF Outcome(s):

UNDP Strategic Plan Environment and Sustainable Development Primary Outcome: Strengthened national capacities to mainstream environment and energy concerns into national development plans and implementation systems

UNDP Strategic Plan Secondary Outcome:

Expected CP Outcome(s): Outcome 3. Energy and Environment: Improved environmental sustainability of development processes

Expected CPAP Output(s): Improved environmental sustainability of development processes and increased energy efficiency/ Environment indicators included into development policies at the sub-national and regional levels

Executing Entity/Implementing Partner: The Power Division of Ministry of Power Energy and Mineral Resources (MoPEMR)

Implementing Entity/Responsible Partners: Sustainable and Renewable Energy Development Authority (SREDA) (Implementing Entity)

Brief Description

The objective of the Project is to reduce the annual growth rate of GHG emissions from the fossil fuel-based power generation by exploiting Bangladesh's renewable energy resources for electricity generation. The basic approach of the Project will be to promote renewable energy in Bangladesh through the recently established Sustainable and Renewable Energy Development Authority (SREDA). For Bangladesh to achieve a greater share of renewable energy (RE) in its energy mix, the Project will support activities that will (i) transform SREDA into a strong RE project facilitation center to bring confidence to private RE investors and increase the number of approved RE projects; (ii) increase the capacities of appropriate government agencies to generate, process, obtain and disseminate reliable RE resource information for use by potential project developers and investors; (iii) increase the affordability of photo-voltaic solar lanterns (PVSLs) for low income households by supporting pilot PVSL diffusion activities; and (iv) increase the share of RE in Bangladesh's power mix through facilitating the financing, implementation and operation of pilot (RE) energy projects using rice husk and solar panels. The lessons learned from the pilot plants will be utilized to scale-up the dissemination of PVSLs and investment in on-grid RE projects and RE technologies.

Programme Period:	2014 - 2018
Atlas Award ID:	00073939
Project ID:	00086516
PIMS #	3948
Start date:	1 January 2014
End Date	31 December 2018
Management Arrangements	NIM
PAC Meeting Date	tbd

Total resources required	$ 53,677,272
Total allocated resources:	$ 53,677,272
• GEF	$ 4,077,272
• UNDP	$ 5,000,000
• Government of Bangladesh	$ 21,150,000
• GIZ	$ 250,000
• Clean Energy Alternatives	$ 200,000
• Tianjin Machinery I&E Co.	$ 20,000,000
• Private Sector	$ 3,000,000
Total:	$ 53,677,272

Agreed by (Government):

Date/Month/Year

Agreed by (Executing Entity/Implementing Partner):

Date/Month/Year

Agreed by (UNDP):

Date/Month/Year

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ACRONYMS

Acronym	Meaning
ADB	Asian Development Bank
BAU	Business-as-usual
BMD	Bangladesh Meteorological Department (under Ministry of Defence)
BPDB	Bangladesh Power Development Board
BUET	Bangladesh University of Engineering and Technology
CDM	Clean Development Mechanism
CER	Center for Energy Research at the United International University in Dhaka
CP	Country Programme
CPAP	Country Programme Action Plan
CSP	Concentrated solar power
CSR	Corporate social responsibility
DoE	Department of Environment
EC-LEDS	USAID-funded project "Enhancing Capacity - Low Emission Development Strategies"
EE	Energy Efficiency
EIAs	Environmental Impact Assessments
EOP	End of Project
ERD	Economic Relation Department
FDI	Foreign direct investment
FY	Fiscal year
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gases
GIS	Geographic information system
GIZ	German Agency for International Cooperation
GoB	Government of Bangladesh
GJ	Gigajoules
IDCOL	Infrastructure Development Company Limited
IEA	International Energy Agency
IISD	International Institute for Sustainable Development
KfW	Kreditanstalt für Wiederaufbau
kgoe	Kilogram oil equivalent
kWh	Kilowatt hours
LED	Light emitting diodes
MDG	Millennium Development Goals
MFI	Micro-finance institution
MJ	Megajoules
MoEF	Ministry of Environment and Forest
MoF	Ministry of Finance
MoPEMR	Ministry of Power, Energy and Mineral Resources
MTDF	Medium Term Development Framework
mtoe	Million tonnes of oil equivalent
NAMA	Nationally appropriate mitigation actions
NGOs	Non-Government Organizations
NREL	National Renewable Energy Laboratory
PBS	Pally Bidyut Samity or rural utility
PIR	Project Implementation Report

Acronym	Meaning
PMU	Project Management Unit
PPA	Power purchase agreement
ProDoc	UNDP Project Document
PSC	Project Steering Committee
PVSL	Photovoltaic solar LED lanterns
RE	Renewable energy
REB	Rural Electrification Board
RERED	Rural Electrification and Renewable Energy Project (World Bank-financed)
RET	Renewable energy technology
SED	Sustainable Energy for Development (GIZ-financed programme)
SHS	Solar home system
SODAR	Sonic detection and ranging
SOLIB	Solar Lantern Initiative for Bangladesh (under GIZ-SED)
SREDA	Sustainable and Renewable Energy Development Authority
SREPGen	Development of Sustainable Renewable Energy Power Generation for Bangladesh
SWERA	Solar and Wind Resource Assessment
TJ	Tera joules
toe	Tons of oil equivalent
ToR	Terms of Reference
UIU	United International University in Dhaka
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WB	World Bank

1. Currency Equivalents[1]

Currency Unit = Taka, Tk

1 USD = Tk 80.26

[1] www.oanda.com (exchange rate effective February 8, 2013)

SITUATION ANALYSIS

Context and Global Significance

1. Bangladesh is one of the most densely populated countries in the world with about 156 million people living on 147,570 km^2 of land as shown on Figure 1. It is also mostly agrarian with about 70% of its population living in rural areas. The development challenges posed by such a high population density and its consequential environmental threats are formidable enough but with climate change effects making Bangladesh the world's most "at risk" country, the challenges take on even greater significance. Despite these and other challenges posed by regular flooding, salinity encroachment in southern districts, structural deficiencies, paucity in energy supply and the heavy dependence on agriculture, the economy has shown a high degree of resilience. It has maintained a steady growth rate in the 6% range over the last few years and is now targeting even higher levels, closer to 7%. Estimates of GDP growth in FY 2010-11 indicate that the economy grew at a rate of 6.7% which is higher by more than 14% when compared to the 5.8% growth in FY 2009-10.

Fig 1: Map of Bangladesh

2. Poverty in Bangladesh is pervasive. As of 2005, the proportion of people living under USD 1.00 per day was 50%. While Bangladesh's per capita income rose from USD 816 to USD 848 in the FY 2011-12, it is still short of the USD 1,006 per capita income target for middle-income countries. Since Bangladesh is an agricultural economy, much of its population still reside in rural areas where they engage in fisheries, agriculture and other forms of primary production. In rural areas, access to health facilities, safe drinking water, proper sanitation and other such basic needs is still limited. In urban areas, due to high population density, per capita availability of resources has also decreased. According to the country's Fifth Five Year Plan, the root causes of poverty are low economic growth, inequitable distribution of income, unequal distribution of productive assets, unemployment and underemployment, high rate of population growth, a low level of human resource development, natural disasters and limited access to public services.

3. The primary energy consumption in Bangladesh is one of the lowest in the world. In 2008, the country's per capita annual energy consumption was about 182 kgoe and per capita electricity generation at 236 kWh. Despite intensive efforts to increase coverage, only 41% of households in Bangladesh in 2009 had access to electricity[2] with per capita electricity consumption of 265 kWh[3].

[2] http://www.worldenergyoutlook.org/media/weowebsite/energydevelopment/WEO2011_new_Electricity_access_Database.xls

[3] This compares with India at 749 kWh, Pakistan at 391 kWh, Sri Lanka at 457 kWh and China at 3,483 kWh.

4. Bangladesh's rural population is estimated to be 70% of its 156 million citizens[4]. An estimated 41% of the 25 million rural households[5] or 10.2 million households have little or no access to electricity or to clean modern energy sources[6]. Even those with access to electricity experience supply disruptions due to supply-demand gap. Renewable energy in rural households from solar home systems constitutes less than 1% of total power generation in the country.

5. Since 2009, the primary energy mix of Bangladesh has changed as the share of natural gas has declined whereas contribution of imported liquid petroleum fuel has increased. In 2009, 55% of natural gas produced was consumed in electricity generation, rising to 58% in 2011. From these analyses, the volume of gas supplied to the power sector rose by 4% between 2009 and 2010 with corresponding declines in supplies to captive generation and household use by 1% and 2% respectively.

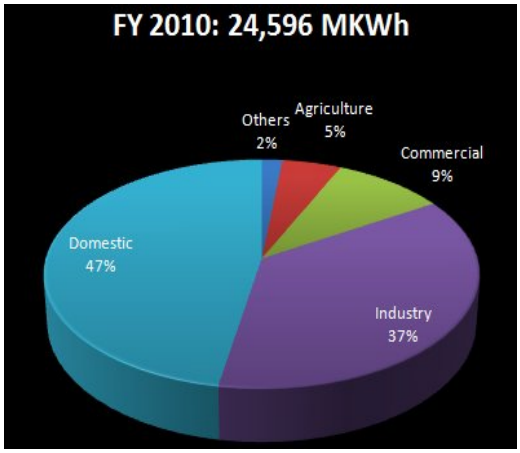
6. Petroleum fuel is the second largest source of commercial energy in Bangladesh. From 1997 to 2007, the demand for oil increased by 2.6%. However, since 2007, oil demand has increased many fold due to diminishing gas supplies, on the one hand, and the need to diversify the fuel use, on the other. In FY 2010-11, total import of crude oil and refined petroleum products stood at about 1.4 million tons and 3.5 million tons respectively.

7. The distribution of 2010 electricity consumption by sectors is shown on Figure 2. The total electricity consumed by the domestic sector was 47% in comparison to the second largest consumer, the industrial sector at 37%. In the power sector in FY 2011, actual generation was 4,890 MW against the forecasted demand of 6,765 MW which led to significant load shedding, often up to 1,335 MW. With generation capacity that is often below this demand, the country has since 2006 been experiencing rolling blackouts throughout the year, often during peak demand hours between 17:00 and 21:00, when electricity demand is most intense. The situation was further exacerbated because of the decline of gas supplies to power plants and associated difficulties with transmission infrastructure. Since 2011, the situation only slightly improved as supply shortages caused by low generational capacity were bridged to some extent through GoB's initiative on using electricity generated from rental captive power plants. As of June 2012, the average daily power generation was 5,500 MW with the highest generation of 6,350 MW achieved on 4th August 2012.

8. To mitigate the impacts of the increasing intermittency of the power supply, the Government of Bangladesh (GoB) announced targets for capacity additions of 9,000 MW (nearly a tripling of current capacity) by 2015 based on their Power System Master Plan 2010 (PSMP) to improve and expand electricity supply to support the 8% GDP growth. To meet the demand with reasonable reliability, the Plan forecasts that installed power generation capacity needs to be increased to 23,000 MW and 37,000 MW by 2021 and 2030 respectively. The PSMP outlined a time bound reform process focusing on infrastructural development, tariff rationalization, efficiency improvement, energy sources and fuel diversification with a target to supply power to all its citizens by the Year 2021.

[4] World Bank 2012 estimate
[5] According to the Bangladesh Population & Housing Census 2011, the size of households in Bangladesh has been a on long term decline, from an average of 5.5 persons per household in 1991, to 4.8 persons in 2001, and to 4.4 persons in 2011
[6] Bangladesh Bureau of Statistics, HIES 2010, http://www.bbs.gov.bd.

Figure 2: Electricity Consumption in 2010 by Sector



9. In recognition of the potential contribution of renewable energy (RE) to sustainable economic growth, Bangladesh has had RE development as a part of its energy policies since 1996. In 2002, a Renewable Energy Policy (REP) was first drafted and a "Vision and Policy Statement on Power Sector Reforms" was issued in 2002 with the objectives of: i) universal access by the year 2020 with improved reliability and quality[7]; ii) stabilizing the financial status of the power sector and increasing its efficiency; iii) operating the sector on commercial principles and increasing private sector participation; and iv) establishing an independent institution, Sustainable Energy Development Agency (SEDA)[8], under the Companies Act, 1994, as a focal point for sustainable energy development and promotion, 'sustainable energy' comprising renewable energy and energy efficiency.

10. The REP was finalized in 2008 with an updated version issued in 2009 defining GoB's current renewable energy targets of 5% of new capacity or 800 MW being renewable energy by 2015, and 10% of new capacity or 2,000 MW being renewable energy by 2021[9]. The objectives of the 2009 REP are to harness the potential of RE, disseminate RE technologies, facilitate both public and private investment in this sector, and increase energy supplies to substitute non-renewable sources of energy. The provision of a feed-in tariff is included in the 2009 REP. A summary of the renewable energy potentials in Bangladesh is provided on Table 1.

11. Despite the short and long-term efforts of the GoB to increase power generation and demand side management, *there are still significant challenges to achieve its vision of universal access by 2021 by relying only on grid power development*. The dispersed nature of rural settlements and the numerous rivers that crisscross Bangladesh make grid electrification in many areas difficult and expensive. As such, several years are required to fully close the demand-supply gap.

[7] The target date for "Energy for All" was recently shifted in 2012 from 2020 to 2021 by the GoB

[8] The name was subsequently changed to the Sustainable and Renewable Energy Development Authority (SREDA) in 2010

[9] The majority of renewable energy generation sources are likely to come from solar, and to a lesser extent, biomass and wind.

Table 1: Renewable Energy Potential for Bangladesh

Renewable Energy Sources	Qualitative Description of Potential
Solar	Insolation has been measured between 4 and 6.5 kWh/m^2/day[10]. As such, solar energy for homes and small businesses is gaining acceptance, and there is potential for the majority of households in Bangladesh to have access to solar energy (see Para 25).
Wind	While wind speed measurements of 4 to 6 m/s during the monsoon season (between May and September) have been made near the ground along coastal areas, wind measurements for commercial wind energy installations are still required to induce investment into and development of wind farms (see Para 24).
Biomass	There is large potential for the generation of energy and power from rice husks, animal waste and agricultural residues[11]. For example, the potential for rice husk.
Mini- and Micro-hydro	Small potential (< 50 MW) considering most of the country is flat.
Wave and Tidal	This resource has not been comprehensively studied and applicable commercial technologies to harness this potential have not yet been identified.

12. In recognition of this challenge, the GoB promoted the ***development of off-grid renewable energy schemes*** as one of the viable near-to-medium-term options to provide electricity for millions of households in the remote areas of Bangladesh. In 2007, the GoB issued the Remote Area Power Supply Systems (RAPSS) guideline to encourage private sector participation in development, operation, and maintenance of electricity generation system and distribution networks in remote rural areas including isolated islands. In part, the RAPSS guideline supplements GoB efforts at achieving the target of universal energy access by 2021, and would be based on least cost options, namely solar photovoltaic and biomass gasification. Deployment of these RE options would be done through the government offering licenses through a competitive process to own and operate RAPSS schemes in areas where mini-grids are determined to be viable.

13. First attempts at developing renewable energy in Bangladesh were undertaken by the Rural Electrification Board (REB) which installed 806 (off-grid and stand-alone) PV-based Solar Home Systems (SHSs) in 1993 in Narsingdi with French financial assistance under the "Diffusion of Renewable Energy Technologies" Pilot Project. A number of stand-alone SHSs with a total capacity of 32.6 kWp and three battery charging stations with a total capacity of 29.4 kWp were installed. Working in tandem with 18 rural utilities (known as Pally Bidyut Samity or PBSs), the REB program for SHS had reached more than 14,800 SHSs by 2005. REB owned the systems and the users paid a monthly fee for the services.

14. Using the lessons learned from REB and the Narsingdi pilot, the GEF-supported "Rural Electrification and Renewable Energy Development" project (GEF ID 1209) was implemented in 2005 to support the scale-up of SHS dissemination through private sector companies and NGOs; the SHSs under this project consisted of a large solar panel, a battery and sufficient power to provide lighting and a fan for 2 bedrooms for a cost ranging

[10] maps.nrel.gov/swera?visible=swera_dni_nasa_lo_res&opacity=50&extent=88.04,20.59,92.67,26.63

[11] Forestry as a source of biomass not included as it is not sustainable.

from USD 180 up to USD 350. This project successfully demonstrated a dissemination approach consisting of participating organizations (mostly NGOs) with refinancing funds for micro-financing of SHSs, a buy-down grant for end users to improve affordability for early participants, and an institutional development grant for the participating organizations to build capacities for promotion of SHSs in rural areas. The initial dissemination targets of 50,000 SHSs were exceeded with more than 250,000 SHSs installed by the end of the GEF project in 2009.

15. The success of the GEF project and the SHS dissemination programs was carried over through the continued engagement of IDCOL, a government-owned infrastructure finance company[12]. Their continued engagement on the SHS program has been supported by the World Bank-supported Rural Electrification and Renewable Energy Development (RERED) project, as well as GIZ, KfW, ADB and the Islamic Development Bank. To date, the Solar Home Systems (SHS) program of Bangladesh has emerged as a viable electrification option for lighting and other basic services in remote rural areas without grid access; there are more than 1.8 million SHSs installed in rural off-grid areas, and over 60,000 systems are being installed per month making it one of the fastest growing SHS programs in the world. The current SHS target is to reach another 2.2 million households by 2014 which will garner support from the World Bank and other development partners.

16. Notwithstanding the success of the SHS dissemination program, it is estimated that the SHSs packages are still unaffordable to more than 10.2 million households or 41% of the rural population in Bangladesh[13]. With the cost of SHS packages in the range of USD 100 to 300, much of the rural population with low incomes and limited saving potential cannot afford these SHS packages. Current sources of light for these households continue to be candles, kerosene lights and "hurricane" lanterns. However, these sources of light are expensive, inefficient, potentially dangerous and a source of greenhouse gases.

17. In 2009, the GIZs "Sustainable Energy for Development" (SED) Program in Bangladesh, a bilateral partnership between the Government of Germany and the Power Division of the MoPEMR, formulated the "Solar Lighting Initiative for Bangladesh" (SOLIB) to enable this segment of the rural population to access solar LED lanterns as a less costly alternative to SHSs. SOLIB is currently field testing a limited number of PVSL models and diffusion modalities through pilot projects. Using lessons learned from these pilot projects, SED will be seeking financial support to scale-up the PVSL diffusion program to improve energy access to these low income households, and assisting the GoB in its vision of universal energy access for all by 2021.

18. The GoB has also been supportive of the development of *on-grid and mini-grid renewable energy schemes.* Since 2008, there have been 3 pilot projects in Bangladesh of this nature including a) a rice husk power project in Kapasia (near Dhaka) on a mini-grid; b) a local grid-connected combined rice husk power plant and silica precipitation facility in Thakurgaon (northwest Bangladesh); and c) a mini-solar grid in Sandwip Island (northwest of Chittagong). Private operators of these projects received financial support through a mix of credit and grants from IDCOL with the intention to provide grid quality electricity to residential and business customers. Unfortunately, the varying degrees of success of these

[12] www.idcol.org

[13] Current SHS costs are in the range of Tk 10,000 to Tk 75,000 (or USD 120 to 900), beyond the financial affordability of an estimated 10.2 million households.

projects have resulted in limited investment into on-grid or mini-grid renewable energy development in Bangladesh.

19. In Kapasia near Gazipur, a 250 kW demonstration rice husk plant at Kapasia, Gazipur was installed by a private investor in 2010 using a downdraft gasification system from India through concessional financing from IDCOL[14]. The plant could not sustain its operations due to a number of factors including:

    - Location of the plant in an un-electrified area with no guaranteed revenue from electricity sales from local residents;
    - Plant location was also far from rice mills which raised the price of sourcing rice husk and increased the generation costs of the plant;
    - The inexperience of the operator to provide consistent electricity supplies to clients; and
    - Lack of operator experience to perform routine maintenance on the equipment and the infrastructure.

20. In Chilarong near Thakurgaon, IDCOL provided concessionary finance at a cost of USD 975,000 to Sustainable Energy and Agro-Resource Ltd. (SEAL) in 2011 for a combined 400 kW rice husk power plant and silica precipitation plant. The electricity to be generated at the plant was to be used for the adjacent silica precipitation plant as well as for an adjacent poultry hatchery and 30 local irrigation pumps. The plant is designed to use locally available rice husk as fuel for power generation with an Indian technology provider, and annual silica production will be in the order of 900 tonnes with 75 kW of electricity generated from the rice husk plant for the adjacent silica production plant. Current issues with the plant, however, include:

    - Delayed start-up of plant operations due to problems with the gasification technology with the possibility that the technology may not be suitable for this application; and
    - The viability of the entire project is dependent on the revenue stream from the silica precipitation plant, not electricity sales.

21. A 100 kWp solar power plant was installed on Sandwip Island by Purobi Green Energy Ltd. in 2010. The plant received a 50% grant from KfW with the remainder financed by IDCOL (80% as loan and 20% equity from Purobi), and serves 400 customers on a mini-grid that also has energy stored in a battery bank for reliable supply of electricity during the night mainly for shops in the market. The success of the Sandwip solar power plant is due to the following factors:

    - With a back-up diesel generator, electricity supplies from the plant to the 400 customers are reliable;
    - With reliable electricity supply, there are customers willing to pay a rate of Tk 32/kWh (USD 0.39/kWh);
    - Battery storage units were imported from Germany with “re-combiner functions” with a 10-year guarantee, and special instructions to fully drawdown batteries to optimize their service life;
    - Purobi Green Energy received a license from BERC on the basis of a waiver of regulations since the solar power plant was less than 1.0 MW.

[14] Plant was financed for an estimated USD 350,000

This business model, however, does not address electricity supplies to those who cannot afford the Tk 32/kWh tariff, and the additional costs associated with the replacement of the battery storage units which will need to be replaced in less than 8 years.

22. The two other pilot projects were on-grid wind pilot projects at Muhuri Dam, Feni (0.9 MW) and Kutubdia Island (1.0 MW) that were set up in 2005 by BPDB. These pilots currently do not operate due to:

    - Design of wind power site without appropriate wind data;
    - Selection of equipment without due regard for its operating conditions and without technical support;
    - The grid being unable to accept wind power into the national grid that is conditioned only to receive firm power sources.

    Currently, only 20 kW of wind power capacity has been installed in Bangladesh. These wind turbine installations are small hybrid and stand-alone applications at various public facilities such as cyclone shelters, the Bangladesh Army and LGED as well as buildings owned by BRAC and Grameen.

23. In summary, only 78 MW of renewable energy capacity has been developed in Bangladesh as of 2012. Table 2 provides a breakdown of this installed capacity.

Table 2: Bangladesh's RE Based Power Capacity as of December 2012[15]

RE Technology	Current Capacity (MW)
Solar home systems	66
Rooftop solar PV systems for new electricity customers	6
Solar systems in government offices	1
Solar systems in commercial establishments and shopping malls	1
Wind energy	2
Biomass based electricity	1
Biogas based electricity	1
Total	**78**

24. A primary reason for the lack of larger and operational wind power plants has been the lack of investment grade wind data. To date, there has been no systematic collection of wind data for these purposes. It is well known that wind speeds are highest during the summer months due to stronger monsoon winds from the south. Current wind resource data measured during the period of 1996 to 2002 at heights of 20 to 30 m is available from LGED, BMD, BCSIR, BCAS, GTZ and other governmental and donor agencies. These data provide some indication of the wind resources available in Bangladesh[16]. However, the data

[15] Power Division of the Ministry of Power, Energy and Mineral Resources, December 2012

[16] A number of efforts have been undertaken over the past decade to improve understanding of wind energy resources in Bangladesh. No data has been collected at a height of 50 meters, normally the minimum design height for large scale wind farms. The UNEP/GEF Solar and Wind Resource Assessment (SWERA) project attempted to rectify this information gap. This project used remote sensing and modelled data, calibrated with existing measurements at ground level up to 20 meters to estimate wind speeds at the required height. Detailed SWERA estimates were that the wind speeds in the coastal areas are up to 5.8 m/s; however, there are strong seasonal and diurnal variations in Bangladesh, and wind power density may be considerably variable amongst locations with the

does not meet standards to make investment decisions that will facilitate the development of commercial wind projects. Primary issues with this data has been the:

- Measurement of wind speeds at lower heights, giving lower values due to obstacles such as trees and buildings in close proximity to the wind data station. Investment grade wind data requires proper siting of stations and the setup of anemometers at wind hub heights of 80 m or higher as well as to avoid the influences of the aforementioned obstacles; and
- Discontinuous nature of the data sets. The monitoring of wind speeds for commercial use needs to be continuous for more than 12 to 24 months.

25. There is abundance of solar data that has been collected by BMD and other governmental and donor agencies. The data, however, needs to be compiled and organized into user friendly formats for the benefit of solar project developers and potential investors[17].

26. Current government plans for the scale-up of renewable energy development in Bangladesh are contained in the plans announced by the Power Division of MoPEMR in June 2012 for the development of 500 MW of solar generation plants roughly divided into "commercial" projects (340 MW) and "social service" projects (160 MW). The Government is proposing that commercial projects be implemented, owned and operated by the private sector, and social projects be implemented by different ministries and other government departments on public assets for the benefit of the general public. The largest of these projects is the solar irrigation program (classified as a commercial projects) that will replace more than 18,000 diesel irrigation pumps before 2016.

Threats and Root Causes

27. Continued economic growth of Bangladesh is closely tied to its ability to provide reliable power supplies to its citizens and commercial and industrial interests. The sluggish growth of the country's power generation capacity is exacerbated by the country's burden of subsidies for the primary use of fossil fuels for electricity generation, transport and lighting and cooking fuels for low income households. Estimates of fuel subsidies range from USD 200 million for kerosene to USD 3.9 billion for oil and gas for power generation, roughly 4% of the country's GDP and an amount that could be used instead to re-invest into growth of the power sector[18].

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same annual wind speed. This would include some locations where wind power density is above 150 W/m^2, sufficient potential for commercial wind generation. An independent assessment by RISOE National Laboratory also found significant wind potential in the coastal areas. Wind energy density predicted by the RISOE model show locations with power density above 200W/m2 over 2000km2 which is highly encouraging. Both of these results are, however, based on model extrapolations. Actual site wind measurements at 50 meters or above over extended periods of time are required to justify investments in large scale applications of wind energy.

[17] The solar energy resource in Bangladesh is abundant plentiful and well documented. Lack of resource data is not considered to be a barrier to solar energy utilization in the country. The SWERA report of 2007 provides information from two modelled data bases – one compiled by the National Renewable Energy Laboratory in the US and the other from DLR Laboratories in Germany. Both these data bases were calibrated to measured data in Bangladesh collected by the Renewable Energy Research Center at Dhaka University. Both sets of results are available online at the SWERA website. The report noted that "variations between maps of NREL and DLR are not large and global horizontal irradiance (GHI) values are within 2%." The SWERA data archive includes monthly and annual maps prepared for diffuse and direct normal radiation. The solar radiation availability is high all over Bangladesh, in the range of 4.0-4.5kWh/m^2/day and the report recommends that "PV should play a vital role in providing electricity to all in rural Bangladesh." It also notes that resources are sufficient for solar thermal technologies.

[18] http://www.iisd.org/gsi/sites/default/files/ffs_bangladesh_czguide.pdf

28. The GoB recognizes renewable energy development as one of the country's keys to economic growth and energy security. However, despite its ability to attract private investment into conventional power generation, the GoB has still not yet been able to catalyze RE investments. The MoPEMR currently is in need of assistance to promote RE to be able to meet the immediate and long-term Government targets for RE development in Bangladesh (5% and 10% by 2015 and 2020 respectively in the 2009 RE Policy).

29. The root cause of slow development of renewable energy is the lack of a functioning government agency dedicated to the promotion and coordination for renewable energy development. Such an agency has been envisioned since 2002 in the first draft Renewable Energy Policy; in December 2012, the Bangladesh Parliament approved the establishment of the Sustainable and Renewable Energy Development Authority (SREDA) with full powers as a government authority to develop policies for renewable energy and energy efficiency programs, and to mobilize resources for RE and EE development programs in Bangladesh. As SREDA is a newly formed entity, it is not yet fully functional. The absence of a functional SREDA has and will have a number of adverse impacts on RE development including:

    - The absence of a central repository for RE resource information such as wind speed data at specific project sites, solar and aerosol data, and biomass availability data;
    - Lack of regulatory control over RE development leading to an absence of technical and implementation oversight, and regulatory enforcement. Currently, RE knowledge and RE development responsibilities are spread over several government agencies including the Power Cell, BPDB and REB. There is not a single government agency dedicated solely to the promotion of RE investments that would include investment incentives such as land concessions, tax holidays, duty free import of RE equipment and feed-in tariffs;
    - Lack of local incentives to build knowledge on RE project development resulting in a poor network for local technical support to prepare bankable RE investment documents;
    - Lack of knowledge on risk assessments on RE projects by commercial lending institutions; and
    - Lack of RE investor confidence.

    These impacts contribute to the current barriers to RE development in Bangladesh as described in detail in Paras 31-39. Without external donor assistance, SREDA will not likely be functional for several years to meet its mandate to promote RE that will meet Government targets under the 2009 RE Policy.

30. Though the SHS Program under IDCOL has been successful with more than 1.8 million installed SHSs and with over 60,000 SHS installed each month[19], an estimated 41% of the 25 million rural households in Bangladesh cannot afford the price of even the least-cost SHS options. As such, an estimated 10.2 million households (or 45 million rural citizens) continue to use subsidized kerosene as a means of providing light during the evenings. With cost escalations of subsidized fossil fuels, there has been heightened interest in providing appropriate RE technologies to this segment of the rural population. The diffusion of appropriate RE technologies would contribute to Bangladesh's energy security, reduce CO_2 emissions, reduce kerosene subsidies by more than USD 186 million annually[20], and likely catalyze investments into other RE resources within the 2009 RE Policy priorities such as

[19] IDCOL

[20] Bangladesh Institute of Development Studies, and the IISD's Global Subsidies Initiative, "A Citizen's Guide to Energy Subsidies in Bangladesh", 2012

solar irrigation pumps, and rooftop solar panels for residential, commercial and industrial buildings.

Barrier Analysis

31. Barriers to the widespread use of RE for power generation in Bangladesh include:

32. *An incomplete policy, regulatory and institutional framework to promote and approve RE power investments*: While this has been partially addressed through the December 2012 parliamentary approval of SREDA as a government authority with full powers to develop and promote renewable energy and energy efficiency programs, SREDA is still a new government entity with limited capacity to fulfil its mandate. As such, SREDA still needs to develop:

    - The institutional coordination protocols between itself and BERC to determine appropriate tariffs for the unique nature of each renewable energy generation technology. This would facilitate the proper energy pricing in Bangladesh and catalyze the development of renewable energy sources;
    - The administrative mechanisms to lobby for duty-free importation of RE-related equipment. While the RE Policy of 2009 exempts import duties and taxes from solar photovoltaic equipment and wind turbines for government agencies, items such as batteries associated with RE equipment have not fallen under these exemptions, thereby discouraging import of quality RE appliances such as solar LED lanterns;
    - Its capacity to revise the existing regulatory framework on issues related to integration of the national grid with generation sources with variable inputs such as wind power;
    - The institutional mechanisms to streamline approvals that will attract RE investment, such as approvals for land acquisition, and impact statements related to environmental impacts, and socio-economic benefits of potential RE projects; and
    - A transparent process for selecting RE developers for future RE-based power generation projects. Such a government-initiated process would include definition of procedures for site selection, tendering of bids, bidding protocols, transparent bid evaluations, and preparation of power purchase agreements specific to renewable energy projects in Bangladesh.

33. *Lack of accessible and complete RE resource data*: While solar data is considered to be adequate for current purposes, datasets for wind and biomass resources do not have sufficient geographic coverage or volume to induce investment decisions. The available data sets are also not compiled in user-friendly formats to developers and other stakeholders, leading to a lack of confidence in the data sets. Moreover, access to these data is difficult requiring contacts with various government departments, discouraging potential RE developers and investors. Much of the currently available data has been largely obtained from initiatives funded by donors, and not by government agencies or private interests.

34. In general, past renewable energy resource assessments in Bangladesh have been largely initiatives funded by donors. In some cases, these assessments have been accompanied by efforts to enhance capacity in the appropriate government agencies such as the Bangladesh Meteorological Department (BMD) under the Ministry of Defence for wind and solar resource assessments and data management; these efforts, however, have not achieved the intended outcomes resulting in RE datasets that are not investment-grade and not readily accessible to RE development professionals. BMD does not have the budgets or the

capacity to generate wind and solar data for investment promotion purposes. Though SREDA has been recently established, it does not have the capacity to manage and disseminate RE resource assessments for wind, solar and biomass to catalyze RE investments.

35. Wind energy during the monsoon season along the coastline of Bangladesh has long been targeted for development into an energy resource. Between 1996 and 2002, GTZ, BCAS and BCSIR generated continuous wind speed data sets over a period of one year at various coastline sites. While this provided some useful information on monsoon wind speeds, these measurements were only taken at 10 to 30 m mast heights, insufficient for investment-grade wind energy data. In 2007, UNEP/GEF assisted the GoB by compiling Bangladesh's wind resource data into the Solar and Wind Energy Resource Assessment (SWERA). While the SWERA report provided wind resource maps based on well documented computer models[21], the information was also regarded as insufficient to meet the needs of project developers, investors and financing institutions. Up until 2012, there has been no concentrated efforts by government, donor community or the private sector to upgrade wind data information to investment-grade; no investment-grade wind speed masts had been installed at the required 80 meters height or above for a period of a full year or two, and there has been no proper evaluation of the wind market potential in Bangladesh using the latest models and wind turbine assumptions.

36. Recent global technological advances in biomass gasification have also catalyzed interest in the use of biomass resources for energy and electricity generation. However, lessons learned from recent IDCOL-financed biomass energy generation projects in Bangladesh (see Paras 18 to 20) indicates that improved understanding of the availability of the biomass resource as well as the local electricity market are required to sustain development and operation of such plants. While two recent studies of rice husk availability for the purposes of electricity generation have been completed[22], there are no local examples nor are there local champions to prepare site-specific studies of rice husk availability for investment level decisions; the preparation of such studies by local consultants would induce private sector investment.

37. *General lack of experience amongst government power sector officers, private sector consultants and suppliers, and academia in the design, implementation, operation and maintenance of RE power projects*: While there are a number of accredited academic and vocational institutes that are providing courses in RET applications and engineering, graduates have not yet acquired RE project development experience in Bangladesh. Though a small number of government officers have attended RE study tours and seminars, they have not been able to sustain their involvement with RE development since these past efforts have been insufficient in developing local RE champions. The SHS Project has also developed RE expertise specific to the project but not for other RE projects. As such, Bangladesh does not have a critical mass of engineering and financial consultants who can prepare bankable documents for RE project financing, or to develop, design, implement, operate and maintain RE-based power generation projects in Bangladesh. The root cause of

[21] These models were calibrated with available measurement data and model-generated wind maps that provided estimated wind speeds at 50 m heights over a significant area of the southern coast of Bangladesh

[22] This includes the "Techno-Economic Feasibility Study of Rice Husk Gasification Based Power Generation Plants for Sustainable Power Supply to Rice Mills of Bangladesh", by GTZ-SED Working Team on Efficient Use of Biomass Energy in Bangladesh, December 2007, and the "Techno-Economic Analysis of Green Electricity Generation From Rice Husk" by Islam and Ahiduzzaman, ICETCESD 2012 March 10-12, 2012, Sylhet, Bangladesh

this experience barrier is the lack of in-country RE projects where Bangladeshi experience in RE development can be nurtured.

38. *Lack of capacity within the Bangladesh financial sector to develop financing packages for RE projects*: While policymakers have identified the need for scaling-up RE investments, IDCOL has been the lone financing institution in Bangladesh with an RE lending portfolio. To date, their loans towards RE projects have been done on a pilot basis with a grant component to assist in lowering capital costs. Outside of IDCOL, there are no Bangladeshi financial institutions that have financed RE projects. The capacity of commercial financing sector in Bangladesh to assess and address risks of renewable energy projects and RET dissemination is limited resulting in virtually no RE projects or technologies being financed by this sector. While this may in part be due to the absence of a government agency focused on RE development, the root cause of this lack of capacity has been the sector's lack of exposure to RE financing packages from other countries such as those that include access carbon markets as a supplemental source of finance.

39. *Poor perceptions of RE projects*: Past RE-based power generation demonstrations such as the Kapasia rice husk power plant, the Chilarong rice husk and silica precipitation plant (near Thakurgaon in Northwest Bangladesh), the Sandwip solar plant, and the BPDB wind projects have only reinforced the perception amongst the investment community and the general public that renewable energy technologies cannot be developed as an efficient and profitable venture. Details of these demonstrations are provided in Paras 47 to 51. A reversal of this perception can only occur with RE projects that are planned and executed according the best international practices.

Stakeholder Analysis

40. The Power Division of the MoPEMR is the umbrella entity that oversees all policy-related matters of the power sector. This includes policies related to generation, transmission, and distribution of electricity. Initiatives to develop RE projects lie within a number of entities including:

- The *Power Cell*, the technical arm of the Power Division that provides the technical assistance for design and implementation of power sector reform activities. To carry out its mandate, the Power Cell also manages:
    - The *Bangladesh Power Development Board (BPDB)* who currently have plans for the development of an 8.0 MW grid-connected solar plant that is a part of the 450 MW combined-cycle plant at Ashuganj, and a 6.5 MW solar-wind-diesel hybrid station at Hatia. Both of these projects are receiving financial assistance from ADB;
    - The *Rural Electrification Board (REB)*;
    - *Other power distribution organizations* all of whom are responsible for developing technical arrangements for purchase of power from RET projects within defined geographic areas and integrating this power into the operation of the grid;

  The Power Cell is currently the strongest government agency involved with RE project development, and is best suited at this time to serve as the implementing partner of SREPGen until SREDA has the capacity to be an implementing entity.

- The *Bangladesh Energy Regulatory Commission (BERC)* is responsible for approving and setting electricity tariffs that it deems justifiable and fair to protect end users.

Usually, BERC acts only upon applications from utilities which must provide detailed explanations justifying the need for higher tariffs. Their potential role on SREPGen is to work with SREDA on feed-in tariffs that will catalyze RE investment as well as protect electricity consumers; and

- *SREDA* which received parliamentary approval in December 2012 for the full set of powers will serve as the government's focal point for primary coordination and responsibility for development of RETs in Bangladesh. The one of the purposes of this Project is to build SREDA's capacity to undertake this role. This will include development and recommendation of policies, regulations, tariffs and incentives; raising awareness on RE incentives for investors, capacity building, technical assistance and other programs approved by the Government; developing, maintaining and disseminating knowledge resources; monitoring implementation of programs, compliance with policies and regulations, and results of RET activities; and recommending to the Government actions to correct problems with compliance or other results. SREDA is proposed as a responsible partner for SREPGen, and possibly the implementing partner when their capacity is deemed sufficient to undertake this role.

41. *IDCOL*, a government owned infrastructure finance company, has been implementing renewable energy programs under the World Bank's RERED project since 2003. This includes the SHS program under a public-private partnership model where Partner Organizations (POs), mostly NGOs, procure and install the systems as per technical standards set by IDCOL. IDCOL is also channeling funds to the private sector for the development of renewable energy projects such as solar-powered mini-grids, solar irrigation schemes and on-grid biomass gasification projects. A RERED II has been proposed by the World Bank commencing in early 2013. IDCOL's potential role on SREPGen is to provide concessional debt financing for on-grid RE projects being proposed by various private RE investors.

42. The private sector will play a key role in the development of the renewable energy market in Bangladesh. In this regard, *Clean Energy Alternatives Inc.* (CEA) located in Dhaka is one of the key stakeholders of this Project in the promotion of RETs and rice husk power projects in Bangladesh. They currently serve as project developers with access to a network of foreign technology manufacturers, fabricators and installers, local and foreign engineering services and other technical organizations that are necessary for the successful construction, installation, operation and maintenance of RE power generation projects. Their potential role on SREPGen is to serve as a RE development resource, more specifically as developers of rice husk power plants, identification of appropriate RETs, stakeholder consultations, networking with the commercial financial sector in Bangladesh, and implementation oversight.

43. The *Center for Energy Research at the United International University* (CERUIU) in Dhaka was setup to enhance research in the fields of renewable and sustainable energy, its utilization and efficient management, and policy formulation through research and development. CERUIU are now developing a modern research laboratory for RE research. CERUIU are also involved in different renewable energy related activities like training, designing low cost high efficiency circuits for LED lamps, enhancing the performance of solar PV systems, and designing diffused reflectors for solar PV panels for enhanced power output. One of their key staff sits on the Technical Board for Renewable Energy Technologies of IDCOL. CERUIU potentially will play a key role in the setup of solar nano-grids in Bangladesh.

Baseline Analysis

Establishment of SREDA

44. The Power Division have specific budgeted plans for the scale-up of a 500 MW of solar power programme in an effort to meet the targets of the 2009 Renewable Energy Policy of 5% of new capacity, or 800 MW being renewable energy by 2015, and 10% of new capacity or 2,000 MW being renewable energy by 2020. The scale-up plans of the Policy will be promoted through the newly formed SREDA (that was established in December 2012 by Parliament). The Policy also articulated the potential of RE, the need to disseminate RETs through public and private investment in the sector, the need to increase energy supplies to substitute non-renewable sources of energy, and provide a feed-in tariff for which there is widespread support amongst experts and policymakers as a means to encourage development of renewable energy. While BERC is responsible amongst other tasks, for the formulation feed-in tariffs (FITs) to catalyze RE investment, it does not have access to the information and resources for detailed analysis required for its formulation. The absence of an appropriate FIT for RE power projects will delay RE investments into Bangladesh, and serve as an impediment to meeting the targets of the 2009 RE Policy. In addition, there is also an absence of understanding of the country's grid characteristics and its ability to absorb the variable loads from RE sources such as wind or solar power. An alternative scenario with GEF assistance envisions the preparation of FIT studies for various RETs by the newly formed SREDA, thus informing BERC of appropriate FIT formulation, enhancing the RE investment environment, and catalyzing RE investment towards the targets of the 2009 RE Policy. This scenario also envisions the preparation of a grid integration study to address the necessary attributes of the Bangladesh national grid (such as input attenuations) to manage the variability of a wind or solar power project

45. With off-grid renewable energy as one of the viable near-to-medium-term options to provide electricity for millions of off-grid households in the remote areas of Bangladesh, the GoB issued the Remote Area Power Supply Systems (RAPSS) guideline in 2007 to allow for private sector participation in development, operation, and maintenance of electricity generation system and distribution networks in remote rural areas including isolated islands. The RAPSS guideline was designed to supplement GoB efforts at achieving its target of universal energy access by 2021, and would be based on renewable energy least cost options such as solar photovoltaic and biomass gasification. The GoB plans to offer licenses for owning and operating RAPSS schemes through a competitive process in areas where mini-grids are determined to be viable. Without a functional dedicated government entity to promote RE development, there will not likely be any development of RE projects under RAPSS due to the general lack of capacity of Government personnel on RE development. An alternative scenario with GEF assistance envisions assistance being provided to SREDA to guide, assist and regulate project proponents towards approval of RE projects in Bangladesh.

Availability of Renewable Energy Resource Information

46. There are ongoing wind power developments in Bangladesh. In February 2012, ReGen Powertech Pvt Ltd from India signed an MOU to conduct wind mapping in 5 coastal regions including Feni, Cox's Bazar, Anawara (south of Chittagong), Kuakata and Khepupara. The company has set up two 80 m wind speed monitoring stations in the Chittagong region to collect investment grade wind speeds to be continuously monitored for one year that will be

used towards the installation of a pilot wind-based power plant (15 MW). In addition, NREL through the USAID-supported EC LEDS Project is scheduled to set up more than four (4) 85 m high mat mast and three (3) SODAR stations to throughout Bangladesh to generate investment-grade wind speed data, with a weighting of stations along the coastline where there is more wind energy potential. The results of the wind speed data collection program by ReGen and NREL will be known in early 2014 or later.

47. The initiatives by ReGen and NREL will provide strong indicators on the viability of Bangladesh's wind resources. If the wind speeds are viable for investment into commercially operated wind energy projects, the Government, likely through SREDA, has stated its need for an entity to store, manage and disseminate the wind data assets for use by potential wind energy investors. SREDA, however, being a newly formed Government agency, will not have nor will it be able develop this capacity over the long term without exposure of its personnel to best international practices for the storage and maintenance of wind speed and other renewable energy databases to be used by potential RE investors. This will limit the interest of RE investors to develop RE projects in Bangladesh, placing higher risks on the Government reaching its targets of the 2009 RE Policy. An alternative scenario envisions GEF assistance to strengthen SREDA capacity to become a focal point for wind energy and other renewable energy resource data, thereby improving the investment environment for potential RE investors. With the improved capacity of SREDA to become the repository for wind data as an outcome of SREPGen, wind energy investments in Bangladesh will be accelerated during the Project period in addition to the investments being made by ReGen.

48. There are current efforts by Clean Energy Alternatives and the Tianjin Machinery Import and Export Company (as detailed in Para 51) to develop grid-connected rice husk-based power projects in northern Bangladesh. While they are undertaking efforts to evaluate various sites for rice husk power plants, they lack resources to assess site specific information on seasonal rice husk availability using best international practices for such assessments. The GIZ-supported SED program has undertaken some studies on rice husk availability in the northwestern region of Bangladesh as an accompaniment to a study on energy efficient rice parboiling[23]. In some areas, more than 50% of the rice husk is used as fuel for parboiling rice with the other 50% being agricultural waste. If energy efficient parboiling units were used, 50% less rice husk would be required for parboiling, making more rice husk available as a potential feedstock for a power plant. The GIZ study also indicates that there is some variability in the use of rice husks amongst the different localities. As such, a grid-connected rice husk power plant design would need to confirm a number of design factors including:

    - Number of rice crops per year;
    - Rice yield according to transplanted or high yielding variety;
    - Farthest distances over which rice husk will be transported to a power plant;
    - Proximate analysis of the rice husk to determine its silica and ash contents and calorific values; and
    - Market analysis of power consumption in the area.

49. While rice husk remains a valuable resource that could provide up to 400 MW of renewable energy to the national grid of Bangladesh, its development may take place without proper efforts to holistically assess rice resource availability on a seasonal basis and without due consideration to other factors such as transport costs from the paddy fields to the power

[23] Ibid 22

plant site. This will certainly delay for several years urgently needed investments into grid-connected biomass power plant investments into Bangladesh. An alternative scenario envisioning GEF assistance would provide technical assistance to project proponents and SREDA to assess rice husk availability on a seasonal basis, and to conduct proximate analysis of the rice husk to evaluate its calorific content and other by-products of the rice husk that could generate other revenue streams[24].

Off-Grid Renewable Energy Pilots

50. Although more than 1.8 million SHSs have been sold in Bangladesh, an estimated 10.2 million households or 41% of Bangladesh's rural population cannot afford the cost of an SHS[25]. The problem is well-known: the main target group for SHS is the rural population with low and uncertain income, with limited savings potential and with low energy consumption that is mainly for non-productive use. Current sources of light for these households continue to be candles, kerosene lights and "hurricane" lanterns. However, these sources of light are expensive, inefficient, potentially dangerous and a source of greenhouse gases. Alternatively, a photovoltaic-powered solar LED lantern (PVSL) that utilizes recent advances and cost reductions of light emitting diodes (LEDs), offers a practical, low cost and clean energy alternative to SHSs. If efficiently disseminated, PVSLs will improve the quality of life for the rural poor and enhance their sustainable use of solar resources and the environment. It is expected that PVSLs will be in high demand by these low income households if PVSL monthly costs (through a credit program) are equivalent or less than the current monthly kerosene costs of these households.

51. In 2009, GIZs "Sustainable Energy for Development" (SED) Program in Bangladesh, a bilateral partnership between the Government of Germany and the Power Division of the MoPEMR, formulated the "Solar Lighting Initiative for Bangladesh" (SOLIB) to enable an estimated 10.2 million households or 41% of Bangladesh's rural population who cannot afford the cost of an SHS[26], access to a photovoltaic-powered solar LED lantern (PVSL) that utilizes recent advances and cost reductions of light emitting diodes (LEDs), offers a practical, low cost and clean energy alternative to SHSs. PVSLs will provide modern lighting appliances to low income rural households that otherwise depend on kerosene for lighting, an unsustainable practice necessitated by a lack of affordable alternatives in the Bangladesh market that includes the SHS being sold under IDCOL. The impact of PVSLs is the improvement of the quality of life for the rural poor and the enhancement of their sustainable use of solar resources and the environment. It is expected that PVSLs will be in high demand by these low income households if PVSL monthly costs (through a credit program) are equivalent or less than the current monthly kerosene costs of these households. The objective of SOLIB is to:

- Create conditions to encourage and enable families to shift from traditional to superior modern lighting systems and improve living standards;
- Efficiently disseminate the use of PVSLs throughout Bangladesh; and
- Mitigate carbon emissions.

[24] This would include silicate and black carbon content in the rice husk.

[25] Income levels of the more than 10 million households in Bangladesh cannot afford the current SHS packages priced in the range of Tk 10,000 to Tk 75,000 (or USD 120 to 900).

[26] Income levels of the more than 10 million households in Bangladesh cannot afford the current SHS packages priced in the range of Tk 10,000 to Tk 75,000 (or USD 120 to 900).

52. The 2009 and 2010 preparations for SOLIB focused on the removal of barriers to the large scale use of PVSLs in poor rural households in Bangladesh. The design of SOLIB has been addressing issues regarding:

    - Quality of PVSLs that are to be sold under this program;
    - The affordability of PVSLs to low income households by instituting buy-down grants that will gradually be phased out, similar to the ongoing program;
    - Delivery modality where PVSLs could be delivered through community-based institutions such as NGOs, the private sector, or a hybrid arrangement; and
    - Financing packages and business models in the context of market imperfections associated with rural financing.

    The impact of the SOLIB design is expected to be the protection of poor households against poor quality lamps, improved ability for the consumer to pay for PVSLs, increased consumer confidence in PVSL products, and sustainability of the PVSL diffusion program.

53. To date, SOLIB is field testing a limited number of PVSL models (estimated to be around 3,000 PVSLs) and diffusion modalities through pilot projects. A significant portion of this effort was invested in ensuring the quality of the PVSLs into SOLIB met the most stringent durability standards; SOLIB has placed high importance on the protection of target but vulnerable consumer groups comprised of the lowest income households. Using valuable lessons from these pilot projects and diffusion of best quality PVSLs, an initial roll-out of 133,000 to 200,000 PVSLs is proposed for 2013 and/or 2014 with the provision that SED can access financial support from donors for buy-down grants to reduce transaction costs, implementation of a micro-credit program, and the delivery of PVSLs to isolated low income households. Without this initial financial support, confidence of these low-income households to purchase PVSLs will not be attained, constraining more widespread use of PVSLs. Moreover, the Government will not be able to offset the use of imported kerosene and reduce kerosene fuel subsidies to the poor estimated to be USD 186 million in FY 2012[27].

54. An alternative scenario with GEF assistance envisions financial support to catalyze the initial roll-out of PVSLs, and technical assistance to strengthen quality control of PVSLs on the SOLIB programme and diffusion efficiencies and enhance the confidence of the end-users of the PVSLs. When this roll-out is completed, the ingredients for a commercially viable PVSL supply and distribution chain can be identified to increase the rate of PVSL deployment, create secondary employment opportunities in rural areas, and create a long-term viable market for PVSLs, and eventual reduction of kerosene-related GHG emissions and subsidies. In addition, the scaled-up program (similar to the IDCOL programme) will continue to remove financial barriers through smart subsidies (subsidies on a sliding scale for a number of years), continued awareness raising regarding quality and care of PVSLs, and expansion of the supply system network through SME development. The impact of these grants and financing schemes should add no additional financial burden on low income households when they purchase PVSLs since the monthly instalments of the credit scheme will approximate their monthly kerosene costs. SOLIB efforts to pilot diffusion of PVSLs are being implemented in collaboration with NGOs.

[27] Ibid 20

Government RE Financing

55. The Government is currently setting up a sustainable energy and renewable energy development funds for financing RE and EE projects as well as SREDA operations. One of these funds is the "Refinance Scheme on Solar Energy, Biogas and ETP – ACSPD Circular No 6" that has been created by the Central Bank to provide commercial loans for RE & EE projects. With increased importance being placed on renewable energy as a means towards energy security, the involvement of SREDA to operationalize these funding sources is important from an RE promotional and regulatory perspective. Operation of these funds without SREDA involvement will lead to stunted RE project development; RE projects outside of the Government's priority would be promoted, and funded projects may incur higher risks of being dysfunctional due to lack of design, administrative, technical and implementation oversight. The result could very likely be the lack of fully operational RE projects over the next 5 to 10 years. An alternative scenario that envisions GEF assistance will build SREDA's capacity to serve as an influential board member on the fund's operational committee. SREDA will then be able to marshal the use of these funds towards RE projects that meet the Government's strategic goals and targets of the 2009 RE Policy.

On-Grid Renewable Energy Pilots

56. Currently, Clean Energy Alternatives (CEA) who are based in Dhaka as project developers and the Tianjin Machinery Import and Export Company (TMIEC) who are based in China as technology suppliers and project financers are collaboratively involved with the development of grid-connected rice husk-based power projects in northern Bangladesh. While rice husk remains a valuable resource that could provide up to 400 MW of renewable energy to the national grid of Bangladesh, the risk of improper development of this source of renewable energy generation is high due to difficulties that will be experienced in maintaining international construction and equipment installation standards, and training operators to optimize operations of the power plant. The lack of exposure to best practices will place further constraints on the Government in reaching their targets in the 2009 Renewable Energy Policy. The primary lesson learned from the Kapasia and Chilarong pilot projects is the need to ensure that rates of return on investment are realized. This would include actions to:

    - Ensure that the technology selected for generation of electricity supply is appropriate and can generate the required rates of return;
    - Carefully study market conditions of the site selected to ensure sufficient supply of feedstock at reasonable prices and demand for electricity from the plant with feed-in tariffs; and,
    - Ensure that the rice husk power plant is constructed, installed, operated and maintained according to the supplier's instructions.

    An alternative scenario with GEF assistance envisions the provision of technical support for best international practices for the engineering, construction and operation of these rice husk power plants.

Specific Government Plans for RE Development in Bangladesh

57. As mentioned in Para 44, the Power Division of MoPEMR announced plans in June 2012 for the development of 500 MW of solar generation plants roughly divided into commercial projects (340 MW) and "social service" projects (160 MW) that will be implemented by

different ministries and other government departments. The largest of these projects is the solar irrigation program to replace more than 18,750 diesel irrigation pumps before 2015. This project will be implemented by IDCOL and partner organizations at the field level to work with farmer groups who own and operate most of the irrigation pump facilities in Bangladesh. The benefits of this replacement program include the reduction of diesel subsidies to the agricultural sector, estimated to be over USD 280 million annually. Since its announcement in June 2012, the program has made little progress to date due to issues related to identification of appropriate technologies that are affordable to farmer groups, design of the dissemination program, design of a financing package and implementation capacity. This has already placed a high risk that the target of 18,000 diesel pumps will not be displaced by 2015. Moreover, the Government will not be able to remove its subsidy burden for diesel fuel to the agricultural sector. An alternative scenario that envisions GEF assistance will provide technical assistance to overcome the aforementioned issues and to meet the project targets of 18,000 installed solar irrigation pump facilities by 2015. The benefit for the Government will be significant relief of subsidies for diesel fuel to the agricultural sector.

STRATEGY

Project Rationale and Policy Conformity

58. Overall, the SREPGen Project is set against a background of rising electricity costs, an increasing reliance of Bangladesh on imported fossil fuels to meet its energy needs, and rising fuel and electricity subsidies. Similar to most developing countries which are increasingly energy importers, the likely increase in future energy costs and the disruption in energy supply could jeopardize Bangladesh's economic growth, and keep a large segment of its population without any access to modern energy sources. The recognition by the GoB for the need to increase the share of renewable energy is in stark contrast with the actual application of RETs in the country, and the urgent need for a government focal agency to coordinate the RE development in Bangladesh.

59. For the GoB to achieve their target of universal access to energy and 2,000 MW of RE generation capacity by 2021, further support will be required for the development and implementation of new RE project opportunities that can be scaled-up. Measures to promote RE investment can be expected to improve energy security, generate employment and serve as a cost-effective GHG emission reduction option. Through targeted assistance on RE development in Bangladesh, the SREPGen project can improve Bangladesh's energy security, and position the country to reduce fuel subsidies and reduce energy sector related GHG emissions.

60. The aim or objective of the project is the reduction in the annual growth rate of GHG emissions from fossil fuel-fired power generation through the exploitation of Bangladesh's renewable energy resources for electricity generation. This project is in line with the GEF-5 CCM goal of supporting developing countries and economies in transition toward a low-carbon development path, and specifically designed to contribute to achieving the strategic objective of promoting investments in renewable energy technologies.

61. The proposed project is consistent with the GoB's Vision of "providing access to affordable and reliable energy to all by the Year 2021", and the 2009 Renewable Energy Policy, in particular to its targets to increase the share of renewable energy to 5% of new capacity, or

800 MW being renewable energy by 2015, and 10% of new capacity or 2,000 MW being renewable energy by 2020. The objectives of the 2009 REP are to harness the potential of RE, disseminate RE technologies, facilitate both public and private investment in this sector, and increase energy supplies to substitute non-renewable sources of energy.

Country Ownership: Country Eligibility

62. The GOB ratified the UN Framework Convention on Climate Change on 15 April 1994.

Country Drivenness

63. To improve Bangladesh's energy security, the GoB identified specific strategies in its Sixth 5-Year Plan (FY2011 – FY 2015) for the energy sector including:

- Increasing power generation to reduce demand-supply gap through public-private partnerships and through power imports from neighbours;
- Mobilization of funds for electricity generation projects through private sector participation in the form of public-private partnerships;
- Provision for incentives for FDI into the power sector as per the Industrial Policy 2010;
- Installation of solar panels in public and private buildings with a view to harnessing solar energy;
- Increasing the use of renewable energy by 5% within plan period; and
- Building public awareness through electronic and print media about RE and EE issues and introducing them in educational curricula.

64. Bangladesh is committed to the development of its renewable energy resources as articulated in the Renewable Energy Policy of 2009. With the Policy targeting of 5% of new capacity (or 800 MW of RE) by 2015, and 10% of new capacity (or 2,000 MW of RE) by 2020, the GoB has made little progress to increase RE development and improve the country's energy security including significant market penetration of SHSs[28]. Investment in on-grid and mini-grid RE systems remains sluggish due to the aforementioned barriers.

65. Renewable energy development is also a part of the solution to reducing the intermittency of the power supply as mentioned in the GoB's Power System Master Plan 2010 (PSMP), designed to improve and expand electricity supply to support the 8% GDP growth. This includes targets for capacity additions of 9,000 MW (nearly a tripling of current capacity) by 2015, 23,000 MW by 2021 and 37,000 MW by 2030 most of which is to be met with conventional power generation sources. The Power Division have stated in its recent policy presentations that the Government is targeting the development of 800 MW of renewable energy by 2015 and 2,000 MW by 2020. To meet this target, the Power Division identified 500 MW of solar power as detailed in Tables 3 and 4. The Power Division has stated that the private sector will play a key role in identifying and financing other RE technologies and projects to reach the 800 MW and 2,000 MW RE targets. SREPGen will assist the Government in the development of solar irrigation pump facilities as detailed in Para 78.

66. The proposed nodal agency for the development of renewable energy in Bangladesh is the Sustainable and Renewable Energy Development Authority (SREDA) that received

[28] The most visible Government effort to date has been the promotion of the Government's RE priorities and the solicitation of RE proposals for funding under the `Green Fund` and other Government RE&EE funds, most of which are very small and insignificant in terms of RE installed capacity targeted by the 2009 RE Policy.

parliamentary approval in December 2012 for its establishment as the lead agency in the development of policy and promotion of renewable energy and energy efficiency.

Table 3: Commercial Solar Power Projects Identified by the Power Division

Type of Solar Project	Capacity (MW)
Solar Irrigation Pumps	150[29]
Solar Park on Government Land	115
Solar Parks in Railway Areas	20
Solar Power in Private Commercial and Residential Buildings	10
Solar Power in Industries	20
Total:	**340**

Table 4: Social Solar Projects Identified by Power Division

Type of Solar Project	Implementing Agency	Capacity (MW)
Solar electrification in rural health centers	Ministry of Health	50
Solar electrification in remote educational institutes	Ministry of Education	40
Solar electrification at Union Information Centers	Local Governmental Division	7
Solar home systems in religious establishments	Ministry of Religious Affairs	12
Solar electrification at remote railway stations	Railway Division	10
Solar PV systems in Government Offices	Public Works Division	41
	Total:	**160**

67. This Project is directly responsive to the joint GoB-UNDP Country Programme Action Plan (CPAP) 2012-2016: UNDAF Pillar 5: Climate Change, Environment, Disaster Risk Reduction and Response, Outcome 2: By 2016, vulnerable populations benefit from natural resource management (NRM); environmental governance, and low emission green development of which there are two sub-outcomes:

    - Outcome 2.3 “Pro-poor plans, strategies and partnership mechanisms are in place to implement low emission green growth with better access to climate financing mechanisms”; and
    - Output 2.4: “On-grid and pro-poor off-grid clean energy technologies promoted”;

68. UNDP Bangladesh has a long history of successful cooperation with the Government, private sector and other stakeholders to promote clean technology and environmental benefits. It has also supported capacity development and policy and program implementation including the Renewable Energy Policy of 2008, and the draft Energy Conservation Act under review by the Government. UNDP Bangladesh will build on this experience in management of this project and will also draw on the technical experts

[29] This will serve as the baseline project that will receive GEF support as detailed in Para 56.

available in the UNDP Asia-Pacific Regional Centre in Bangkok to advise and assist the project.

Design Principles and Strategic Considerations

69. The barrier removal activities envisioned for this proposed GEF project are designed to catalyze investments in renewable energy-based power generation that will deliver results that can be attributed to meeting GoB goals for a 800 MW target for RE by 2015 (and 2,000 MW by 2020) in the overall energy mix for Bangladesh; providing access to RE for a larger segment of the rural population; creating favourable conditions conducive to private investment in RE from both local and foreign sources; and implementing renewable energy for electricity generation projects in an efficient, technically sound and sustainable manner. With the GEF project in place over a design period of 5 years, there will be a greater likelihood of GoB meeting its renewable energy targets of 1,500 MW by early Year 2018, the scheduled end of the GEF project.

70. To achieve sustainable growth in the renewable energy share of power generation and the GoB's vision of universal access to energy for all by the Year 2021, a strong and capable government organization is needed to be the driving force to ensure that necessary policies, programmes and incentives are carried forward to realize the benefits (national and global) from the utilization of renewable energy resources for meeting the country's energy requirements. The central approach of the SREPGen Project will be to promote RE development in Bangladesh through building the capacity of SREDA as the focal institution for renewable energy development in Bangladesh. MoPEMR received parliamentary approval in December 2012 for the establishment of SREDA and full powers as an authority. Project work to address the full range of barriers and accelerate RE growth in Bangladesh will be conducted with the Power Division and SREDA.

71. Given SREDA's limited capacity and time constraints in achieving the GoB's RE targets, specific sub-implementing organizations with specialized expertise in RETs, RE policies and financing mechanisms will be requested to support SREDA's programs to develop and mobilize RE investments. The Project will select these organizations on the basis of their ability to provide technical assistance, training and program implementation that support GoB's RE development targets. This will include organizations that can attract RE foreign expertise into Bangladesh, and implement, manage and operate pilot RE investments in close collaboration with SREDA. By supporting this business modality, the Project will demonstrate the need for strong government support for private RE investments in Bangladesh that will boost investor confidence. This will increase the likelihood of rapid and effective implementation of key components of this Project.

72. Wherever possible and practical, the proposed SREPGen Project will augment ongoing RE development and RET application opportunities. As such, there will be an emphasis on promoting and showcasing RET applications with strong demonstrative value that will catalyze replication of RE-based power generation projects in other areas of Bangladesh. As such, this project will not invest in SHS as it is already a relatively mature technology in Bangladesh and has already received wide-ranging support over a number of years.

73. However, based on the successful model established under the SHS initiative, this project will facilitate market development of promising RETs such as PVSLs, which will provide the lowest income households in the country access to modern renewable energy. In this

respect, this project will bring SREDA in close collaboration with GIZ and IDCOL to identify aspects of PVSL diffusion where GEF funding can add the most value. UNDP Bangladesh has a long-standing relationship with GIZ and will leverage that partnership as much as possible.

Project Goal, Objective, Outcomes and Output/Activities

74. The objective of this project is reduction in the annual growth rate of GHG emissions from fossil fuel-fired power generation through the exploitation of Bangladesh's renewable energy resources for electricity generation. This will be achieved through the removal of barriers to the application of RE-based power generation in Bangladesh.

75. **Component 1: RE policy and regulatory support program:** This component addresses the barrier concerning the lack of appropriate policy and regulatory framework for RE power investment. The expected outcome from the outputs that will be delivered by the activities that will be carried out under this component is the evolution of SREDA into a facilitation center that supports private sector RE investment development, enables regulators to determine fair flexible tariff structures, brings confidence to private RE investors, and increases the number of approved RE projects. The following outputs will contribute to the achievement of this outcome:

- *Output 1.1: Completed studies on RE policy and tariffs and grid integration with RE power sources*. This output will provide support for specific analysis and policy development activities by SREDA and other experts to develop and assist in the implementation of new policies and regulations to facilitate approval and growth of RE projects in Bangladesh. GEF support will be required for technical assistance to conduct:
  - A study on supportive regulations such as feed-in-tariffs (FIT), power purchase agreements, permitting procedures, approval of RE incentives such as duty-free imports. The FIT study will provided to BERC for the determination of the final tariffs for various RE projects; and,
  - A grid integration study that will address the necessary attributes of the Bangladesh national grid (such as input attenuations) to manage the variability of a wind or solar power project, operational parameters for renewable energy power plants (REPPs), interconnections with national (HV) grid and distribution networks (LV), and optimum dispatch and scheduling of various types of renewable energy capacity.

- *Output 1.2: SREDA operational rules*. SREDA with the assistance of GIZ have been formulating implementing rules, regulations, and an organizational strategic plan to clarify roles and responsibilities of proposed SREDA personnel to support implementation of the 2009 RE Policy. Moreover, with a significantly large low income population that do not have access to the grid, the SREDA strategic plan should also include a "pro-poor off-grid" dimension for RE promotion into its operations[30]. GEF

[30] SREDA can include an officer or a department that:
- provides 'pro-poor analyses and strategies with the institutionalized responsibility of analyzing RE projects, regulations and policies to identify entry points for introducing pro-poor programmes
- incorporates human development and poverty reduction indicators into the regular M&E activities of SREDA
- sets up a units that focus on supporting livelihood improvement initiatives using renewable energy

assistance is required for the incremental technical assistance in continuing the drafting of implementing rules and regulations and update of strategic plans for SREDA as the need arises during the Project period;

- *Output 1.3: Trained SREDA staff in RE development.* To facilitate SREDA's evolution into a "one-stop shop" facility for private sector investors and project developers into the Bangladesh RE market, the capacity of SREDA personnel and RE project proponents will be built in tandem with supportive regulations and SREDA operational rules (Outputs 1.1 and 1.2). GEF assistance will be required for the technical assistance needed to build the capacity of SREDA personnel, domestic RE project proponents, and local technical, engineering and financial consultants through:
  - Training workshops on wind, solar, and biomass energy system design and applications including site identification, collection and use of bankable RE data and information, identification of appropriate technologies, potential implementation plans, and quality control monitoring;
  - Financial analyses of RE projects including an impact review of feed-in tariffs and carbon finance;
  - Training a critical mass or a roster of private investors, consultants and RE service providers who can develop RE projects by developing an inventory of priority RE projects based on economic and energy generation criteria. A certification system will be developed for attendees of these workshops and seminars; the certification will be used to qualify for inclusion on a SREDA roster of power plant development professionals that can used by potential RE investors. These actions will sustain the strengthening of local capacity for the design, development and operation of RE projects in Bangladesh;
  - Monitoring, reporting and verification (MRV) of operational RE generation sources to international standards and GHG reduction reporting to MoEF.

- *Output 1.4: SREDA-managed RE investment facilitation center.* Assistance will be provided to SREDA to initiate development and operationalize an RE investment facilitation center or a "one-stop shop" facility for private sector investors and project developers getting into the Bangladesh RE market. GEF assistance will be required for the technical assistance to develop this center including the development of promotional materials, strategically located offices to interface with investors, civil society and financers, and the launching and sustained updating of a SREDA website. Such a website will contain all information necessary for potential RE investors and developers. This would include the Government's RE priority projects, RE resource datasets, financial incentives for RE development offered by the GoB, participating financial institutions and funds for developing RE projects in Bangladesh, rules and regulations for receiving RE concessions in Bangladesh, rules and regulations for RE development, roster of accredited locally available technical assistance for RE, and list of ongoing RE developments.

This project component is expected to result in (a) the evolution of SREDA into a strong project facilitation center for supporting private sector development efforts for commercial

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- liaises with other relevant government agencies and ministries related to social welfare and development planning that may lead to discussions on poverty alleviation, support on existing poverty mapping and the creation of RE strategies for poor low income households

RE projects; (b) increased understanding of the RET market that will enable regulators to determine fair but flexible tariff structures; (c) increased confidence of private investors in developing RET projects due to government clarity on policy and tariffs; and (d) increased number of RE project approvals utilizing a tariff structure that is more supportive of renewable energy development.

76. **Component 2: Resource assessment support program**. This component is intended to address the barriers associated with the lack of reliable RE resource data that can be used by prospective RE project developers and investors. The expected outcome from the deliverables of the activities that will be conducted under this component is increased capacity of SREDA and other relevant government agencies in generating, processing, obtaining, and disseminating reliable RE resource information for use by GoB and potential project developers and investors (including increased availability of wind, solar and biomass resource information). The outputs from this project component will contribute to the: (a) Increased availability of reliable RE resource data that meets international standards for RE resource assessments, and can facilitate investment decisions into commercial RE-based energy projects; (b) Increased technical capacities of the BMD and SREDA to generate and process reliable RE resource data for use by the GoB and potential RE-based power project generation developers and investors; and (c) Increased knowledge of SREDA on sites that would interest potential RE-based energy project investors. The following outputs will contribute to the achievement of this outcome:

- *Output 2.1: Wind resource maps*: A major element of this project component will be to build the capacity of SREDA to coordinate wind data collection generated from wind data collection stations being financed by USAID (under the EC-LEDS project with NREL as the contractor), ADB and private investors for wind power projects. These stations have been setup for collecting data for wind mapping at several strategic coastal locations. In addition to its coordination role, SREDA will also have its capacity built to calibrate wind mapping data, and to provide more detailed data at specific locations that may be prime sites for wind development. In addition to this assistance, capacity of the BMD to collect, manage, and disseminate wind speed data in coordination with SREDA will be strengthened. GEF assistance is required to:

    - Conduct an assessment of BMD's capacity to collect, store, manage and calibrate wind speed data for investment purposes to international standards. This would include BMD's knowledge of state-of-the-art tools for wind resource measurement, availability of skilled technicians and professional staff, and current systems for database storage;
    - Assist BMD and SREDA to take custody of new wind speed datasets generated by NREL, ReGen and other stakeholders (commencing in 2014), and to prepare the datasets for dissemination to interested wind energy investors. This will involve transfer of datasets from stakeholders to BMD and to SREDA in formats that are easily accessible and preferably on a secure website;
    - Evaluate and assess the merits and demerits of having real-time access to wind resource data with specific reference to Bangladesh, and to make recommendations on a comprehensive system to access wind data from BMD to SREDA and wind power investors. This will tie in with Output 1.4;
    - Identify and recommend a comprehensive GIS system for potential wind farm sites using experience from available GIS systems from different organizations and possibilities of linking wind resource data related information on these existing GIS systems;

- Identify and recommend wind forecasting, information management and exchange system for integrated wind farm operation;
- Identify and recommend standard wind mast system for future wind power investors, including recommended height and equipped with necessary anemometers, sensors, data loggers, solar panel, auxiliary battery power, and data communication to control rooms;
- Publish wind maps together with a dynamic information setup, available on request and online through a SREDA or BMD website. This will be presented as an official compilation of updated wind data and wind maps from all potential wind resource-rich areas in the country (inclusive of those areas where previous mapping has been done)[31]. These will also tie-in with Output 1.4.

- *Output 2.2: Investment-grade solar resource data*: On this activity, available solar data from BMD will be compiled and organized in user friendly formats and posted on a publicly accessible website possibly through Output 1.4. GEF assistance would be required to collect and manage the solar data from BMD on a SREDA website that can be accessed by potential solar power project developers for larger solar projects such as CSP.

- *Output 2.3: Biomass resource data*. Significant biomass resource data collection is not envisioned in this project[32]. However, considering the possibility of significant investments to be made into biomass power plants (mainly rice husk) and the uncertainties of biomass availability at site specific locations, the collection and analyses of site-specific biomass availability information will assist SREDA and project proponents in the development and implementation of biomass-based power generation projects. The GIZ-financed SED Programme is already active in this area through its activities in energy efficient rice parboiling activities under which rice husk data are being made available. These sets of information will be used in addressing such specific issues as seasonality availability of biomass resources, evaluation of the economically and technically feasible transport distances for various types of resources, percent of crop residues available for power generation, and percent of crop residues that need to be returned to the soil to comply with good agricultural practices. GEF assistance will be required to reduce the uncertainties of rice husk availability by:

  - Assessing its seasonal availability in a selected region;
  - Reviewing current uses of rice husks for energy for a particular location;
  - Reviewing ongoing practices of storage and disposal of surplus rice husk;
  - Estimating remaining rice husk available for power generation; and

[31] Wind maps are generally updated on a regular basis to incorporate annual data from wind data collection stations. This Project envisions such a scenario under SREDA and BMD.

[32] The biomass resources in Bangladesh are also fairly well understood. The total supply of biomass for energy, from agricultural residues, forests and livestock and poultry waste, was estimated in 2001-2002 at 56.38 million tons. Crop residues include rice straw, husk and bran from rice plants, tails, roots and bagasse from sugarcane, wheat straw, and jute residue. The trees as well as twigs and leaves are used as fuel. Forest biomass is available on a sustainable basis from designated forest areas (Bangladesh has a small area of land under true forest coverage), homestead and road side trees, and other social forests. Cattle dung is an important source of biomass fuel in Bangladesh. There are about 22 million cattle in Bangladesh, which produce about 0.22 million tons of wet dung daily. There were about 130 thousand poultry farms with over190 million birds reported in the country in 2005-2006, producing an estimated 0.018 – 0.020 million tons of litter of daily. (LGED-FAO 2006, Zaman and Sarkar, 2008) According to Infrastructure Development Company Limited (IDCOL) sources quoted in 2010, Bangladesh has now has 215,000 poultry farms and 15,000 cattle farms where electricity could be generated by establishing biogas plants (Al-muyeed and Shadullah, 2010).

- Collecting and posting the data on a SREDA website (Output 1.4) that can be accessed by potential biomass power project developers.

77. **Component 3: Diffusion of photovoltaic-powered solar LED lanterns (PVSLs) to low-income households:** This "pro-poor" component is designed to dovetail and scale-up ongoing efforts led by the GIZ-SED supported SOLIB programme to overcome an inability of marginal low income households to pay for high quality PVSLs. Activities on this component are more focused on issues relating to PVSL affordability, protecting low income consumers from poor quality products, boosting and sustaining their confidence in the quality and durability of PVSLs in the program, and sustaining the growth of PVSLs to the estimated 10.2 million low income households in Bangladesh whose income is insufficient to afford an SHS. To this end, a combination of buy-down grants and credit financing schemes similar to the SHS programme under IDCOL and the Government's waiving of VAT, duties and other levies[33] to improve PVSL affordability are proposed by SOLIB to reduce transactions costs to end consumers. GEF assistance is proposed to augment the pilot diffusion through building the capacity and business skills of community-level organizations and enterprises as Partner Organizations (POs), and to provide buy-down grants to catalyse interest and demand for PVSLs amongst these vulnerable low income households. The targeted area for development of these organizations will be in the Cox's Bazar region where "village conservation organizations" (VCOs) were under the UNDP-GEF "Coastal and Wetland Biodiversity Management Project" to institutionalize community ownership of community natural resources. In this regard, the capacity of VCOs can be built to lead community efforts to disseminate PVSLs to its constituents. The expected outcome is increased affordability of PVSLs to low income households. The following outputs will contribute to the achievement of this outcome:

    - *Output 3.1: Established financial mechanism that includes a credit scheme and buy-down grants*. GEF assistance is required for the following proposed activities under this output:

        - Provision of "buy-down" grants during Years 1 and 2 in the range of USD 10 to 15 per PVSLs delivered to the targeted VCOs and POs[34], and
        - Technical assistance throughout the Project to build the capacity of the VCOs and their MFI partners to prepare and execute financial agreements with end-users to implement this financial mechanism.

      The proposed financial mechanism is similar to the SHS Programme where end-users will provide a down-payment for the PVSL[35] and sign a PVSL purchase contract under a micro-finance scheme with an NGO or entrepreneur sanctioned by the recipient community. After the PVSL is delivered, the POs will apply for re-financing from IDCOL for a portion of the microfinance they extend to the low income households. After technical and other verifications through SREDA, IDCOL will release the credit and a fixed subsidy (assumed to be USD 15 per PVSL for this Project design and GHG emission reductions) to the POs. This refinancing provides the POs with funds to sell more PVSLs in other remote areas. The capacity of microfinance institutions (MFIs) will

[33] Namely the batteries and LED lights

[34] The exact amount of buy-down grant will be determined by the ability of the grant to reduce monthly payments of PVSLs to an equivalent of monthly kerosene costs of low income families.

[35] A down-payment of USD 7.14 has been assumed based on a USD 50.00 PVSL (Inclusive of all bank charges and transaction costs as detailed in Annex V. This has been counted as a source of co-financing for the Project.

be strengthened to support lending to rural low-income households for the purchase of PVSLs. Traditionally, MFIs in Bangladesh have targeted income generating activities whereas this project component focuses on consumer type products. In this regard, capacity building of MFIs will be required to extend credit to this financial mechanism.

A draft financial mechanism for PVSL diffusion is provided in Annex V.

- *Output 3.2: PVSL delivery models that provide product support and credit collection.* To deliver this output, the following activities will be carried out:

  - Development and implementation of a capacity development program for VCOs and their partner enterprises on the sale, distribution to remote villages, and product support of PVSLs. These entities will be trained on the distribution of PVSLs, collecting credit on a monthly basis, supporting PVSL products in the event of malfunction, and bringing confidence to their client base so that they can increase their sales and product support to other communities;
  - Development of a "dealer sales" model where a dealer purchases complete PVSLs or components from manufacturers or importers and sells, them directly to households[36]. The NGOs and VCOs will be assisted in the proper application of the "dealer sales" model;
  - Conducting of advocacy and campaign programs for the delivery of PVSLs to established and trusted local business outlets such as small electrical shops and hardware stores in small towns along with a network of rural agents augmented by NGO services. This will introduce a market approach to the delivery modality and contribute to the program's long term sustainability by lowering risk profiles associated with lending to rural customers;
  - Provision of measures to ensure women as target beneficiaries of PVSL usage in the household use and in the sale and servicing of PVSLs. Measures to be taken will consist of awareness raising campaigns, monitoring of women's usage and business involvement of PVSLs, and results-based adaptive management to improve PVSL benefits to women.

  GEF assistance will be required for the development of delivery models for PVSLs towards full commercialization, and for monitoring, reporting, verification and adaptive management of the operational performance of the proposed delivery model.

- *Output 3.3: PVSL Certification Procedures and Quality Oversight of Diffusion Activities.* SOLIB has already initiated a system of quality control for PVSLs involving a number of well-known international testing institutes[37]. With PVSLs undergoing testing at these institutes prior to entry to SOLIB, PVSL quality benchmarks have been set laying a strong foundation for the creation of a PVSL regulatory regime. This regime will be designed to ensure that PVSLs imported into or made in Bangladesh meet international standards and specifications for durability and performance. Work will be carried out towards the approval, establishment and enforcement of the PSVL regulations. GEF assistance will be required to:

[36] The dealer sales model has been successfully deployed in other countries such as China, India, Sri Lank, Indonesia and Viet Nam where most qualified dealers have received project support in the form of business finance, capacity building and marketing assistance.
[37] This includes the Frauhofer Institute of Solar Energy Systems (http://www.ise.fraunhofer.de/en)

- Provide oversight to the systems in place to ensure PVSL quality is sustained throughout the diffusion process; and
- Work with Government of Bangladesh agencies to create the appropriate regulatory regime that will include certification procedures for PVSLs entering the program (for minimum durability, longevity and luminosity standards), lower taxes and reduced delays in permitting and licensing for the import of solar LED lanterns into Bangladesh.

These interventions will protect a vulnerable sector of Bangladesh's population from the vagaries of substandard products and remove doubts regarding the long term reliability of PVSLs supplied under this program.

For the purposes of calculating emission reduction benefits of this component, the Project will target the payment of buy-down grants for 133,000 PVSLs in Years 1 and 2 to low income households. Using the cash flows generated from the credit collection scheme in Years 1 and 2, the Project will then be able to disseminate another 313,100 PVSLs during Years 3, 4 and 5. This will reduce domestic demand of 2.6 litres of imported kerosene per household per month, which will translate into a direct emission reduction of 75 kilograms of CO_2 per household per year. This will lead to a total direct emission reduction of 68,000 tonnes of CO_2 by the EOP and post-project direct emission reduction of 605,000 tonnes of CO_2 by 2028, 10 years after the EOP. This component will be implemented as an extension of the current GIZ program under special arrangements as detailed in Paras 95 to 96.

78. **Component 4: Renewable energy investment scale-up**: This component will address the barriers of a lack of capacity within the financial sector to developing financing packages for RE projects and poor perceptions of RE projects in Bangladesh. It will do so by supporting SREDA efforts to assist RE project developments already identified as priority programs by the GoB. This component will support: (1) improving SREDA influence on newly created RE funds, as part of a larger low cost sustainable energy fund or a standalone fund; (2) creation of a third party guarantee program (similar to a loan portfolio guarantee scheme) specifically designed to share risks between lenders, borrowers and third parties; and (3) the full cycle RE project development and demonstration involving best practices for planning, design, installation, maintenance, skills development and operational support for RE projects. Selected RE projects include rice husk power generation[38], "solar nano-grids" for rural households, and solar irrigation pumps with the intention of demonstrating sustainable business models for RE investments in Bangladesh to potential investors. The expected outcome is the increased share of renewable energy in Bangladesh's power generation mix resulting from a catalyzed RE investment environment. The following outputs will contribute to the achievement of this outcome:

- *Output 4.1: RE projects funded by SREDA-operated RE funds*. There are a number of planned RE funds in Bangladesh to support and catalyze RET investments. GEF will provide the technical assistance to assist with the development of these RE funds, in the formulation or amendment of fund charters and operational guidelines as well as building the capacity of SREDA personnel to serve on the Board of these funds. One of these funds is the "Refinance Scheme on Solar Energy, Biogas and ETP – ACSPD Circular No 6" that has been created by the Central Bank to provide commercial loans for RE & EE

[38] This may include a hybrid solar rice husk project that would reduce the risks of rice husk shortages through the generation of solar power to the grid during the day. This hybrid RE project would be feasible if there is a continued global reduction trajectory in the cost of solar panels, a distinct possibility given the slower economic growth globally.

projects. SREDA presence on the Board or loan approval committees would be extremely useful since it would bring specialized knowledge of RE issues and perspectives on national priorities and needs. In this way, SREDA could influence how RET projects are implemented and concurrently help in overcoming barriers in project implementation especially in regard to permitting requirements, land acquisitions and power purchase agreements in cases where grid supply is involved. RE fund charters should align with the GoB RE strategic objectives in terms of what RE initiatives the fund will support, sourcing of funds, fund management structure, project eligibility criteria and evaluation guidelines, loan security and repayments, rating system of borrowers, decision making for the loan approval process, and guidelines loan monitoring and loan closure. As the SREDA governance environment improves, the Project will seek to scale up the size of these funds through mobilization of public and private funding as well as NAMA and carbon funds for subsequent large-scale investments in RE technology;

- *Output 4.2: Bankable documents for financing pilot grid-connected RE projects*. As detailed in Para 54, there are ongoing efforts by the Tianjin Machinery Import and Export Company (TMIEC) and Clean Energy Alternatives (CEA) to develop grid-connected rice husk power projects. This includes identification of the appropriate gasification technology and entrepreneurs who will take an equity position on these projects and manage them. GEF incremental technical assistance is required to improve their pre-project development activities that includes the delivery of the following:

    - A location report supported by desk studies and surveys for four rice husk projects ranging from 2 to 3 MW or larger depending on technical parameters;
    - Survey of rice husk availability and a detailed report on rice husk consumption of four selected rice husk milling clusters to determine the amount of husk that traditional mills use for parboiling and the amounts that can be saved[39]. This report will also contain how much paddy is husked in households within a "reasonable" distance of the cluster and how this source of husk can be made available for use by the planned power plants. This deliverable can be linked with Output 2.3 that would involve SREDA in the context of serving as a repository for biomass resource information for RE development;
    - A cost effective intervention strategy for replacement of boilers in these rice husk milling clusters to reduce inefficient rice husk use and increase the total supply of husk for power generation. The report should also include an analysis of the costs of conversion and how these costs can be internalized as investment costs of the power plant and paid back by the mills in husk supply;
    - The feasibility of wind and solar hybrid installations at each of the four rice husk sites. The report should be supported by desk studies and reports on the availability of wind and solar, and an economic analysis for the inclusion of additional RE resources at these sites;
    - A bankable site specific feasibility document for each of the four rice husk plants or hybrid plants if deemed feasible. This will include feasibility-level engineering plans, social and environmental assessment of the project[40], cost estimates, construction

[39] Recently, GIZ-SED conducted a survey to determine the availability of husk in a cluster in North Bangladesh. By far, the largest concentrations of plants in the cluster were traditional operations or "chatals". They also found that 80% of the husk produced during milling were being used in highly inefficient boilers for parboiling, leaving only 20% for sale for other purposes. Current GIZ-SED efforts to improve boiler efficiency will reduce rice husk consumption for parboiling by 50%, availing more rice husk for electricity production.

[40] This will include stakeholder consultations with the affected communities.

and implementation plans, operation and maintenance, projected revenue streams, financial and risk analyses[41], and rates of return;
- Draft agreements between the parties, the rice mill clusters and the power plant; and
- Negotiation of these agreements that will result in a win-win situation.

For rice husk power plants, they will be constructed in areas with an abundance of rice husk from 3 crop rotations. Care will be exercised to justify the technology selection in so far as the technology will be appropriate under Bangladeshi operating conditions, and that the technology supplier will provide technical support whenever required. The completion of this document will facilitate the approval of capital financing a minimum of two grid-connected RE power plants, and serve as a template for other similar RE projects to obtain financing. TMIEC will provide approximately 72% of plant financing through buyer's or supplier's credit with the remaining 28% as equity finance from prospective entrepreneurs who are to be identified during the Project. Details of the proposed technology for the rice husk power projects in Bangladesh are provided in Annex VI.

- *Output 4.3: Operational pilot rice husk grid-connected RE plants.* GEF assistance is required to increase the likelihood of operational pilot RE plants for selected entrepreneurs who will have a minimum 28% equity stake on these projects. Pilot power plants studied under Output 4.2 need to be constructed with the oversight of project engineers to ensure that the constructed facilities meet international standards of construction and installation, to ensure compliance with best practices to maximize environmental and social benefits of the projects, and to provide the assurances that the constructed RE project will generate the designed electricity outputs and investor returns. GEF assistance will be required to:

  - Provide engineering and implementation supervision and oversight to ensure adherence to international standards during construction, equipment installation and commissioning phases of the power plant project. The oversight should also ensure that the project teams maintain good community relations during all phases of the project development as well as during operations;
  - Train and certify plant operators and supervisors in all aspects of the process technology. This will include the preparation of maintenance schedules, and training of maintenance staff. Local plant managers must also be trained in all aspects of plant management and technology processes as well as supply and value chain systems development;
  - Using the four plants as a framework, build SREDA capacity for monitoring, reporting and verification (MRV) of power generation of the RE power plants to the Ministry of Environment and Forest (MoEF) for reporting to the UNFCCC on carbon reductions generated by RE investment into Bangladesh.

  For the purposes of calculating emission reduction benefits from rice husk power plants, the Project will target the development and operationalization of four 3.0 MW rice husk power plants in Years 2, 3, 4 and 5. The Project will also develop bankable studies for an additional two 3.0 MW plants to be completed by the end of the Project. This will lead

[41] One of the primary risks of grid-connected rice husk projects is the rise in the price of rice husk. If this risk cannot be mitigated (due to a low feed-in tariff), the rice husk project may need to be converted to a captive application where local rice mill owners can use the heat or electricity for their milling operations. This, of course, is not a preferred option in that the objective is to provide grid-based renewable energy projects.

to an estimated 213,840 MWh of renewable energy delivered to the Bangladesh grid, and a direct emission reduction from the displacement of fossil fuelled power generation of 136,858 tonnes of CO_2 by the EOP and post-project direct emission reduction of 807,459 tonnes of CO_2 by 2028, 10 years after the EOP. If there are other RE grid-connected power plants opportunities other than the aforementioned rice husk power plants, the Project will support them with the approval of the Project Steering Committee.

- *Output 4.4: Bankable plans for solar or RE nano-grid installations.* CERUIU has been promoting the installation of "nano-grid" as a means to reduce the cost of SHSs by 25% per household. In a Bangladeshi context, a nano-grid is an electricity grid that connects 10 to 25 households. Cost savings are realized from the use of LEDs that will reduce the energy demand and hence, the size of solar panels or in the case of biomass, the size of engines required. The source of power for a proposed nano-grid system is likely solar but could also be rice husk, other biomass resources or a hybrid solution. One of the barriers to solar nano-grids in Bangladesh, however, is ownership and maintenance of the nano-grid. A nano-grid package proposed for GEF support consists of solar-based energy for 10 households plus an irrigation pump with inverter[42]. GEF support will be required to:
  - Identify 6 nano-grid sites for development;
  - Conducting stakeholder analysis and consultations on the willingness of the households to pay for the power supplied by the nano-grid;
  - Identification of owner and operator of the nano-grid;
  - Design and costing of the nano-grids;
  - Preparation of a document for financing of nano-grids; and
  - Closing the agreements for financing of the nano-grids.

  Preliminary design details of a solar nano-grid are provided in Annex VII.

- *Output 4.5: Functioning nano-grid installations.* The key aspect of the solar or RE nano-grid installation is the functioning of the business model that provides reliable solar or other renewable energies to households in exchange for tariffs that go towards operation of the system and debt servicing. The key person will be the owner of the nano-grid and his/her ability to sustain the nano-grid business model. GEF assistance will be required to:

  - Provide funds for the equipment sizing/specification, selection and purchase; and installation of 6 pilot nano-grids;
  - Provide oversight into the sourcing of equipment and materials for the nano-grid;
  - Provide oversight into the installation of nano-grid equipment; and,
  - Monitor nano-grid delivery of power to each household. This will include the monthly cost for operating and financing the system, the ability of the owner or operator to collect on monthly payments, the amount of kerosene or fossil fuels offset by the solar nano-grid, the willingness and ability of neighbouring households to participate in the installation of other nano-grids, the willingness of financial institutions to finance other nano-grids; and SREDA ability to undertake a role in the promotion of nano-grids.

[42] The package consists of a 1.9 kWp solar panel, 480 AH battery bank @ 12V, a 1.1 kW AC irrigation pump, a charge controller, and LEDs at a cost of less than USD 6,800 or Tk 5,50,000.

- *Output 4.6: Solar irrigation pump investments.* This output provides assistance to one of the RE development priorities of MoPEMR, and to accelerate delivery of solar irrigation pump installations. There are currently over 6 solar irrigation pump stations in Bangladesh, all of which have a capital cost that will not lead to replication of these arrangements. With a target of over 18,750 diesel-fuelled irrigation pumps by 2015, GEF assistance is required to support SREDA efforts to meet this 2015 target and beyond. Assistance will be provided in:

    - Provide assistance to MoPEMR to verify their baseline diesel energy consumption from irrigation pumping activities;
    - Clarifying business arrangements of current irrigation pumps and how this market can be transformed towards solar energy for irrigation pumping;
    - Identification of solar technologies and installation designs that are economically feasible for each shallow tubewell (STW), deep tubewell (STW) and surface water sources, and meet the irrigation needs. These technologies will also need to backed by the necessary technical support and guarantees;
    - Determination of appropriate pricing of installations;
    - Formulation of financing mechanisms that can be adopted by the current owners and users of irrigation pump facilities;
    - Preparation of implementation plans and facilitation of the solar irrigation pump investment, totalling around 2,000 pump solar pump installations by the EOP;
    - Setup and implementation of MRV functions for GHG reductions as well as energy and fuel subsidy savings.

- *Output 4.7: Replication plans for additional RE projects.* The activities to deliver the aforementioned outputs under this component should catalyze interest in the replication of additional RE investments. To deliver this output, SREDA will work closely with private entrepreneurs, community organizations and other NGOs as well as relevant government agencies to promote and support the development of these projects. GEF support will include:

    - Arrangement of circulars and printed media on the planning, design, implementation and operation of RE projects;
    - Workshops and seminars for SREDA personnel and prospective project proponents on developing replication RE projects;
    - Assisting project proponents in collaboration with SREDA personnel on the design of RE projects, arranging of RE project financing under management of SREDA (both concessional and commercial financing sources from Output 4.1), and executing financial closures on renewable energy projects. This may include assistance to BPDB who are receiving financial assistance from ADB to install 14.5 MW of renewable energy capacity within Years 1 and 2 of the Project[43].

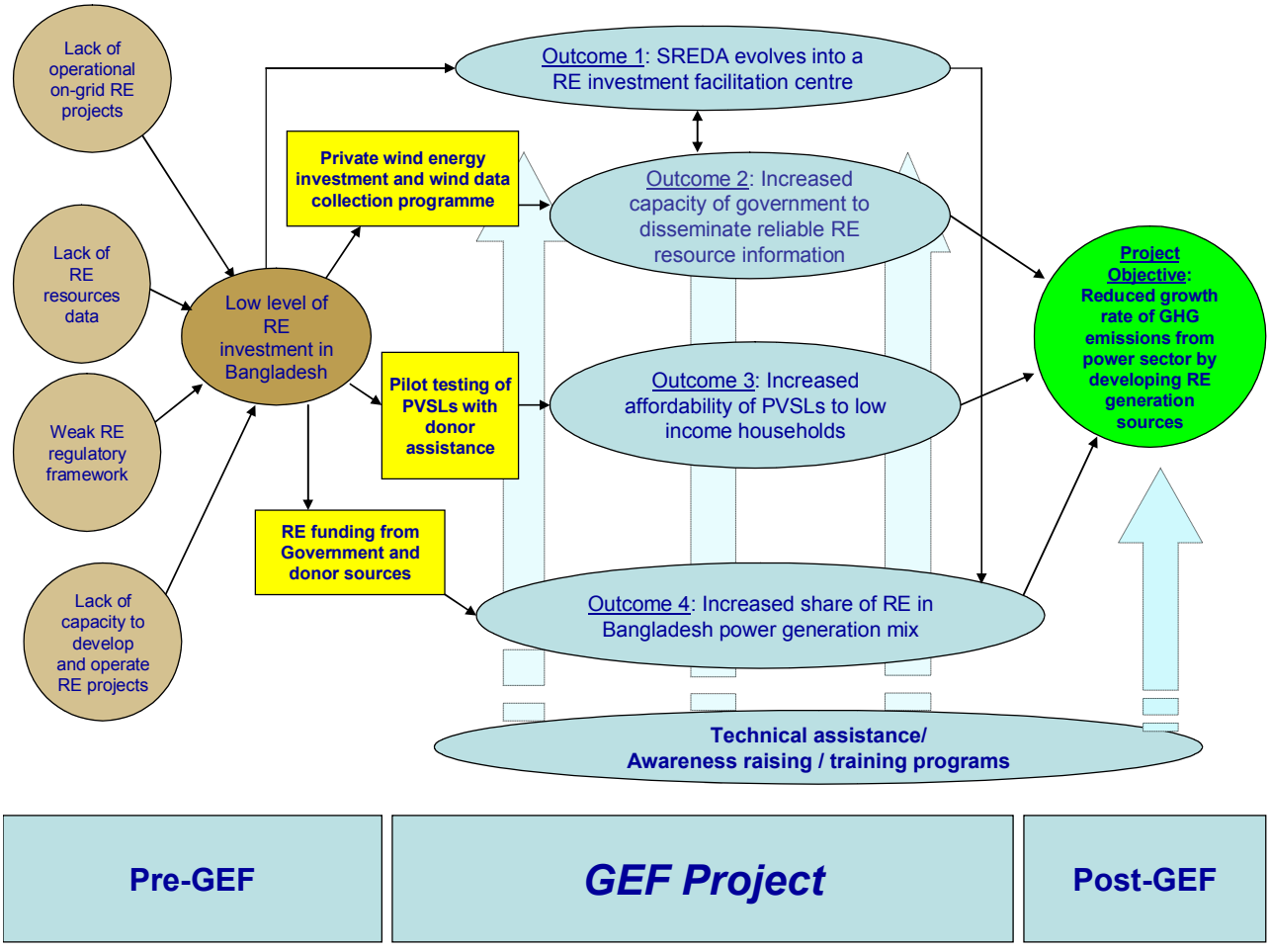
Component 4 will target the direct development of over 27.5 MW of installed RETs from rice husk power generation, solar power or RE for nano-grids and solar irrigation pumps. The development of these RE pilot projects will result in direct emission reductions of 62,000 tonnes of CO_2 emissions, and the potential for more from replicated projects in rice husk power generation, solar power or RE for nano-grids, solar irrigation pumps and other RET applications.

[43] This includes ADB-financing support for an 8.0 MW grid-connected solar plant that is a part of the 450 MW combined-cycle plant at Ashuganj, and a 6.5 MW solar-wind-diesel hybrid station at Hatia.

79. Without these planned interventions and successfully developed and implemented pilots for RET diffusion and renewable energy power generation projects, it is difficult to see how RE development can grow in Bangladesh towards its targets for 2015 and 2020. Without the GEF project, the current investment climate will not attract the required volume of independent renewable energy power producers. Without the removal of the identified barriers, the grid-connected renewable electricity market will be slow to develop, if it develops at all, and much of Bangladesh's rural population will no have access to modern energy sources. The objective of SREPGen is the reduction of the annual growth rate of GHG emissions from fossil fuel-fired power generation, and use of kerosene as a primary fuel for lighting. To contribute to the achievement of this goal, the project will create investment friendly conditions by removing a range of knowledge, policy and regulatory, institutional and financial barriers. This includes the direct development of 40 MW of power generation with RETs and to facilitate the formation of public-private partnerships for future RET development that replicate the experiences of RET development.

80. Figure 3 is a flowchart of how the Project will be implemented. Figure 4 is an indicative implementation schedule of how SREPGen will be implemented.

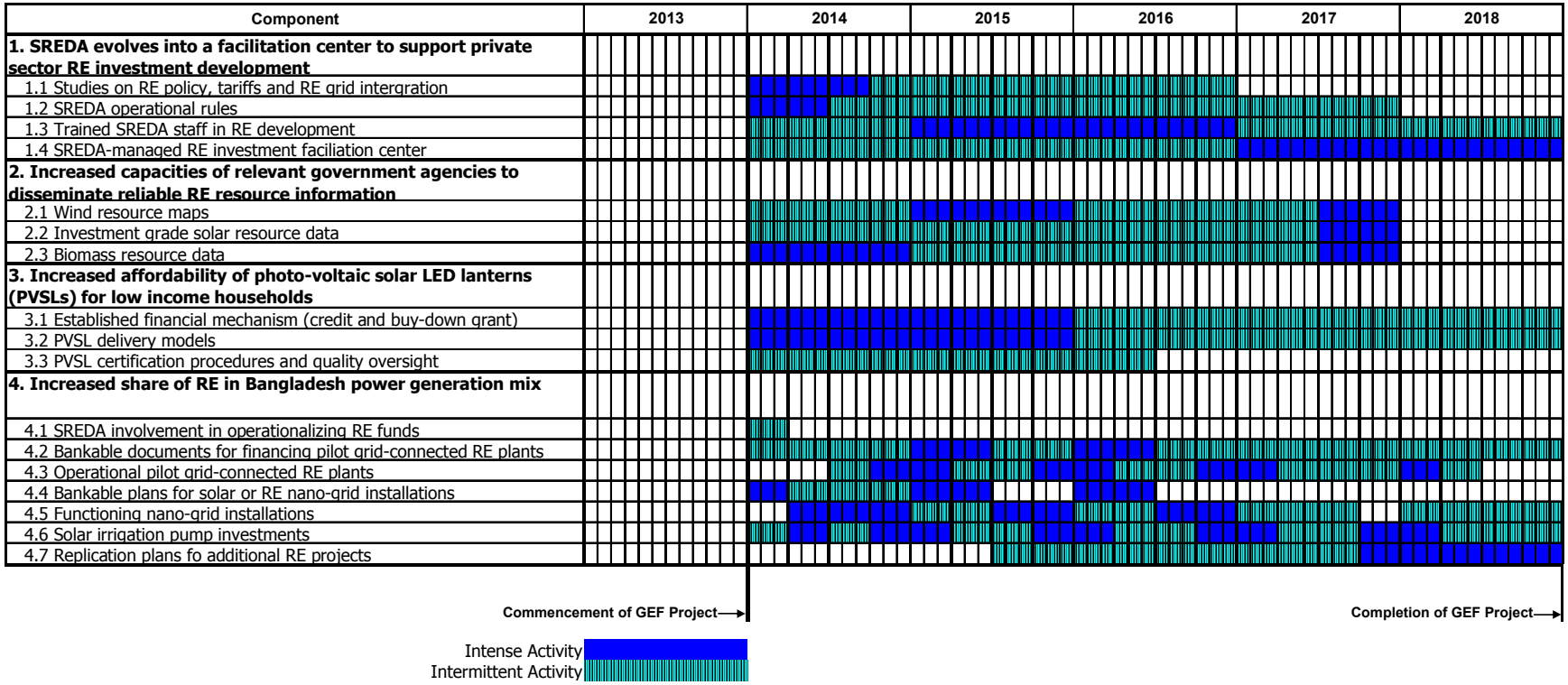
Figure 3: Project Flowchart



Legend:

Barriers
Baseline activities
GEF activities
Project objective

Figure 4: Indicative Implementation Schedule for SREPGen



Key Indicators and Risks

Indicators

81. The most direct impact of the proposed Project as it relates to core GEF objectives is the reduction in CO_2 emissions from the power sector, and from low income households. Other impact indicators to gauge the success of the Project includes:

- Number of PVSLs disseminated to low income households that can more easily access solar energy through a financial mechanism where monthly costs of kerosene are replaced by monthly costs towards payment of a PVSL. The impact of the Project through provision of a USD 15 buy-down grant will result in the initial diffusion of 133,000 PVSLs in Years 1 and 2 and cumulatively more than 420,000 PVSLs by Year 5, and a direct GHG reduction of over 68,000 tonnes CO_{2eq} from the displacement of kerosene by the EOP;
- An operational RE fund under SREDA management. The impact of this fund will be the availability of funds to finance pilot RE projects and targeted research for RETs. This will provide more confidence to potential investors of certain RE investments leading to a desired scale-up of RE investments;
- Number of operational and planned grid-connected rice husk projects. The impact of operational rice husk power plants in Bangladesh will increase the confidence of SREDA to promote more projects and to close potential investments in grid-connected biomass power projects and RE power projects in general. The impact of four operational 3.0 MW rice husk power plants during the Project will be the direct GHG reduction of over 136,900 tonnes CO_{2eq} by the EOP;
- Number of operational and planned nano-grids. The impact of 6 operational nano-grids (each connecting 10 households each to solar or other forms of renewable energy) will be the demonstrated feasibility of a sustained business model on which to provide rural households with the equivalent of a current solar home system but at a reduced cost. The Project's investment into 6 pilot nano-grids and technical assistance for another 128 nano-grids will result in a direct GHG reduction of 95 tonnes CO_{2eq} by the EOP;
- Number of solar irrigation pumps installed. The impact of Project assistance towards the installation of 2,000 solar irrigation pump facilities by the EOP will be to demonstrate a sustained financial mechanism on which local business persons, cooperatives amongst farmers, and individual farmers can implement a transformation of irrigation pumps to solar energy and assist the GoB in reducing its fuel related subsidies to the agricultural sector. This will result in direct GHG reduction of 8,200 tonnes CO_{2eq} by the EOP;
- Number of approved RE projects and offsets from imported fossil fuels. This indicator will reflect the increasing confidence of SREDA in the promotion of RE projects and of potential RE investors who will have confidence on the rates of return on their initial investments;
- Number of RE resource databases that are available on a website including wind speeds, solar data and biomass. This will enable potential RE investors to easily access RE information that can guide their RE investment decisions, and have the impact of scaling-up RE investments.

Table 5 provides a summary of the expected direct and post-project indirect GHG emissions from the Project.

Table 5: Summary of GHG Emissions from Project Interventions

Intervention Description	Detail	Tonne CO_{2eq}	
		Direct GHG Reductions[44]	Post-Project Direct GHG Reductions[45]
PVSL diffusion	133,000 PVSLs distributed in Years 1 and 2 of Project with an additional 311,000 distributed in Years 3, 4 and 5 (a total of 444,000 or an equivalent to 12.6 MW)	68,300	604,500
Grid connected rice husk power development	4 – 3.0 MW plants commissioned in Years 2, 3, and 4 (equivalent to 12 MW)	136,900	807,500
Nano-grids powered by solar panels or other sources of renewable energy	Each nano-grid supplies solar power or other forms of renewable energy to 6 households for LED lighting, fans and an irrigation pump. A total of 134 nano-grids installed by the EOP (equivalent to 0.028 MW)	100	2,500
Solar irrigation pumps	2,000 photovoltaic irrigation pumps installed by EOP (equivalent to 15.5 MW)	8,200	309,000[46]
Totals:		***213,500***	***1,723,500***

Risks

82. The overall project risk is moderate. While all possible efforts have been made in the design of SREPGen to mitigate perceived project risks, there are inevitably some unavoidable residual risks that will have to be carefully monitored and managed to ensure project success. Project risks can be categorized as external (global and policy-related) and internal (risks inherent to the Project design that could be controlled by Project management). Internal risks and recommended mitigation measures are summarized on Table 6 and provided in detail in the "Offline Risk Log" in Annex I.

83. External risks include:

- Continued or sustained levels of energy subsidies to fossil fuels and electricity prices. While the GoB is trying to reduce these subsidies, political pressure may result in the GoB being unable to reduce subsidies to the extent that the economics of renewable energy projects may not be attractive;
- Inability of Project to build the necessary institutional capacity due to Government policy of moving government officials every 3 years or less. With each change of officer, the corporate memory of the institution needs to be rebuilt resulting in a loss of time and a lack of institutional development;
- Failure to secure co-financing from potential project partners. This may result from a global shortage of capital which will impact the attainment of this Project outcome,

[44] This is the cumulative emissions reduction during the Project period.

[45] This includes cumulative emission reductions for the first 10 years after the EOP.

[46] These GHG reductions were based on Government figures on diesel usage for irrigation pumping. The Project will need to independently verify these figures to portray an accurate baseline for actual diesel usage for irrigation pumping.

namely the development and scale-up of larger grid-connected renewable energy investments in Bangladesh.

Table 6: Internal Project Risks and Mitigating Actions

Risk	Level of Risk	Mitigating Actions
Terms and conditions for replication phase are not sufficiently attractive for private investors (IPPs)	Moderate	The project will be designed to minimize the risk profile of RET projects in Bangladesh that includes more knowledge on resource availability, tariffs, intermittent generation, off-take and payment guarantees, strengthened capacity, improved resource assessment information, and improve the financial climate for RE projects. RE projects will be developed as a partnership between project proponents. The GEF project will concentrate resources and attention on the relatively modest RE projects to increase the potential for replication.
Delays due to lack of government capacity	High	The project will be designed for implementation by a nodal agency, SREDA, whose mandate is to promote renewable energy project development.
Insufficient capital made available for RE investment scale-up	Moderate	Implementation of pilot projects will demonstrate to potential RE investors that RE projects can be successfully implemented in Bangladesh, raising the confidence of financial institutions to avail capital financing through carbon funds or NAMA financing.
Returns on investment not realized due to RETs or RE projects not generating sufficient renewable energy	Moderate	The Project will provide quality control assistance to RE project and operational personnel on international standards and best practices for RE deployment that will ensure maximum power generation and return of investment, and to programmes disseminating off-grid RETs meet international quality standards, and adhere to guarantees provided by the suppliers and manufacturers.

Cost Effectiveness

84. With dwindling reserves of domestically available natural gas, Bangladesh is increasingly dependent on imported fossil fuels. This has been noticeable particularly with the increase in the number of rental power plants produced by GoB in 2011 to reduce the energy supply-demand gap. Through activities of SREPGen, Bangladesh has the potential to reduce this dependence, improve its energy security and to reduce GHG emissions through the reduced consumption of fossil fuels for power generation and as a primary fuel for household use.

85. The GoB has a Renewable Energy Policy as well as a dedicated agency, SREDA, to promote and sustain RE investments in Bangladesh. As well, it only has 78 MW of renewable energy capacity developed to date with a need for scaled-up development of RE resources to offset the rising costs of imported fossil fuels and increased costs of fuel subsidies. The SREPGen Project has been designed to remove barriers to scaled-up RE development in Bangladesh. Without this Project, the growth of RE projects in Bangladesh will be stunted without a coordinated approach through SREDA and with a lack of investor confidence into a poorly regulated RE market. Moreover, the country will be unable to meet its target of universal access to energy for all its citizens by the Year 2021.

86. The GEF contribution of USD 4,077,272 will result in a cumulative direct emission reduction of 213,500 tonnes CO_{2e} from the pilot PVSL diffusion program, the rice husk power projects,

the nano-grid systems and the solar irrigation program during the 5-year duration of SREPGen. In consideration of the service life of the Project's technologies, the direct and direct post-project emission reductions[47] will be 1.94 million tonnes CO_{2eq}. This translates into a GEF abatement cost of USD 2.10 per tonne CO_{2eq}.

87. SREPGen will also boost investor confidence and generate lessons and knowledge on effective implementation of renewable energy projects and deployment of RETs to low income households. This will catalyze RE investment and dissemination of PVSLs after the completion of the Project. As such, SREPGen will also generate indirect emission reductions resulting from:

- Well-managed pilot programs (bottom-up) that will result in the reduction of 5.7 million tonnes CO_{2eq} based on a replication factor of 3; and
- The development of a SREDA-managed RE investment facilitation center and an enabled RE investment environment (top-down) that will result in the reduction of 2.3 million tonnes CO_{2eq} based on a causality factor of 0.2.

Sustainability and Replicability

Sustainability

88. The SREPGen project is designed to ensure that RE investment conditions by the EOP are favorable to the extent that RE development in Bangladesh is sustained well after SREPGen is completed. Sustainability of this GEF project will be ensured through a stronger government agency, SREDA, that will:

- Emerge as the focal point for policy and promotional development of RE in Bangladesh;
- Have the experience of developing RE projects or disseminating RETs to low income families;
- Delegate the collection of and store renewable energy resource data for use by potential RE investors and other government agencies;
- Have an inventory of RE projects that would interest potential RE investors;
- Have streamlined procedures to approve RE projects for investment; and
- Manage RE research and development initiatives in close collaboration with academic institutes and private sector entities in Bangladesh.

Replicability

89. The pilot diffusion of PVSLs and the use of the buy-down grant mechanism will at first demonstrate that this program can deliver PVSLs that are robust and have a long service life for end users at the low income scale, and secondly, demonstrate the successful diffusion of these PVSLs to the more than 10 million off-grid and remote low income households in Bangladesh. With PVSL quality standards set by the GoB, consumer confidence will result in the replication of the diffusion model to meet the expected growing demand for quality PVSLs.

[47] Direct post-project emissions in this context refer to a 10-year GEF influence period after the EOP.

90. The pilot development of the rice husk power plants (or possibly a hybrid rice husk-solar plant if determined to be financially feasible) will provide valuable operational experience and data that will boost investor confidence that on-grid RE projects can be successfully developed in Bangladesh with adequate rates of return. With SREDA being able to provide guidance on RE development priorities and streamlined approvals of such projects, the likelihood of replication of the pilot on-grid RE projects will increase. Similar pilot demonstrations for the solar or RE nano-grids and the solar irrigation pumps will have the same approach to boost replication.

PROJECT RESULTS FRAMEWORK

Primary applicable Key Environment and Sustainable Development Key Result Area (same as that on the cover page, circle one): 1. Mainstreaming environment and energy OR 2. Catalyzing environmental finance OR 3. Promote climate change adaptation OR 4. Expanding access to environmental and energy services for the poor.
Applicable GEF Strategic Objective and Program: GEF-4 CC4 Strategic Program SP3: Increased production of renewable energy in electricity grids
Applicable GEF Expected Outcomes: Total avoided GHG emissions from on-grid RE electricity generation
Applicable GEF Outcome Indicators: Market penetration of on-grid renewable energy (% from renewables); GHG emissions from electricity generation (tons CO_{2eq}/ kWh); and $/ tons CO_{2eq}

	Indicator	Baseline	Targets End of Project	Source of verification	Assumptions
Project Objective: [48] Reduction in the annual growth rate of GHG emissions from fossil fuel-fired power generation through the exploitation of Bangladesh's renewable energy resources for power generation	▪ Cumulative direct post-project CO_2 emission reductions resulting from the RE technical assistance and investments by end-of-project (EOP), Mtons CO_2. ▪ % share of RE in the power generation mix of Bangladesh	▪ 0 ▪ 1[49]	▪ 1.64 [50] ▪ 6[51]	▪ Project final report as well as annual surveys of energy consumption & reductions for each RE project	▪ Economic growth in the country will continue ▪ Government support for RE development and utilization will not change
Outcome 1:[52] **SREDA evolves into a facilitation center to support private sector RE investment development, enable regulators to determine fair flexible tariff structures, bring confidence to private RE investors, and increase the number of approved RE projects**	• Number of on-grid RE projects approved based on studies of improved RE policy and tariffs and RE grid integration and SREDA operational rules • Number of on-grid RE projects facilitated by SREDA operational rules • Number of RE development project proponents that were	• 0 • 0 • 0	• 4 • 4 • 6	• Completed studies on RE policy/tariffs, and RE grid integration[53] • Guidebooks on SREDA operational rules that assist SREDA on developing RE power projects in Bangladesh • RE training course materials • Training evaluations by participants • SREDA project approvals	• Continued government support for SREDA • Capacity of government does not substantially delay approval of RE policies and RE projects

[48] *Objective (Atlas output) monitored quarterly ERBM and annually in APR/PIR*
[49] Based on 72 MW of installed capacity of renewable energy (see Table 1 for breakdown) against total installed capacity of 7,600 MW in 2012
[50] Over a period of 10 years from 3 RE projects constructed during a 10-year GEF influence period after the EOP, and with an assumed grid emissions factor of 0.64 tonnes CO_{2eq}/MWh.
[51] This should include all on-grid and on-grid RET applications
[52] *All outcomes monitored annually in the APR/PIR.*
[53] This will include a policy/tariff study (for RE policy to catalyze development of solar, wind and biomass projects), and a grid integration study to define operational parameters for solar, wind and biomass plants with the national high voltage grid

	Indicator	Baseline	Targets End of Project	Source of verification	Assumptions
	assisted by SREDA staff in the technical design and approval of their projects			• Annual reviews of key performance indicators of SREDA Strategic Plan	
Outcome 2: Increased capacities of relevant government agencies to generate, process, obtain and disseminate reliable RE resource information for use by GoB and potential project developers and investors	• Number of implemented wind energy projects that were designed based on the wind maps • Number of RE resource assessments and data gathering that were carried out by the private sector • Number of biomass-based power generation projects that were designed based on the biomass resource assessment data	• 0 • 1[54] • 0	• 1 • 7 • 4	• Wind map atlas for Bangladesh • Websites where data on wind speeds, solar irradiation and biomass seasonal availability (complete with geographic distribution and replenishment needs for agricultural soils) are available • Biomass resource assessments for a particular locality • Website with RE resource data that is regularly updated	• Government budgets for RE data collection are replenished on an annual basis • Sustained government perception that RE data collection is a high national priority
Outcome 3: Increased affordability of photovoltaic solar LED lanterns (PVSLs) for low income households	• Number of government-certified PVSL models that meet international standards for functionality and durability that are imported into the country • Number of low income households that are able to afford monthly payments from established and operational financial mechanisms for the purchase and use of PVSLs • Number of PVSL supply and delivery chains that also	• 1[55] • 0 • 0	• 5 • 133,000 (Yr 2) 423,000[56] • 3	• Circulars published on certification procedures for PVSLs acceptable to the program • Procedural guidelines for implementing financial mechanisms to increase sales of PVSLs amongst low income rural households • Monitoring reports on the development of PVSL supply and delivery chains • Sales reports	• Potential consumers accept quality of PVSLs sold on the program and the associated credit program

[54] Completed assessments are detailed in "Techno-Economic Analysis of Green Electricity Generation from Rice Husk", Islam, Sadrul A.K.M. and Md. Ahiduzzaman, IECTCESD March 2012, Sylhet, Bangladesh.

[55] This is developed by SOLIB Program under GIZ.

[56] This includes a total of 133,000 PVSLs distributed in Years 1 and 2.

	Indicator	Baseline	Targets End of Project	Source of verification	Assumptions
	provide product support and credit collection by Year 2 • Number of PVSL supply and delivery chains that also provide product support and credit collection by Year 2 • Number of PVSLs disseminated to rural households outside of the project by EOP	• 0 • 0	• 1 • 423,000		
Outcome 4: Renewable energy accounts for an increased share of Bangladesh's power generation mix	• Number of RE projects that are financed through RE funds where SREDA has had involvement in operationalization • MW of RE on-grid projects installed by EOP • MW of RE off-grid projects installed by EOP • % increase of RE in Bangladesh's power generation mix by EOP • MW capacity of RE generation projects (on-grid and off-grid) in planning and design stages by EOP	• 0 • 7 • 72[57] • 1.5 • 0	• 2 • 19 [58] • 100 [59] • 2.8 • 1,200[60]	• Documents on the RE fund charter and applications for RE projects • Documentation of on-grid RE project feasibility, financial viability and financial closure of RE projects involving biomass, solar, or wind • Monitoring reports on RE project construction and operations or off-grid RET diffusion • Records of power generation being transmitted to industrial, commercial or residential customers • Design documents for replication projects	• Sufficient annual replenishment of RE development funds • Capacity of government does not substantially delay approval of RE policies and RE projects

[57] Solar home systems installed capacity as reported by the Power Division of MoPEMR

[58] This includes 12 MW of installed rice husk power plants

[59] This includes 0.028 MW of nano-grids installed, 12.6 MW of PVSLs (or 421,800 PVSLs) diffused amongst low income households, and 15.5 MW or 2,000 solar irrigation pump facilities installed over a 5-year project period.

[60] This should include the MW equivalent of on-grid RE projects and captive RE projects (that are on-grid or are on mini-grids)

TOTAL BUDGET AND WORK PLAN

Award ID:	00073939	Project ID(s):	00086516
Award Title:	Development of Sustainable Renewable Energy Power Generation		
Business Unit:	BGD10		
Project Title:	Development of Sustainable Renewable Energy Power Generation		
PIMS no.	3948		
Implementing Partner (Executing Agency)	The Power Division under the Ministry of Power Energy and Mineral Resources (MOPEMR)		

GEF Outcome/Atlas Activity	Responsible Party/ Implementing Agent	Fund ID	Donor Name	Atlas Budgetary Account Code	ATLAS Budget Description	Amount (USD) Year 1 2013	Amount (USD) Year 2 2014	Amount (USD) Year 3 2015	Amount (USD) Year 4 2016	Amount (USD) Year 5 2017	Total (USD)	Notes
Outcome 1: SREDA evolves into a facilitation center to support private sector RE investment development	MOPEMR	**62000**	GEF	71200	International Consultants	6,000	6,000	6,000	6,000	6,000	30,000	Note 1
				71300	Local Consultants	17,600	28,900	20,300	11,300	14,900	93,000	Note 2
				72100	Contractual Services	50,000	100,000				150,000	Note 3
				71600	Travel	3,680	3,680	3,680	3,680	3,680	18,400	Note 4
				72200	Equipment	10,000	2,000	2,000	2,000	2,000	18,000	Note 12
				75700	Training Workshops	25,000	25,000	25,000	25,000	15,000	115,000	Note 5
					Total GEF Outcome 1	112,280	165,580	56,980	47,980	41,580	424,400	
					Total Outcome 1	**112,280**	**165,580**	**56,980**	**47,980**	**41,580**	**424,400**	
Outcome 2: Increased capacities of relevant government agencies to generate, process, obtain and disseminate reliable RE resource information	MOPEMR	**62000**	GEF	71200	International Consultants	6,000	6,000	6,000	6,000	0	24,000	Note 6
				71300	Local Consultants	9,700	9,700	7,700	7,700	0	34,800	Note 7
				72100	Contractual Services	0	0	25,000	15,000	0	40,000	Note 8
				71600	Travel	1,680	1,680	1,680	1,680		6,720	Note 9
				72300	Materials and Goods	0	0	0	0		0	
				72500	Office Supplies	0	0	0	0	0	0	
					Total GEF Outcome 2	17,380	17,380	40,380	30,380	0	105,520	
					Total Outcome 2	**17,380**	**17,380**	**40,380**	**30,380**	**0**	**105,520**	
Outcome 3: Increased	MOPEMR	**62000**	GEF	71200	International Consultants	6,000	12,000	12,000	12,000	9,000	51,000	Note10
				71300	Local Consultants	23,500	29,900	31,700	24,400	20,300	129,800	Note11

GEF Outcome/Atlas Activity	Responsible Party/ Implementing Agent	Fund ID	Donor Name	Atlas Budgetary Account Code	ATLAS Budget Description	Amount (USD) Year 1 2013	Amount (USD) Year 2 2014	Amount (USD) Year 3 2015	Amount (USD) Year 4 2016	Amount (USD) Year 5 2017	Total (USD)	Notes
affordability of PVSLs for low income families				72100	Contractual Services						0	
				71600	Travel	4,100	5,360	5,360	5,360	4,520	24,700	Note 4
				72200	Equipment	6,000	6,000	6,000	6,000	6,000	30,000	Note12
				72600	Grants	500,000	1,000,000	500,000			2,000,000	Note13
					Total GEF Outcome 3	539,600	1,053,260	555,060	47,760	39,820	2,235,500	
					Total Outcome 3	**539,600**	**1,053,260**	**555,060**	**47,760**	**39,820**	**2,235,500**	
Outcome 4: Renewable energy accounts for an increased share of Bangladesh's power generation mix	MOPEMR	**62000**	GEF	71200	International Consultants	14,000	40,000	36,000	30,000	18,000	138,000	Note14
				71300	Local Consultants	57,600	80,700	79,900	81,800	81,900	381,900	Note15
				72100	Contractual Services	45,000	86,000	60,000	88,000	50,000	329,000	Note16
				71600	Travel	22,360	39,080	39,640	37,560	32,040	170,680	Note17
				72200	Equipment	15,000	5,000	25,000	25,000	15,000	85,000	Note18
				72500	Office Supplies	5,400	2,000	2,500	2,000	2,500	14,400	
					Total GEF Outcome 4	159,360	252,780	243,040	264,360	199,440	1,118,980	
					Total Outcome 4	**159,360**	**252,780**	**243,040**	**264,360**	**199,440**	**1,118,980**	
PROJECT MANAGEMENT (including M&E)	MOPEMR	**62000**	GEF	71200	International Consultants	0	0	12,000	0	12,000	24,000	Note19
				71300	Local Consultants and Local Staff	23,000	23,000	23,000	23,000	23,000	115,000	Note20
				72400	Communications	2,500	2,000	2,000	2,000	2,000	10,500	Note 21
				72500	Office Supplies	3,000	4,000	4,000	4,000	3,372	18,372	Note 22
				72500	Travel	0	0	0	0	0	0	
				74100	Audit	5,000	5,000	5,000	5,000	5,000	25,000	
					Total GEF Project Management	33,500	34,000	46,000	34,000	45,372	192,872	
					Total Project Management	**33,500**	**34,000**	**46,000**	**34,000**	**45,372**	**192,872**	
GEF Total						**862,120**	**1,523,000**	**941,460**	**424,480**	**326,212**	**4,077,272**	
UNDP Total											**0**	
Grand Total						**862,120**	**1,523,000**	**941,460**	**424,480**	**326,212**	**4,077,272**	

Summary of Funds:

	Amount Year 1	Amount Year 2	Amount Year 3	Amount Year 4	Amount Year 5	Total
GEF	862,120	1,523,000	941,460	424,480	326,212	4,077,272
UNDP	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	5,000,000
GoB	530,000	2,330,000	1,830,000	1,830,000	14,630,000	21,150,000
GIZ	100,000	50,000	50,000	25,000	25,000	250,000
Clean Energy Alternatives	40,000	40,000	40,000	40,000	40,000	200,000
TMIEC		5,000,000	5,000,000	5,000,000	5,000,000	20,000,000
Private Investors	450,000	500,000	700,000	660,000	690,000	3,000,000
TOTAL	***2,982,120***	***10,443,000***	***9,561,460***	***8,979,480***	***21,711,212***	***53,677,272***

Notes:

1. This includes professional time for the Chief Technical Advisor (CTA) (@USD 3,000/week) being in Bangladesh 2 weeks per year on this component
2. This includes professional time for the National Project Manager (NPM) @USD 900/week for a total of 45 weeks, the Capacity Building Advisor (CBA) @ USD 800/week for a total of 60 weeks, and the M&E Officer (M&E) @USD 450/week for a total of 10 weeks
3. This includes USD 100,000 for study on FITs and incentives to catalyze RE development, and USD 50,000 for grid integration study with RE projects
4. This includes per diems and air travel for international consultants
5. Cost of capacity building workshops over the 60-month period of the Project with 5 workshops conducted each year on various RE topics
6. This includes professional time for the CTA (@USD 3,000/week) being in Bangladesh 2 weeks per year for Years 1 to 4
7. This includes professional time for the NPM @USD 900/week for a total of 12 weeks, the CBA @ USD 800/week for a total of 12 weeks, and the M&E @USD 450/week for a total of 8 weeks
8. This includes USD 40,000 for local IT firm to integrate RE resource info onto secure government website
9. Only includes per diems for international consultants
10. This includes professional time for the CTA (@USD 3,000/week) for a total of 17 weeks from Years 1 to 5
11. This includes professional time for the NPM @USD 900/week for a total of 78 weeks, the CBA @ USD 800/week for a total of 26 weeks, the Financial Expert (FE) @ USD 800/week for a total of 26 weeks, and the M&E @USD 450/week for a total of 40 weeks
12. Purchase of field testing equipment for PVSLs
13. These are for buy-down grants to catalyze the PVSL market for Years 1 and 2. Grants are paid after the PVSLs are disseminated
14. This includes professional time for the CTA @USD 3,000/week for a total of 30 weeks from Years 1 to 5, and an International Finance Specialist (IFS) @ USD 4,000/week for a total of 12 weeks from Years 1 to 4. IFS will focus on TA for Output 4.1, while the CTA focuses 80% of time on coordinating and supervising investment Outputs 4.2 to 4.7.
15. Activities under output 4.2 will be outsourced to an experienced firm who will prepare location reports, carry out detailed surveys of husk availability at the proposed 4 sites, develop cost-effective strategies for boiler replacements/retrofits, and develop agreements to ensure the supply of rice husk from the selected clusters and milling plants. The contractors will also assist in the identification and selection through appropriate methods of the equity sponsors. Under this budget line, approximately 90% of the funds under this budget line shall be used for this purpose with the balance of 10% to be used for developing and supervising RE hybrid and nano-grid investments. FE will focus on TA for Output 4.1; the NPM and M&E will spend more than 80% of their time assisting in the oversight of the development of RE investments (Outputs 4.2 to 4.7); the CS and LCA will provide more than 80% of their time towards the development of the investments for rice husk power plants and associated hybrid RE options on Output 4.2 and 4.4; the PE will devote more than 80% of his/her time on developing, supervising implementation and oversight for rice husk power plant investments (Outputs 4.2, 4.3) and RE hybrid nano-grid investments (Outputs 4.4, 4.5). SREDA and the PMU should also consider outsourcing this expertise to local or foreign companies if the appropriate companies with the required expertise can be found.

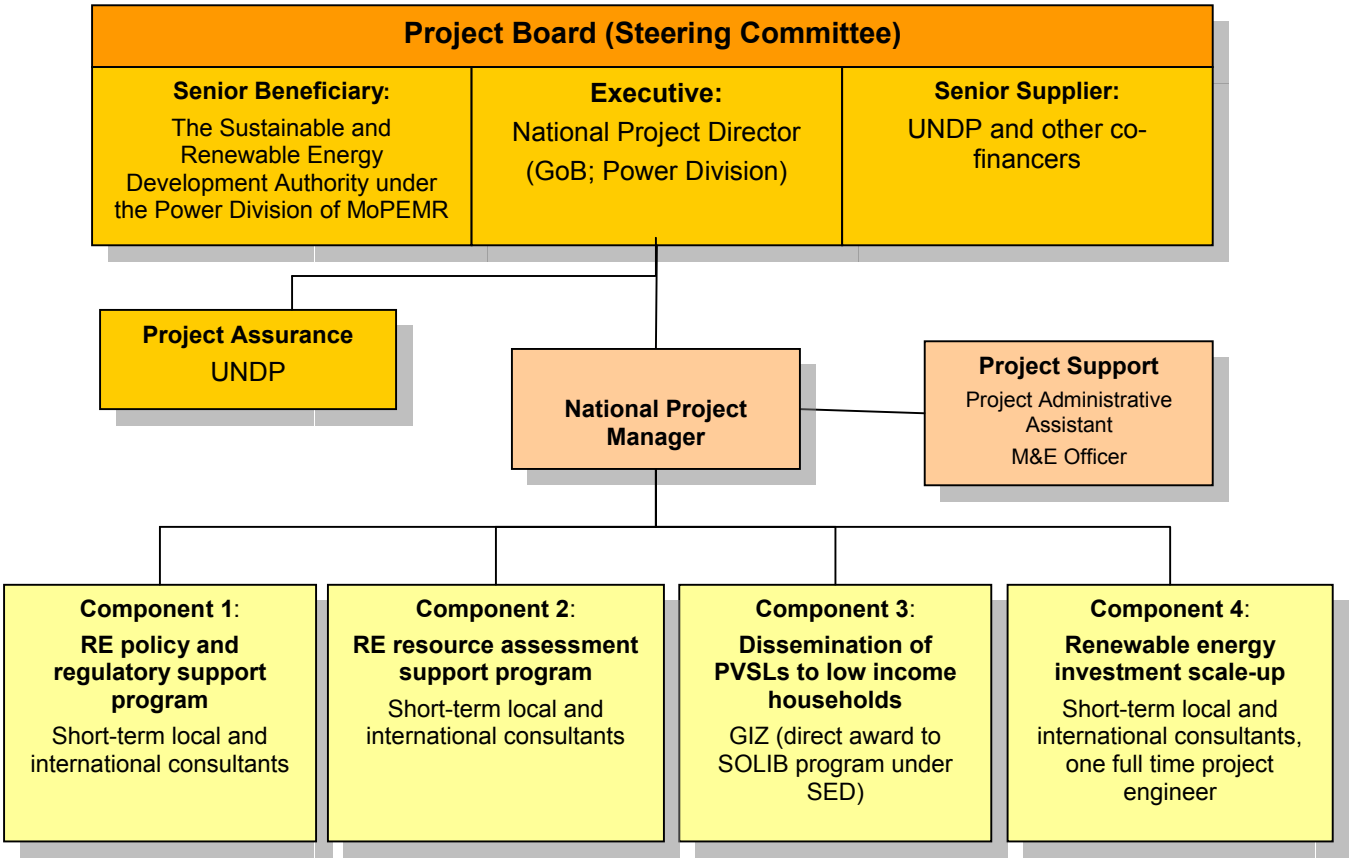
16. Details of this cost includes $35,000 for each bankable study for rice husk plant (yrs 2, 3 and 4, output 4,2), $100,000 outsourced assistance for training operators, maintenance staff and supervisors (Yrs 2 to 5, Output 4.3), $20,000 for nano-grid bankable feasibility study (Yr. 1, Output 4.4), $50,000 for consultant study for technology and site identifications for solar irrigation pump installations (Yrs 1 and 2, Output 4.6), $50,000 outsourced assistance to prepare listing of SREDA-priority RE projects and SREDA brochures on their RE support program (Yrs 4 and 5. Output 4.7). Activities under output 4.3 will be outsourced to the firms selected under Note 15. The firm shall have experience in rice husk based power plants and specialized in activities detailed in the body of this document.
17. Travel budget for project staff to remote investment sites around Bangladesh that includes vehicle travel, public transport, and accommodation.
18. Years: 1, 2, 3 and 4: USD 15,000, 5,000, 10,000, and 10,000 for office equipment and computers respectively to support TA for SREDA; Years 2, 3 and 4: USD 15,000 each year towards procurement of equipment for 6 nano-grid investments at $7,500 for each grid
19. International consultant for mid-term and terminal evaluations of the Project @USD 3,000/week for a total of 8 weeks during Years 3 and 5
20. This includes professional time for all PMU staff including the NPM @USD 900/week for a total of 20 weeks, the M&E @USD 450/week for a total of 100 weeks, and the Administrative Assistant (AA) @ USD 200/week for a total of 260 weeks or full time throughout the Project
21. For cell communications by PMU and project team with other stakeholders on field activities
22. Office stationary and supplies

MANAGEMENT ARRANGEMENTS

Project Organization Structure

91. The project will be implmented according to UNDP's National Implementation Modality (NIM), as per the NIM project management implementation guidelines agreed by UNDP and the Government of Bangladesh. The project is co-financed with funding from the GEF and UNDP acts as the *GEF Executing Agency*. Components 1, 2 and 4 of the Project will be implemented by the Power Division of MoEPMR, who will assume the overall responsibility for the achievement of Project results as the *Implementing Partner (GEF Local Executing Agency).* The Power Division will designate a senior official as the *National Project Director (NPD)* for the Project. The NPD will be responsible for overall guidance to project management (for all components), including adherence to the Annual Work Plan (AWP) and achievement of planned results as outlined in the ProDoc, and for the use of UNDP funds through effective management and well established project review and oversight mechanisms. The NPD also will ensure coordination with various ministries and agencies provide guidance to the Project team to coordinate with UNDP, review reports and manage administrative arrangements as required by the Government of Bangladesh and UNDP. This would include the contribution of office space within the premises of SREDA to full-time personnel of the Project Management Unit (PMU). The PMU will be headed by National Project Manager (NPM).

Figure 3: Project Organization Structure



92. SREPGen has been designed as an umbrella project which includes capacity building of its *Implementing Entity*, SREDA. Component 3 can be viewed as building upon and providing support to the existing SOLIB program which has already addressed a number of implementation issues[61]. As such, Component 3 will have to be outsourced and executed in the same manner as SOLIB under GIZ-SED. SED has been involved along with UNDP in promoting SREDA from 2005 and is an approved partner of the Power Division. SED has modelled the SOLIB program as a private sector undertaking with NGOs and retailers as the key PVSL distribution outlets with a PMU to co-ordinate the different activities and monitor the program. Evaluation and oversight will be the responsibility of SREDA and the Project Board.

93. UNDP will provide overall management and guidance from its Country Office (CO) in Dhaka and the Asia Pacific Regional Centre (APRC) in Bangkok, and will be responsible for monitoring and evaluation of the project as per normal GEF and UNDP requirements. The PMU under the CO will manage the day-to-day activities of the Project under the guidance of the NPD. The PMU will have four full-time personnel: Project Manager, M&E Officer, an Engineer and an Administrative Assistant Draft. Terms of reference (ToRs) for these PMU staff are contained in Annex IV.

General

Collaborative Arrangements with Related Projects

94. The proposed Project will have collaborative arrangements with a number of other donor initiatives that support renewable energy, described as follows:

- The GIZ-funded Sustainable Energy for Development (SED) Project which has provided soft assistance to the MoPEMR with the establishment of SREDA, various energy efficiency programs including EE for parboiling rice, identification of gasification technologies for rice husk, sourcing and testing of PVSL models appropriate for Bangladesh, and a small pilot PVSL diffusion program. The proposed Project will work closely with SED on Output 3.1 to provide initial buy-down grants required by SOLIB to catalyze PVSL sales to low income rural households, on Output 3.2 to augment SOLIB designs to improving efficiencies of the diffusion of PVSLs to low-income households on a larger scale, and on Output 3.3 to augment PVSL certification procedures and quality oversight of the diffusion activities;
- The UNDP-funded project on “Low Emission Green Development” which will support activities that encourage investment and development of technologies that reduce GHG emissions. Exact activities will be determined during the course of SREPGen.

95. This proposed project will establish the necessary communication and coordination mechanisms through its PMU and PSC with the Project Management Board to ensure proper coordination between the various projects. UNDP Bangladesh will also take the lead in ensuring adequate coordination and exchange of experiences. In addition, the project will seek to coordinate its actions with other UNDP energy and climate change activities in Bangladesh. Similarities in the strategy of the proposed project may extend an opportunity

[61] PVSL quality and distribution issues include quality assurance, distribution modality, import mechanism, import duties and surcharges, how and where the grants will be applied, how PVSLs are priced, and importantly, the refinancing regime.

to share lessons and exploit synergies, in particular in the areas of harmonization and mutual recognition. Also, the proposed project will also seek to coordinate actions with other existing government commitments and non-government initiatives.

96. The Power Division will ensure that the activities on SREPGen are properly coordinated with the other activities under which SREDA or the Power Division and its subordinate agencies are undertaking or promoting, such as solar farms or hybrid wind-solar plants for power generation under BPDB, as well as linking with incentive programs of MoPEMR.

97. The Power Division will ensure co-finance and cooperation from its other programs, some of which are funded by other donor agencies. Co-financing details are provided on Table 7.

Table 7: Co-Financing Details

Co-Financer	Amount (USD)	General Description of Co-Financed Activities
UNDP	5,000,000	• Parallel co-financing of low emission green development. Exact activities to be co-financed to be determined during the Project
Government of Bangladesh	150,000 20,000,000 1,000,000	• In-kind assistance, office space at SREDA office as a contribution to Project Management • Access to the "Green" Renewable Energy Fund from Output 4.1 • Waiving of VAT, duties and other levies for imported parts, batteries and LED lights related to PVSLs. This will contribute to the financing mechanism that will increase low income household access to PVSLs under Output 3.1
GIZ (through SED)	250,000	• Scale-up of PVSL diffusion on SOLIB that will contribute to Output 3.1 • Development of initial PVSL certification procedures that will contribute to Output 3.3 • Scale-up of energy efficient parboiling technology that will increase availability of rice husk for power generation. This programme will contribute to the Project's Output 2.3: Biomass resource data • Provide policy support to promote and develop renewable energy and energy efficiency activities
Private Sector Investors	200,000 20,000,000 3,000,000	• In-kind support from Tianjin Machinery Import and Export Company and Clean Energy Alternatives for identification of appropriate technology and entrepreneurs to manage and operate rice husk power plants as a contribution to Outputs 4.2 and 4.3 • Supplier's or buyer's credit from TMIEC as a contribution to building an operational rice husk power plant in Output 4.2 • Low income household equity for 421,822 PVSLs sold during the Project period through down-payment of $7.14 for each PVSL as a contribution to Output 3.1
Total:	**49,600,000**	

98. GoB is in the process of implementing the existing "Renewable Energy Policy" to create a more investor friendly environment, creating an "Energy Conservation Act", and gearing MoPEMR towards a more focused approach to application of RETs. Development partners (i.e. UNDP, World Bank, ADB, GIZ and USAID) are involved with these activities. ADB and GIZ are linked with this proposed project as a co-financer and will be working with the project

team to ensure that the components funded by each organization fit into the overall strategy. All donors active in RE power generation will be invited62 to participate in the Project Board.

99. On solar irrigation pumps and solar mini-grids, SREPGen will coordinate closely with the Power Division and IDCOL to identify gaps that GEF can fill. IDCOL will also be an important partner in the financing of biomass power plants, along with the private sector.

Prior Obligations and Prerequisites

100. There are no prior obligations and prerequisites.

Audit Arrangements

101. The Government will provide the UNDP Resident Representative with certified periodic financial statements, and with an annual audit of the financial statements relating to the status of UNDP (including GEF) funds according to the established procedures set out in the programming and finance manuals. The audit will be conducted by the legally recognized auditor of the Government, or by a commercial auditor engaged by the Government.

Agreement on Intellectual Property Rights and Use of Logo on Project Deliverables

102. To accord proper acknowledgement to GEF for providing funding, a GEF logo should appear on all relevant GEF-supported project publications, including among others, project hardware, if any, purchased with GEF funds. Any citation on publications regarding projects funded by GEF should also accord proper acknowledgement to GEF. Alongside GEF and UNDP logo, a SREDA/MoPEMR logo may also be featured as the Implementing Partner of the proposed project.

MONITORING FRAMEWORK AND EVALUATION

103. The project team and the UNDP Office in Dhaka supported by the UNDP-GEF Regional Coordination Unit in Bangkok will be responsible for project monitoring and evaluation conducted in accordance with established UNDP and GEF procedures. The Project Results Framework provides performance and impact indicators for project implementation along with their corresponding means of verification. The GEF CC Tracking Tool will also be used to monitor progress in reducing GHG emissions. The M&E plan includes: inception workshop and report, project implementation reviews, quarterly and annual review reports, independent mid-term evaluation, and independent final evaluation. The following sections outline the principle components of the Monitoring and Evaluation Plan and indicative cost estimates related to M&E activities. The M&E budget is provided on Table 8.

Table 8: M&E Work Plan and Budget

[62] Amongst donors actively involved in promoting RE power projects, resources should be coordinated as effectively as possible. To the extent that this GEF project can facilitate cooperation and dissemination of lessons learned to all active donors, this increases the probability that share of RE in power generation will increase rapidly and the Governments ambitious goals will be achieved. Including these donors in the steering committee will encourage better cooperation and information sharing.

Type of M&E activity	Responsible Parties	Budget US$ *Excluding project team staff time*	Time Frame
Inception Workshop and Report	▪ Project Manager ▪ UNDP CO, UNDP GEF	Indicative cost: 5,000	Within first four months of project start up
Measurement of Means of Verification of project results.	▪ UNDP GEF RTA/Project Manager will oversee the hiring of specific studies and institutions, and delegate responsibilities to relevant team members.	To be finalized in Inception Phase and Workshop.	Start, mid and end of project (during evaluation cycle) and annually when required.
Measurement of Means of Verification for Project Progress on *output and implementation*	▪ Oversight by CTA with support from the Project Manager ▪ Project team	To be determined as part of the Annual Work Plan's preparation.	Annually prior to ARR/PIR and to the definition of annual work plans
ARR/PIR	▪ Project manager and team ▪ UNDP CO ▪ UNDP RTA ▪ UNDP EEG	Indicative cost: 5,000 for the first year for the completion and update of the GEF CCM Tracking Tool	Annually by July
Project Board meetings	Project Manager	7,000 x 5 years	Following IW and annually thereafter.
Periodic status/ progress reports	▪ Project manager and team	None	Quarterly
Mid-term Evaluation	▪ Project manager and team ▪ UNDP CO ▪ UNDP RCU ▪ External Consultants (i.e. evaluation team)	Indicative cost: 15,000	At the mid-point of project implementation.
Final Evaluation	▪ Project manager and team, ▪ UNDP CO ▪ UNDP RCU ▪ External Consultants (i.e. evaluation team)	Indicative cost : 18,000	At least three months before the end of project implementation
Project Terminal Report	▪ Project manager and team ▪ UNDP CO ▪ local consultant	0	At least three months before the end of the project
Audit	▪ UNDP CO ▪ Project manager and team	Indicative cost per year: 5,000 x 5 years	Yearly
Visits to field sites (UNDP staff travel costs to be charged to IA fees)	▪ UNDP CO ▪ UNDP RCU (as appropriate) ▪ Government representatives	5,000 x 5 years	Yearly
TOTAL indicative COST Excluding project team staff time and UNDP staff and travel expenses		130,000 (+/- 5% of total budget)	

104. Project start: A Project Inception Workshop will be held within the first 4 months of the project starting with those with assigned roles in the project organization structure, UNDP country office and where appropriate/feasible regional technical policy and program advisors as well as other stakeholders will be invited. The Inception Workshop is crucial to building ownership for the project results and to plan the first year annual work plan. The Inception Workshop would address a number of key issues including:

a) Assisting all partners to fully understand and take ownership of the project;

b) Detailing the roles, support services and complementary responsibilities of UNDP CO and RCU staff vis-à-vis the project team;
c) Discussing the roles, functions, and responsibilities within the Project's decision-making structure including reporting and communication lines, and conflict resolution mechanisms. The Terms of Reference of project staff will be discussed again as required;
d) Finalization of the first annual work plan based on the project results framework and the relevant GEF Tracking Tool if appropriate. A review and agreement on the indicators, targets and their means of verification will be required as well as a re-check of assumptions and risks;
e) Providing a detailed overview and reach consensus on reporting, monitoring and evaluation (M&E) requirements, the M&E work plan and budget;
f) Discussion of financial reporting procedures and obligations, and arrangements for annual audit;
g) Planning and scheduling Project Board meetings;
h) Clarification of roles and responsibilities of all project organisation structures as well as planned dates of meetings where the first PSC meeting should be held within the first 12 months following the inception workshop.

105. An Inception Workshop report is a key reference document and must be prepared and shared with participants to formalize various agreements and plans decided during the meeting.

106. Quarterly Progress Report: Contents of the QPR include:
- Progress made as reported in the Standard Progress Report (SPR) and monitored in the UNDP Enhanced Results Based Managment Platform;
- Based on the initial risk analysis submitted, the risk log shall be regularly updated in ATLAS (if applicable otherwise outside ATLAS). Risks become critical when the impact and probability are high;
- Project Progress Reports (PPR) as generated in the Executive Snapshot and based on the information recorded in Atlas;
- Other ATLAS logs that are used to monitor issues and lessons learned. The use of these functions is a key indicator in the UNDP Executive Balanced Scorecard.

107. *Annual Project Review /Project Implementation Reports (APR/PIR)*: APRs/PIRs are key reports prepared to monitor progress since project start and in particular for the previous reporting period (30 June to 1 July). The APR/PIR combines both UNDP and GEF reporting requirements, and includes, but is not limited to, reporting on the following:

- Progress made toward project objective and project outcomes, each with indicators, baseline data and end-of-project targets (cumulative);
- Project outputs delivered per project outcome (annual);
- Lesson learned/good practice;
- AWP and other expenditure reports;
- Risk and adaptive management;
- ATLAS QPR;
- Portfolio level indicators (i.e. GEF focal area tracking tools) that are used by most focal areas on an annual basis.

108. Periodic Monitoring through site visits: UNDP CO and the UNDP RCU staff will conduct visits to project sites based on the agreed schedule in the project's Inception

Report/Annual Work Plan to assess first hand project progress. Other members of the Project Board may also join these visits. A Field Visit Report/BTOR will be prepared by the CO and UNDP RCU and will be circulated no less than one month after the visit to the project team and Project Board members.

109. Mid-term of project cycle: The project will undergo an independent Mid-Term Evaluation at the mid-point of project implementation. The Mid-Term Evaluation will determine progress being made toward the achievement of outcomes and will identify course correction if needed. It will focus on the effectiveness, efficiency and timeliness of project implementation; will highlight issues requiring decisions and actions; and will present initial lessons learned about project design, implementation and management. Findings of this review will be incorporated as recommendations for enhanced implementation during the final half of the project's term. The organization, terms of reference and timing of the mid-term evaluation will be decided after consultation between the parties to the project document. The Terms of Reference for this Mid-term evaluation will be prepared by the UNDP CO based on guidance from the Regional Coordinating Unit and UNDP-GEF. The management response and the evaluation will be uploaded to UNDP corporate systems, in particular the UNDP Evaluation Office Evaluation Resource Center (ERC). The relevant GEF Focal Area Tracking Tools will also be completed during the mid-term evaluation cycle.

110. End of Project: An independent Final/Terminal Evaluation will take place three months prior to the final Project Board meeting and will be undertaken in accordance with UNDP and GEF guidance. The final evaluation will focus on the delivery of the project's results as initially planned (and as corrected after the mid-term evaluation, if any such correction took place). The final evaluation will look at impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental benefits/goals. The Terms of Reference for this evaluation will be prepared by the UNDP CO based on guidance from the Regional Coordinating Unit and UNDP-GEF.

111. The Final Evaluation should also provide recommendations for follow-up activities and requires a management response which should be uploaded to PIMS and to the UNDP Evaluation Office Evaluation Resource Center (ERC). The relevant GEF Focal Area Tracking Tools will also be completed during the final evaluation. During the last three months, the project team will prepare the Project Terminal Report. This comprehensive report will summarize the results achieved (objectives, outcomes, outputs), lessons learned, problems met and areas where results may not have been achieved. It will also lay out recommendations for any further steps that may need to be taken to ensure sustainability and replicability of the project's results.

112. Learning and knowledge sharing: Results from the project will be disseminated within and beyond the project intervention zone through a number of existing information sharing networks and forums. In addition:

- The project will participate, as relevant and appropriate, in UNDP/GEF sponsored networks, organized for senior personnel working on projects that share common characteristics;
- The project will identify and participate, as relevant and appropriate, in scientific, policy-based and/or any other networks, which may be of benefit to project implementation though lessons learned

113. The project will identify, analyze, and share lessons learned that might be beneficial in the design and implementation of similar future projects. Identifying and analyzing lessons learned is an on-going process and the need to communicate such lessons as one of the project's central contributions is a requirement to be delivered not less frequently than once every 12 months. UNDP/GEF shall provide a format and assist the project team in categorizing, documenting and reporting the lessons learned. To this end a percentage of project resources will also need to be allocated for these activities.

LEGAL CONTEXT

114. This Project Document shall be the instrument referred to as such in Article I of the Standard Basic Assistance Agreement between the Government of Bangladesh and the United Nations Development Program, signed by the parties on 17 November 1993. The host country-implementing agency shall, for the purpose of the Standard Basic Assistance Agreement, refer to the government co-operating agency described in that Agreement.

115. Consistent with the Article III of the SBAA, the responsibility for the safety and security of the implementing partner and its personnel and property, and of UNDP's property in the implementing partner's custody, rests with the implementing partner. The implementing partner shall:

- Put in place an appropriate security plan and maintain the security plan, taking into account the security situation in the country where the project is being carried;
- Assume all risks and liabilities related to the implementing partner's security, and the full implementation of the security plan.

116. UNDP reserves the right to verify whether such a plan is in place, and to suggest modifications to the plan when necessary. Failure to maintain and implement an appropriate security plan as required hereunder shall be deemed a breach of this agreement.

117. The implementing partner agrees to undertake all reasonable efforts to ensure that none of the UNDP funds received pursuant to the Project Document are used to provide support to individuals or entities associated with terrorism and that the recipients of any amounts provided by UNDP hereunder do not appear on the list maintained by the Security Council Committee established pursuant to resolution 1267 (1999). The list can be accessed via: http://www.un.org/Docs/sc/committees/1267/1267ListEng.htm. This provision must be included in all sub-contracts or sub-agreements entered into under this Project Document.

ANNEXURES

Annex I: Risk Analysis

OFFLINE RISK LOG

Project Title: Development of Sustainable Renewable Energy Power Generation (SREPGen)	**Project ID:**	**Date:**

#	Description	Date Identified	Type	Impact & Probability	Countermeasures / Management Response	Owner	Submitted, updated by	Last Update	Status (compared with previous evaluation)
1	Terms and conditions for replication phase are not sufficiently attractive for private investors (IPPs)		Political	P = 1 I = 5	The project will be designed to minimize the risk profile of RET projects in Bangladesh. Elements that may influence risk to the investor as well as to the utility (the buyer) will be minimized because issues related to resource availability, tariffs, intermittent generation, off-take and payment guarantees will be adequately addressed through the components of the project that strengthen capacity, improve resource assessment information, support improvements in the policy and regulatory environment and improve the financial climate for RE projects. The success of these activities in mitigating risk factors will be highlighted through the experiences that will be drawn from the successful completion of RE projects. Project activities will be implemented in partnership between the party investing in the project and the government so that both perspectives, that of the potential private investors and the government will be reflected in the final policy	Project manager	Submitted by Project Proponent, updated by Project Manager		

#	Description	Date Identified	Type	Impact & Probability	Countermeasures / Management Response	Owner	Submitted, updated by	Last Update	Status (compared with previous evaluation)
					documents. The GEF project will concentrate resources and attention on the relatively modest RE projects to increase the potential for replication.				
2	Delays due to lack of government capacity		Political	P = 4 I = 5	The project will be designed for implementation by a nodal agency, SREDA, whose mandate is to develop renewable energy projects.	Project manager	Submitted by Project Proponent, updated by Project Manager		
3	Insufficient capital made available for RE investment scale-up		Financial	P = 3 I = 4	As a part of the technical assistance and capacity building, this risk will be mitigated through the implementation of pilot projects that will demonstrate to potential RE investors that RE projects can be successfully implemented in Bangladesh. This will raise the confidence of financial institutions that are more likely to avail capital financing through carbon funds or NAMA financing.	Project manager	Submitted by Project Proponent, updated by Project Manager		
4	Returns on investment not realized due to RETs or RE projects not generating sufficient renewable energy		Technical	P = 3 I = 5	Quality control is a central part of the Project where international standards and best practices for RE deployment are provided to Project personnel to ensure maximum power generation and return of investment. The Project will also support close supervision and coordination of RE managers and operational personnel to ensure all RE equipment meets specifications,	Project manager	Submitted by Project Proponent, updated by Project Manager		

#	Description	Date Identified	Type	Impact & Probability	Countermeasures / Management Response	Owner	Submitted, updated by	Last Update	Status (compared with previous evaluation)
					and operational personnel adhere to best operational practices. The Project will also support quality control of off-grid RETs to ensure the adequacy of technical support of RETs distributed in off-grid areas, and to adhere to guarantees provided by the suppliers and manufacturers.				
5	The project proposes to support four RE technologies that each have associated climate risks and mitigative impacts were identified: • *PVSLs to be used by low income households*. No potential major risks to the functionality of these appliances has been identified other than decreased availability of solar inputs to the PVSLs. • *Rice husk power plants in the northwest regions of Bangladesh.* These plants may be exposed to feedstock shortages from an increase in flood		Technical	P=3 I=1 for all technologies except rice husk power plants (P=4, I=4)	Countermeasures for each of these technologies includes: • *PVSLs to be used by low income households*. The solar panels on the PVSLs selected on the Project, will be able to charge the batteries even on cloudy days and the batteries will supply light for several days depending on the number of hours the appliance is utilized each day; • *Rice husk power plants in the northwest regions of Bangladesh.* The Project will ensure proper rice availability studies are conducted to ensure power plants are sized according to rice husk availability at a particular location is guaranteed 9 out of 10 years. Plant operations will managed so that there is a 3-day supply of feedstock in the event of a flood that prevents transport of rice husk to a plant;	Project manager	Submitted by Project Proponent, updated by Project Manager		

#	Description	Date Identified	Type	Impact & Probability	Countermeasures / Management Response	Owner	Submitted, updated by	Last Update	Status (compared with previous evaluation)
	frequencies (drought risk is thought to be minimal due to the abundance of irrigation water in these areas); • *Solar nano-grids that service more than 10 households:* No potential major risks to the functionality of solar nano-grids other than decreased availability of solar inputs to the panels. • *Solar irrigation pumps:* One potential major climate-related risk would be the flooding of the areas where solar panels are located, if there is increased severity of flooding in Bangladesh as a climate change impact.				• *Solar nano-grids that service more than 10 households:* Similar to the PVSLs, the solar panels for nano-grids selected for the Project, will be able to charge the batteries even on cloudy days and the batteries will supply light for several days depending on the number of hours the appliance is utilized each day; • *Solar irrigation pumps:* The solar panel area will need to be flood-proofed by placing the solar panels in an elevated area higher than the design flood levels.				

Submitted by Project Manager _____ Approved by UNDP Programme Analyst _____

Annex II: Detailed CO_2 Calculations and Assumptions

A. Direct Emission Reductions

There are four RE activities that will lead to direct emission reductions during the proposed 5-year duration of SREPGen include:

- The diffusion of PVSLs (Output 3.2). Initially, GEF funds will be used to provide a buy-down grant of USD 15 for an initial distribution of 133,000 PVSLs over Years 1 and 2 of the Project. With the GIZ-supported SOLIB program having already screened and selected the best PVSLs for the market, the likelihood of replication sales of PVSLs will increase in Years 3, 4 and 5. Revenue from the sales of the PVSLs from Years 1 and 2 can be revolved into procurement of PVSLs supplies for Years 3, 4 and 5. This can result in the cumulative sales of more than 420,000 PVSLs by the EOP, and a cumulative emission reduction of 68,277 tonnes CO_{2eq} by the EOP. This is illustrated in Table II-1;
- The commissioning of 4 - 3.0 MW rice husk power plants in Years 2, 3, 4 and 5 (Output 4.3). This will lead to the generation of renewable energy and GHG reductions from fossil fuels used for electricity generation to the national grid by 136,900 tonnes CO_{2eq} over the 5-year duration of SREPGen, assuming a grid emissions factor of 0.64 tonnes CO_{2eq}/MWh. This is illustrated on Table II-2;
- The financing and installation of 6 nano-grids in Years 2, 3 and 4 (Output 4.5). This will lead to the interest and further sales of nano-grids into rural areas of Bangladesh, and a forecast of another 128 nano-grid installations by the EOP resulting from direct technical assistance from the Project. A cumulative direct emission reduction from 134 nano-grids (equivalent to displacing a monthly household kerosene consumption of 2.6 liters/month) will be 95 tonnes CO_{2eq} by the EOP. This is illustrated in Table II-3;
- The technical assistance for the identification, procurement and installation of over 2,000 solar irrigation pumps to displace diesel fueled irrigation pumps (Output 4.6). Cumulative emission reductions of 8,157 tonnes CO_{2eq} at the EOP are based on the assumption that the program will be successful in the installation of 20 pump sites by Year 1, 80 by Year 2, 300 by Year 3, 600 by Year 4 and 1,000 by Year 5. This is illustrated in Table II-4;

B. Direct Post-Project Emission Reductions

Direct emission reductions will also generate emission reductions after the Project from technical and financial assistance activities, and the generation of ERs during the service life of the direct investments of the Project after the EOP. Post-project direct emissions were rationalized as follows:

- The financing of PVSLs under Output 3.2 will continue to revolve indefinitely from the initial PVSL diffusion of 133,000 in Years 1 and 2. Assuming a 7-year service life of each PVSL with a 3% failure rate each year (due to misuse or lack of replacement). This is illustrated on Table II-5;
- Technical assistance towards the construction of 6 rice husk power projects under Output 4.3 will continue to operate after the EOP, and 2 plants will be constructed and commissioned after the EOP to effect the reduction of over 807,500 tonnes CO_{2eq} after the EOP. This is illustrated on Table II-2;
- Nano-grids under Output 4.5 will have had direct assistance from the Project and will continue to operate up to their service life of 10 years. This is illustrated on Table II-6;

- Solar irrigation pump installations from Output 4.6 will be operating with a minimum service life of 10 years. This is illustrated on Table II-7.

C. Indirect Emission Reductions

These are estimated using the GEF Manual for guidance on top-down and bottom-up factors. Indirect emission reductions are mainly based on a replication factor and causality factor on the cumulative direct emission reductions of the pilot projects (i.e. PVSL diffusion, grid-connected rice husk power projects, nano solar grids and solar irrigation pumps). The calculations and assumptions are shown on Table II-8.

Table II-1: Emission Reductions from PVSL Dissemination

Baseline: Kerosene Lamps

Model Type	name	Hurricane	Kerosene lamps
Fuel consumption per household	liters/month	2.6	http://cdm.unfccc.int/Panels/ssc_wg/meetings/027/ssc_027_an06.pdf
	liters/yr	31.2	
Energy content of kerosene	MJ/liter	35.7	IPCC default number
Energy consumption per household	MJ/year	1,113.8	
Carbon emission factor for kerosene	tCO_2/TJ	67.2	IPCC default number
Estimated CO2 emission of each household	tCO2/household/yr	0.0749	
	kg CO2/household/yr	74.9	
Cost of kerosene for each household	Tk/month	BDT 200.00	From interviews of villagers
Bangladesh taka per USD	BDT/USD	BDT 81	
Assumed number of off-grid households buying SLs	households	10,200,000	

Assumptions for PVSL Deployment - Determine size of Project Areas

Energy saved through displacement of kerosene lamps	MJ/yr-household	1113.8	
	MWh/yr-household	0.31	
ERs generated per household/yr	tCO_2	0.075	
Assumed annual failure rate of SLs	%	3.0%	Maximum failure rate that can borne by suppliers
ERs generated per SL-yr	USD	$0.22	
Potential maximum annual ERs in Bangladesh	tCO_{2eq}/yr	763,698	
Assumed VCS Purchase Price	USD/t CO2	$3.00	
Landed Cost of Solar LED Lantern	USD	$35.50	

	Unit	Value	Year -1	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
			2012	2013	2014	2015	2016	2017	2018	2019
Rollout of PVSLs										
Number of households with kerosene displaced in 2012			0	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Number of households with kerosene displaced in 2013/23				*0*	0	0	0	0	0	0
Number of households with kerosene displaced in 2014/24					*63,000*	61,110	59,277	57,498	55,773	54,100
Number of households with kerosene displaced in 2015/25						*70,000*	67,900	65,863	63,887	61,970
Number of households with kerosene displaced in 2016/26							*98,203*	95,257	92,399	89,627
Number of households with kerosene displaced in 2017/27								*91,877*	89,120	86,447
Number of households with kerosene displaced in 2018/28									*120,642*	117,023
Number of households with kerosene displaced in 2019/29										*130,537*
Number of households with kerosene displaced in 2020/30										
Number of households with kerosene displaced in 2021/31										
Number of households with kerosene displaced in 2022/32										
Cumulative SLs installed up to 2032										
Energy Savings and ER Generation										
Cumulative Number of households where kerosene displaced at end of year (less 3% failure rate after Year 1)				0	63,000	131,110	225,380	310,495	421,822	539,704
Energy saved for the year households receive SLs	GJ				31,744	36,664	50,134	46,904	61,589	66,640
	MWh				8,818	10,184	13,926	13,029	17,108	18,511
Energy saved for households that received SLs previously	GJ				0	68,067	141,654	243,506	335,466	455,747
	MWh				0	18,907	39,349	67,641	93,185	126,596
Total energy saved for the year	GJ				31,744	104,731	191,788	290,410	397,055	522,387
Solar Power Generated	MW				1.0	3.3	6.1	9.2	12.6	16.6
ER volume for year households receive SLs	tonnes CO_{2eq}				2,134	2,465	3,370	3,153	4,140	4,480
ER volume for previous years SLs received	tonnes CO_{2eq}				0	4,575	9,522	16,368	22,550	30,635
Total ER volume year	tonnes CO_{2eq}			0	2,134	7,040	12,892	19,521	26,690	35,115
Cumulative CERs	tonnes CO_{2eq}		0	0	2,134	9,174	22,066	41,587	68,277	103,392

End of GEF Project →

Table II-2: Emission Reductions from Rice Husk Power Plants

Energy generated by Rice Husk plant (MWh)	Installed Capacity (MW)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
RH Plant 1	3			21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	**299,376**
RH Plant 2	3				21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	**277,992**
RH Plant 3	3					21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	**256,608**
RH Plant 4	3						21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	**235,224**
RH Plant 5	3							21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	**213,840**
RH Plant 6	3								21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	21,384	**192,456**
Total Rice Husk Energy Generated (MWh)		**0**	**0**	**21,384**	**42,768**	**64,152**	**85,536**	**106,920**	**128,304**	**128,304**	**128,304**	**128,304**	**128,304**	**128,304**	**128,304**	**128,304**	**128,304**	**1,475,496**
Annual Emission Reduction (tCO_{2eq})		**0**	**0**	**13,686**	**27,372**	**41,057**	**54,743**	**68,429**	**82,115**	**82,115**	**82,115**	**82,115**	**82,115**	**82,115**	**82,115**	**82,115**	**82,115**	**944,317**
Cumulative ERs			**0**	**13,686**	**41,057**	**82,115**	**136,858**	**205,286**	**287,401**	**369,516**	**451,630**	**533,745**	**615,859**	**697,974**	**780,088**	**862,203**	**944,317**	

End of GEF Project →

Assumptions:

1. With no estimates of MWh generated from proposed 50 MW CSP plants, assumptions on MWh generated were made
2. Other plants were assumed to also be 50 MW
3. Average number of hours that rice husk plant is generating electricity — 24 hrs/day, 330 days/year
4. Avg net capacity factor — 90% assumed
5. Bangladesh grid emissions factor — 0.64 tonnes CO_2/MWh
6. Cumulative ERs 10 yrs after EOP — 807,460 tonnes CO_2
7. Assumed service life of plant — 20.00 years
8. Lifetime of energy produc — 2,566,080 MWh

Table II-3: Emission Reductions from Nano-Grid Installations

Baseline: Kerosene Lamps

Model Type	name	Hurricane	Kerosene lamps
Fuel consumption per household	liters/month	2.6	http://cdm.unfccc.int/Panels/ssc_wg/meetings/027/ssc_027_an06.pdf
	liters/yr	31.2	
Energy content of kerosene	MJ/liter	35.7	IPCC default number
Energy consumption per household	MJ/year	1,113.8	
Carbon emission factor for kerosene	tCO_2/TJ	67.2	IPCC default number
Estimated CO2 emission of each household	tCO2/household/yr	0.0749	
	kg CO2/household/yr	74.9	
Cost of kerosene for each household	Tk/month	BDT 200.00	From interviews of villagers
Bangladesh taka per USD	BDT/USD	BDT 81	
Assumed # of off-grid households needing solar energy	households	12,000,000	

Assumptions for Nano-Grid Installation

Energy saved through displacement of kerosene lamps	MJ/yr-household	1113.8
	MWh/yr-household	0.31
ERs generated per household/yr	tCO_2	0.075
Assumed households under one nano-grid	households	6
ERs generated per nano-grid installation	tCO_2	0.449
Assumed VCS Purchase Price	USD/t CO2	$3.00
Cost of Nano-grid installation	USD	$35.50

	Unit	Value	Year -1	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
			2012	2013	2014	2015	2016	2017	2018	2019
Displacement of Kerosene with Nano-grid										
Number of households with kerosene displaced in 2013				0	0	0	0	0	0	0
Number of households with kerosene displaced in 2014					6	6	6	6	6	6
Number of households with kerosene displaced in 2015						18	18	18	18	18
Number of households with kerosene displaced in 2016							60	60	*60*	60
Number of households with kerosene displaced in 2017								300	300	300
Number of households with kerosene displaced in 2018									420	420
Number of households with kerosene displaced in 2019										600
Cumulative SLs installed up to 2030				0	6	24	84	384	804	1,404
Energy Savings and ER Generation										
Cumulative Number of households where kerosene displaced at end of year (less 3% failure rate after Year 1)				0	6	24	81	372	780	1,362
Annual energy saved for households linked with nano-grid	GJ			0	7	27	91	415	869	1,517
	MWh			0	2	7	25	115	241	421
Solar Power Generated	MW			0.0	0.0	0.0	0.0	0.0	0.028	0.0
Total ER volume year	tonnes CO_{2eq}			0	0	2	6	28	58	102
Cumulative ERs	tonnes CO_{2eq}		0	0	0	2	8	36	95	197

End of GEF Project →

Table II-4: Emission Reductions from Solar Irrigation Pump Dissemination

Baseline: Diesel Pumps

Diesel consumption per pump	tonnes/year	0.748	From Power Division of MoPEMR
Assumed pump capacity	kWp	8.000	
Number of months per year for irrigation	months	5	
Diesel density	tonnes/m3	0.84	
Diesel consumption	m3/month	0.178	
	liters/year	890	
	liters/month	178	
	liters/day	5.9	
Energy content of diesel	MJ/liter	36.4	IPCC default number
Energy consumption per solar irrigation pump	MJ/year	32,413.3	
Carbon emission factor for diesel	kgCO_2/liter diesel	2.68	IPCC default number
Estimated CO2 emission of diesel pump per year	kgCO2/diesel pump/yr	2,386	
	t CO2/diesel pump/yr	2.4	
Bangladesh taka per USD	BDT/USD	BDT 81	

Assumptions for Solar Irrigation Pumps

Energy saved through displacement of diesel irrigation pumps	MJ/yr-diesel pump	32413.3	
	MWh/yr-household	9.00	
ERs generated per solar irrigation pump	tCO_2	2.386	
Assumed VCS Purchase Price	USD/t CO2	$3.00	
Cost of Solar irrigation pump installation	USD		Not known at this time

	Unit	Value	Year -1	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
			2012	2013	2014	2015	2016	2017	2018	2019
Displacement of Diesel with Solar Irrigation Pumps										
Number of diesel irrigation pump displaced in 2013				0	0	0	0	0	0	0
Number of diesel irrigation pump displaced in 2014					20	20	20	20	20	20
Number of diesel irrigation pump displaced in 2015						80	80	80	80	80
Number of diesel irrigation pump displaced in 2016							300	300	*300*	300
Number of diesel irrigation pump displaced in 2017								600	600	600
Number of diesel irrigation pump displaced in 2018									1,000	1,000
Number of diesel irrigation pump displaced in 2019										1,500
Cumulative SLs installed up to 2028				0	20	100	400	1,000	2,000	3,500
Energy Savings and ER Generation										
Cumulative Number of irrigation pump installations where diesel is displaced at end of year (less 3% failure rate after Year 1)				0	20	100	388	970	1,940	3,395
Annual diesel energy saved	GJ			0	648	3,241	12,576	31,441	62,882	110,043
	liters			0	17,810	89,048	345,505	863,762	1,727,524	3,023,167
	MWh			0	180	900	3,493	8,734	17,467	30,568
Solar Power Generated	MW			0.0	0.2	0.8	3.1	7.8	15.5	27.2
Total ER volume year	tonnes CO_{2eq}			0	48	239	926	2,315	4,630	8,102
Cumulative ERs	tonnes CO_{2eq}		0	0	48	286	1,212	3,527	8,157	16,259

Assumed service life of solar irrigation pump 10 years
Lifetime of energy production per PVSL disseminated by Project 174,672 MWh

End of GEF Project →

Table II-5: Direct Post-Project ERs from PVSL Diffusion

	Unit	Value	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Rollout of PVSLs														
Number of households with kerosene displaced in 2012			*0*	*0*	*0*	0	0	0	0	0	0	0	0	0
Number of households with kerosene displaced in 2013/23			0	0	0	0	0	0	*161,449*	156,605	151,907	147,350	142,929	138,641
Number of households with kerosene displaced in 2014/24			57,498	55,773	54,100	52,477	0	0	0	*169,683*	164,593	159,655	154,866	150,220
Number of households with kerosene displaced in 2015/25			65,863	63,887	61,970	60,111	58,308	0	0	0	*175,661*	170,391	165,279	160,321
Number of households with kerosene displaced in 2016/26			95,257	92,399	89,627	86,938	84,330	81,800	0	0	0	*183,432*	177,929	172,591
Number of households with kerosene displaced in 2017/27			*91,877*	89,120	86,447	83,853	81,338	78,898	76,531	0	0	0	*190,597*	184,879
Number of households with kerosene displaced in 2018/28				*120,642*	117,023	113,512	110,107	106,803	103,599	100,491	0	0	0	*198,607*
Number of households with kerosene displaced in 2019/29					*130,537*	126,621	122,822	119,138	115,563	112,097	108,734	0	0	0
Number of households with kerosene displaced in 2020/30						*148,682*	144,221	139,895	135,698	131,627	127,678	127,678	0	0
Number of households with kerosene displaced in 2021/31							*147,129*	142,715	138,434	134,281	130,252	126,345	122,554	0
Number of households with kerosene displaced in 2022/32								*157,713*	152,982	148,392	143,941	139,622	135,434	131,371
Cumulative SLs installed up to 2032														
Energy Savings and ER Generation														
Cumulative Number of households where kerosene displaced at end of year (less 3% failure rate after Year 1)			310,495	421,822	539,704	672,195	748,255	826,962	884,255	953,176	1,002,766	1,054,473	1,089,588	1,136,629
Energy saved for the year households receive SLs	GJ		46,904	61,589	66,640	75,904	75,111	80,514	82,421	86,625	89,677	93,644	97,302	101,391
	MWh		13,029	17,108	18,511	21,084	20,864	22,365	22,895	24,063	24,910	26,012	27,028	28,164
Energy saved for households that received SLs previously	GJ		243,506	335,466	455,747	583,110	669,558	745,436	805,091	1,061,686	1,116,920	1,174,514	1,213,627	1,266,023
	MWh		67,641	93,185	126,596	161,975	185,989	207,066	223,637	294,913	310,256	326,254	337,119	351,673
Total energy saved for the year	GJ		290,410	397,055	522,387	659,013	744,669	825,950	887,512	1,148,311	1,206,597	1,268,158	1,310,928	1,367,414
Solar Power Generated	MW		9.2	12.6	16.6	20.9	23.6	26.2	28.1	36.4	38.3	40.2	41.6	43.4
ER volume for year households receive SLs	tonnes CO_{2eq}		3,153	4,140	4,480	5,102	5,049	5,412	5,540	5,823	6,028	6,295	6,541	6,815
ER volume for previous years SLs received	tonnes CO_{2eq}		16,368	22,550	30,635	39,197	45,008	50,108	54,118	58,662	61,927	65,217	67,310	75,266
Total ER volume year	tonnes CO_{2eq}		19,521	26,690	35,115	44,299	50,057	55,520	59,659	64,485	67,955	71,512	73,850	82,082
Cumulative CERs	tonnes CO_{2eq}		41,587	68,277	103,392	147,691	197,748	253,268	312,927	377,411	445,367	516,878	590,729	672,810

End of GEF Project →

Table II-6: Direct Post-Project ERs from Solar Nano-Grid Installations

	Unit	Value	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Displacement of Kerosene with Nano-grid														
Number of households with kerosene displaced in 2013			0	0	0	0	0	0	0	0	0	0	0	0
Number of households with kerosene displaced in 2014			6	6	6	6	6	6	6	6	6	6	6	6
Number of households with kerosene displaced in 2015			18	18	18	18	18	18	18	18	18	18	18	18
Number of households with kerosene displaced in 2016			60	60	60	60	60	60	60	60	60	60	60	60
Number of households with kerosene displaced in 2017			300	300	300	300	300	300	300	300	300	300	300	300
Number of households with kerosene displaced in 2018				420	420	420	420	420	420	420	420	420	420	420
Number of households with kerosene displaced in 2019					600	600	600	600	600	600	600	600	600	600
Cumulative SLs installed up to 2030			384	804	1,404	2,004	2,604	2,804	3,104	3,454	3,854	4,454	5,154	5,154
Energy Savings and ER Generation														
Cumulative Number of households where kerosene displaced at end of year (less 3% failure rate after Year 1)			372	780	1,362	1,944	2,526	2,720	3,011	3,350	3,738	4,320	4,999	4,999
Annual energy saved for households linked with nano-grid	GJ		415	869	1,517	2,165	2,813	3,030	3,354	3,732	4,164	4,812	5,569	5,569
	MWh		115	241	421	601	782	842	932	1,037	1,157	1,337	1,547	1,547
Solar Power Generated	MW		0.0	0.028	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Total ER volume year	tonnes CO_{2eq}		28	58	102	146	189	204	225	251	280	323	374	374
Cumulative ERs	tonnes CO_{2eq}		36	95	197	342	531	735	960	1,211	1,491	1,815	2,189	2,563

End of GEF Project →

Table II-7: Direct Post-Project ERs from Solar Irrigation Pump Installations

	Unit	Value	Year 5 2018	Year 6 2019	Year 7 2020	Year 8 2021	Year 9 2022	Year 10 2023	Year 11 2024	Year 12 2025	Year 13 2026	Year 14 2027	Year 15 2028
Displacement of Diesel with Solar Irrigation Pumps													
Number of diesel irrigation pump displaced in 2013			0	0	0	0	0	0	0	0	0	0	0
Number of diesel irrigation pump displaced in 2014			20	20	20	20	20	20	20	20	20	20	20
Number of diesel irrigation pump displaced in 2015			80	80	80	80	80	80	80	80	80	80	80
Number of diesel irrigation pump displaced in 2016			*300*	300	300	300	300	300	300	300	300	300	300
Number of diesel irrigation pump displaced in 2017			600	600	600	600	600	600	600	600	600	600	600
Number of diesel irrigation pump displaced in 2018			1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Number of diesel irrigation pump displaced in 2019				1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Cumulative SLs installed up to 2028			2,000	3,500	5,000	7,500	10,500	14,000	18,000	18,750	18,750	18,750	18,750
Energy Savings and ER Generation													
Cumulative Number of irrigation pump installations where diesel is displaced at end of year (less 3% failure rate after Year 1)			1,940	3,395	4,850	7,275	10,185	13,580	17,460	18,188	18,188	18,188	18,188
Annual diesel energy saved	GJ		62,882	110,043	157,205	235,807	330,130	440,173	565,937	589,518	589,518	589,518	589,518
	liters		1,727,524	3,023,167	4,318,810	6,478,214	9,069,500	12,092,667	15,547,714	16,195,536	16,195,536	16,195,536	16,195,536
	MWh		17,467	30,568	43,668	65,502	91,703	122,270	157,205	163,755	163,755	163,755	163,755
Solar Power Generated	MW		15.5	27.2	38.8	58.2	81.5	108.6	139.7	145.5	145.5	145.5	145.5
Total ER volume year	tonnes CO_{2eq}		4,630	8,102	11,574	17,362	24,306	32,408	41,668	43,404	43,404	43,404	43,404
Cumulative ERs	tonnes CO_{2eq}		8,157	16,259	27,833	45,195	69,501	101,910	143,578	186,982	230,386	273,790	317,194

Assumed service life of solar irrigation pump	10	years
Lifetime of energy production per PVSL disseminated by Project	174,672	MWh

Table II-8: Indirect Emission Reductions from Solar Irrigation Pump Installations

Development of Sustainable Renewable Energy Power Generation (DESREG)

			Activities Contributing to Indirect Emissions Reductions	
		1)	Pilot dissemination of PVSLs	
		2)	Pilot grid-connected rice husk power plant projects	
		3)	Financing and setup of nano solar grids	
		4)	TA towards the setup and operation of solar irrigation pump	
		5)	Strengthened linkages between SREDA and new RE funds	
			Indirect Bottom-up	
Step 15	Enter Replication Factor. Please refer to section 2 (e) in the Manual for further guidance. Also see table below for standardized suggestions. Not all projects will fit these suggestions, if using a different replication factor explain rationale in the as	**15)**	**Replication Factor**	**3**
Notes:	The Project is strengthening SREDA linkages with new RE funds during the Project			
Assumptions:	There will be some credit and guarantee facilities as well as market transformation activities		Direct Emissions Reductions	2,133,864

Standardized Suggestions

Project Type	**Suggested Replication Factor**
Solar Home Systems	2
ESCO	2
Market transformation and demonstration capital	3
Credit and guarantee	4

Step 16	Sense check automatic results	**16)**	**Results: Indirect bottom up-emissions**	**6,401,593.34 Tons CO2 e**
				6,401.59 KT CO2 e
				6.40 MT CO2 e
			Indirect Top Down	
Step 17	Enter 10 year market potential	**17)**	**Enter P10 (Tons CO2 e)**	**2,133,864**
Notes:	10-yr market potential based on cumulative direct emission reductions from all RET pilots during DESREG			
Assumptions:				
Step 18	Enter GEF Causality Factor. Please refer to section 2 (e) in the Manual for further guidance. Also see table below for standardized	**18)**	**Enter Causality Factor (%)**	**80**
Notes:	Project will support the development of an enabling investment environment			
Assumptions:	If DESREG performs as designed, the top-down factor should reflect the dominating nature of the project interventions			

Standardized Suggestions

Pick Causality Factor	**%**
Level 5 - "Critical"	100
Level 4 - "dominating"	80
Level 3 - "substantial but modest"	60
Level 2 - "modest"	40
Level 1 - "weak"	20

Step 19	Sense check automatic results	**19)**	**Results: Indirect top-down emissions**	**1,707,092 Tons CO2 e**
				1,707.09 KT CO2 e
				1.71 MT CO2 e

Annex III: Agreements

Annex IV: Terms of Reference for Project Staff and Consultants

Regular Project Staff

1. National Project Manager (NPM):

Duties and Responsibilities: The incumbent will be responsible for implementation of the project, including mobilization of all project inputs, supervision of project staff, consultants and oversight of sub-contractors. The PM will be the leader of the Project Team (PT) and shall liaise with the government, UNDP, and all stakeholders involved in the project. S/he will be specifically responsible for (a) overall management of the project, (b) work closely with project stakeholders and ensure the project deliveries as per project document and work plan, (c) ensure technical coordination of the project and the work related to legal and institutional aspects, (d) mobilize all project inputs in accordance with UNDP procedures and GEF principles, (e) finalize the ToR for the consultants and subcontractors and coordinate with UNDP Procurement for recruitment, procurement and contracting, (f) supervise and coordinate the work of all project staff, consultants and sub-contractors, (g) ensure proper management of funds consistent with UNDP requirements, and budget planning and control, (h) prepare and ensure timely submission of monthly reports, quarterly consolidated financial reports, quarterly consolidated progress reports, annual, mid-term and terminal reports, and other reports as may be required by UNDP; (i) submit the progress reports and key issue report to the **National Steering Committee**, (j) prepare quarterly and annual work plan, (k) provide regular input to UNDP corporate system ATLAS for financial and program management on project progress, financial status and various logs, (l) arrange for audit of all project accounts for each fiscal year (m) undertake field visit to ensure quality of work, and (n) undertake any activities that may be assigned by UNDP and **National Steering Committee**.

Qualifications and Experience: The incumbent should have a minimum Bachelor degree in Engineering with MBA/Master degree or Masters in energy/environment or other relevant academic discipline and profession qualifications with at least ten (10) years professional experience at senior level. S/he should have extensive experience and technical ability to manage a large project and a good technical knowledge in the fields related to private sector development, climate change, energy efficiency and institutional development and/or regulatory aspects. S/he must have effective interpersonal and negotiation skills proven through successful interactions with all levels of project stakeholder groups, including senior government officials, financial sectors, private entrepreneurs, technical groups and communities. S/he should have ability to effectively coordinate a complex, multi-stakeholder project and to lead, manage and motivate teams of international and local consultants to achieve results. Good capacities for strategic thinking, planning and management and excellent communication skills both in English and Bengali are essential. Knowledge of UNDP project implementation procedures, including procurement, disbursements, and reporting and monitoring will be an added advantage.

***2.* Monitoring and Evaluation Officer (M&E):**

Duties and Responsibilities: Under the direct supervision of UNDP and the Project Manager, the incumbent will be assigned to develop and implement a monitoring system to capture the project activities and results under the supervision of Project Manager. S/he will be responsible specifically for (a) developing and setting up the overall framework for project monitoring and evaluation (M&E), (b) prepare the monthly, quarterly and annual monitoring plan for project activities, (c) monitor and evaluate the compliance of actual progress and performance against

the planned work plan and expected quality, (d) analysis of the effect of current actual performance to the project timetable and budgets, (e) prepare reports for project management including identification of problems, causes of potential bottlenecks (if any) in project implementations, (f) recommendations on how to reduce the impact of deviations vs. work plans, (g) prepare the ToRs for mid-term and final evaluation in accordance to UNDP and GEF guidelines, (h) design and implement a system to identify, analyze, and disseminate lesson learned, (i) assist the PM in preparation of various progress report, (j) coordinate with the international and national consultants and other stakeholders, (k) facilitate exchange of experiences by supporting and coordinating participation in any existing network of UNDP/GEF projects sharing common characteristics, (l) identify and participate in additional networks, for example scientific or policy-based networks that may also yield lessons that can benefit project implementation and (m) any other related activities as assigned by Project Manager.

Qualifications and Experience: The incumbent should have a minimum Masters degree in Energy/Environment, Statistics, Economics or other relevant academic disciplines from a recognized university. S/he should have at least five (5) years hands-on experience in energy and environment field specifically monitoring and evaluation of projects. S/he should have proven experience in planning, design and implementation of M&E systems, the logical framework approach and other strategic planning approaches, training in M&E development and implementation and/or facilitating learning-oriented analysis sessions of M&E data with multiple stakeholders, data and information analysis and analytical report writing. S/he should have the willingness to undertake regular field visits and interact with different stakeholders, especially primary stakeholders. S/he must have willingness to undertake regular field visits and interact with different stakeholders, especially primary stakeholders. Computer proficiency in MS Office (Word, Excel and PowerPoint) and other common software is a prerequisite. Computer literacy in graphic design software will be appreciated. Fluent both in written and spoken English and Bengali is essential.

3. **Admin Assistant (AA):**

Duties and Responsibilities: The incumbent will be responsible to provide overall administration and financial services of the project such as processing payments, raising requisition, purchase order, projects logs etc. using UNDP corporate software ATLAS. S/he will be responsible to provide information to UNDP Project web, RRMC reporting and administrative trouble shooting. S/he will also perform (a) word processing, drafting routine letters/messages/reports, mailing (b) arrange travel, itinerary preparation for project related travels, (c) assist to arrange workshops/seminar/training programs and mailing, (d) work at reception desk and make appointments and schedule meeting, (e) assist in work-plan and budgeting, (f) photocopying, binding and filing, (g) maintenance of all office equipment and keeping inventory/records of supplies and their usage and any other duties assigned by Project Manager or concerned officials.

Qualifications and Experience: The incumbent should have at least a Bachelor degree in any discipline from a recognized university. S/he should have at least 3 years relevant working experience with foreign aided projects or international development or organizations. Computer proficiency in MS Office (Word, Excel and PowerPoint) and other common software is a prerequisite. Diploma in computer/secretarial science is desirable but not essential. Basic knowledge in procurement, petty cash handling, logistics supports, and filling systems is a basic requirement. Knowledge of UNDP project implementation procedures, including procurement, disbursements, and reporting and monitoring is preferable. Fluent both in written and spoken English and Bengali is required.

Key Short-term Consultants

Detailed TORs of the national and international consultants will be developed during the Project Inception period, in the first 3 months after project start-up, by the NPM in consultation with UNDP and the implementing partners.

4. International Consultant: Chief Technical Advisor (CTA) for Components 1 to 4

- Provide management oversight for project as required and recommend actions that focus work plans on achieving key milestones in a timely manner;
- Recommend special expertise to be deployed on the Project to assist in its achievement of key milestones
- Provide the interface between Project team and key specialist consultants, both domestic and international when appropriate.

5. International Consultant: Financial Specialist (ICS) for Component 3

- Assess the baseline conditions for capital financing of RE projects and RET diffusion programs;
- Closely assess available mechanisms for financing capital costs for RE projects including biomass (rice husk), solar and wind;
- Determine feasible financial mechanisms for scaling-up RE investments in Bangladesh;
- Provide work plan and oversight for local finance expert (FE) to facilitate financing mechanisms for scaling-up RE investments.

6. National Consultant: Capacity Building Advisor (CBA) – Components 1, 2, 3 and 4

- Provide a baseline for skills and absorptive capacity within SREDA to promote and regulate RE development, and with prospective RE managers, operators and plant personnel to manage an RE plant or an RET diffusion program;
- Consult with relevant institutions, government officers, financial institutions, and the consulting industry on the RE knowledge gaps of these stakeholders;
- Design and deliver appropriate training materials and workshops on RE planning, design, implementation, operation and maintenance as well as financing of RE projects.

7. National Consultant: Financial Expert (FE) – Components 3 and 4

- Financial analyst to develop bankable feasibility documents;
- Assist SREDA in the implementation of financial mechanisms as recommended by the ICS;
- Facilitate capital and RE financing from foreign banks with carbon funds or NAMA-linked funds under the direction of senior project staff.

8. National Consultant: Contract Specialist – Component 4

- Review RE facilitation process under SREDA and determine where contractual agreement assistance is required;
- Provide templates and support for RE concessions for the tendering and contracting of supply and installation services for RE equipment and technologies as determined by the NPM;

- Serve as the key facilitator in the evaluation of bids and award of contracts for RE concessions and key supply and install contracts.

9. National Consultant: Project Engineers (PE) – Component 4

- Mechanical/combustion engineers specializing in rice husk technology with at least 10 years in the relevant field;
- Civil engineer with at least 10 years experience with industrial design to supervise construction of buildings and installation of plant equipment;
- Boiler engineers with at least 10 years experience to assist with the design and retrofitting of rice mill boilers and power plant boilers if required;
- Electrical engineers with minimum 10 years experience in power plant electrification and interfacing with the grid;
- All engineers will work closely with SREDA personnel and project proponents to ensure lessons learned on-the-job are imparted to them.

10. National Consultant: Legal Specialist (LS) – Component 4

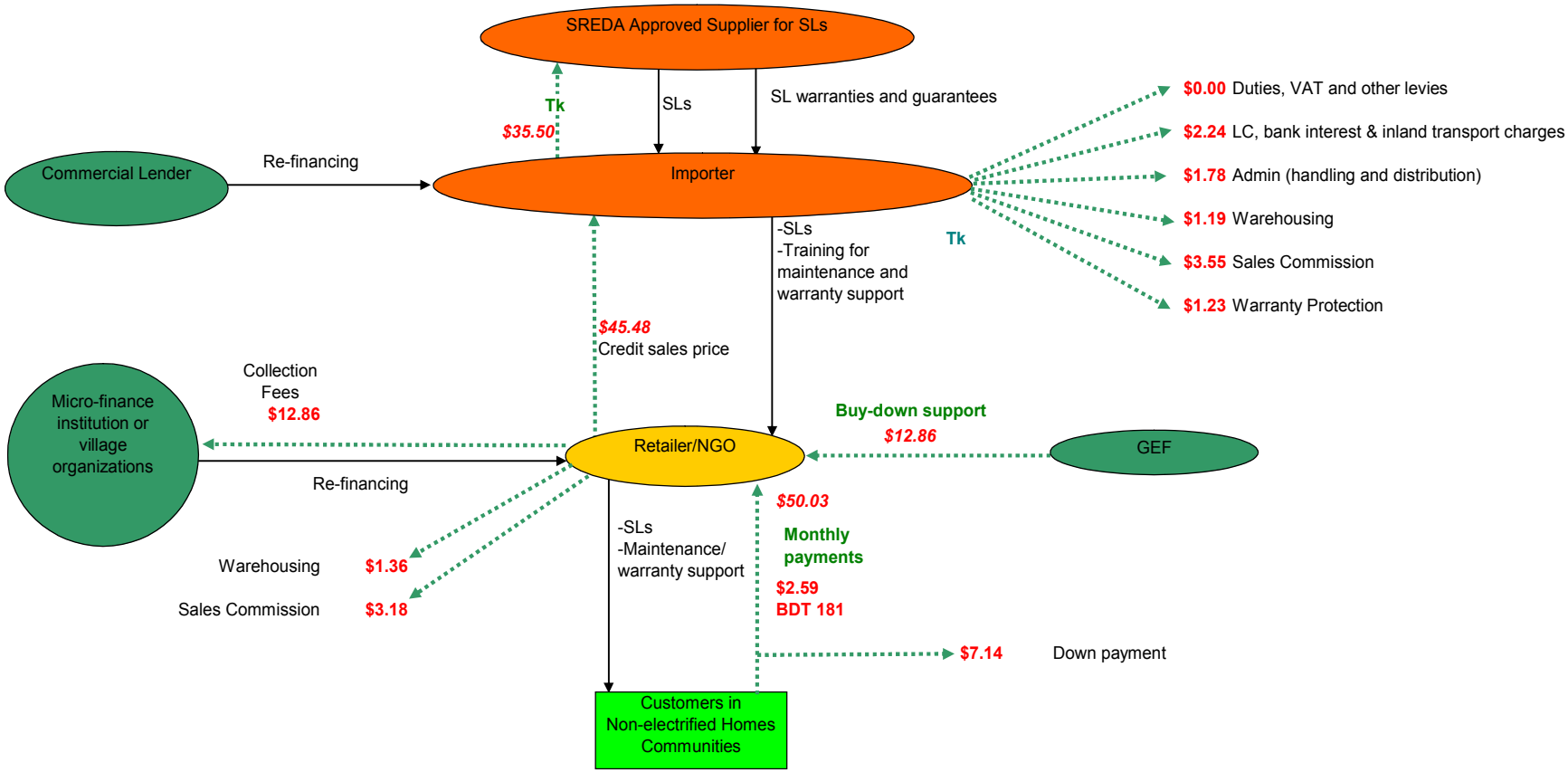
- Provide legal services regarding contractual issues for the supply of rice husk and power purchase agreements for the supply to the grid;
- Provide legal advice on arbitration issues during the execution of the contracts involving direct project involvement (i.e. through direct investments or Project TA).

A reputable consulting firm should be hired to carry out Outputs 4.2 and 4.3, and must provide some of the aforementioned consultants, namely the National Financial Expert (FE), National Contract Specialist (CS), National Project Engineers (PE), the National Legal Specialist (LS) and a Survey Specialist with appropriate experiences.

Annex V: Details of PVSL Diffusion Program Design

Figure V-1 illustrates the supply chain from the SREDA-approved supplier of PVSLs to an importer in Bangladesh who has national logistical support throughout Bangladesh to supply PVSLs to regional distribution centers. At the regional distribution centers, NGOs and local retailers will access micro-financing institutes to borrow money to purchase PVSLs for distribution at the field level. The retailer will also have warehousing charges as well as collection fees and a sales commission. The collection fees consisting of a number of collectors who will visit each household on a monthly basis to collect the monthly fee as well as provide any technical support required. Government is waiving of duties, VAT and other levies totaling USD 2.49 per PVSL; this is reflected in the Government's co-financing on this Project.

Figure V-1: PVSL Supply Chain and Financing Logic



Annex VI: Details of Grid-Connected Rice Husk Power Plants

Situation Analysis

The cultivation of rice results in two major types of residues – Straw and Husk. Both these residues have attractive potential in terms of energy. The outermost layer of the paddy grain is rice husk also called rice hull. It is separated from the brown rice during the milling process. Burning rice husk produces rice husk ash (RHA), if the burning process is incomplete carbonized rice husk (CRH) is produced. Around 20% of the paddy weight is husk. In 2008 world paddy production was 661 million tons and consequently 132 million tons of rice husk were also produced. While there are some uses for rice husk it is still often considered a waste product in the rice mill and therefore often either burned in the open or dumped on wasteland. Husk has a high calorific value and therefore can be used as a renewable fuel. The husk has energy content of about 14 GJ/tonne so that the energy potential world-wide would be some 1.5 billion GJ/year, which at US$5/GJ would have an annual value of US$7.5 billion. This amount of energy is equivalent to over 1 billion barrels of oil per year. The husk also contains between 15 and 20% of mineral matter the majority of which is amorphous silica.

As the 4th largest rice producing country in the world, Bangladesh produces almost 36 million tons of rice annually according to the Bangladesh Rice Research Institute (BRRI). However, the number might be somewhat optimistic since other estimates put the production at around 35 million tons per year. Rice husks amounts to about 20% of total processed paddy, meaning each ton of processed rice produces about 200-220kg of rice husk as by-product. This means that the agricultural economy in Bangladesh produces between 800-880 million kilograms of rice husk most of which is inefficiently utilized. In common practice, rice husk is usually used directly as fuel for burning, for drying of paddy before milling, some as cattle feed or indirectly in producing briquettes. The main consumer of the rice husk energy is the milling sector; about 70% of rice husk energy is consumed by the rice parboiling system. The importance of Rice Husk and Rice Straw as an attractive source of energy can be seen from the following statistics:

Rice Straw
- 1 ton of Rice paddy produces 290 kg Rice Straw
- 290 kg Rice Straw can produce 100 kWh of power
- Calorific value = 2400 kcal/kg

Rice Husk
- 1 ton of Rice paddy produces 220 kg Rice Husk
- 1 ton Rice Husk is equivalent to 410- 570 kWh electricity
- Calorific value = 3000 kcal/kg
- Moisture content = 5 – 12%

The benefits of using rice husk as a resource are numerous. Primarily, it provides electricity and serves as a way to dispose of agricultural waste. In addition, steam, a by-product of power generation, can be used for paddy drying applications, thereby increasing local incomes and reducing the need to import fossil fuels. Rice husk ash (RHA), the by-product of rice husk power plants, can be used in the cement and steel industries directly further decreasing the need to import these materials. RHA amounts to between 18 – 20 % of the rice husk. Silica is the major constituent of RHA and the following tables gives typical composition of rice husk and rice husk ash. With such a large ash content and silica content in the ash it becomes economical to extract silica from the ash, which has wide market and also takes care of ash disposal

Table VI-1: Composition of Rice husk ash on dry basis

Element	Mass Fraction %
Silica (SiO2)	80 – 90 %
Alumina	1 –2.5 %
Ferric oxide	0.5 %
Titanium dioxide	Nil
Calcium oxide	1 – 2 %
Magnesium oxide	0.5 – 2.0 %
Sodium oxide	0.2 – 0.5 %
Potash	0.2 %
Loss on Ignition	10-20%

From the table it is clear that silica is the major constituent of the rice husk ash. Nowadays, silica extraction from RHA is becoming a common practice. This not only provides value addition but also solves the problem of large amount of ash disposal.

Rice straw can either be used alone or mixed with other biomass materials in direct combustion. In this technology, combustion boilers are used in combination with steam turbines to produce electricity and heat. The energy content of rice straw is around 14 MJ per kg at 10 percent moisture content. The by-products are fly ash and bottom ash, which have an economic value and could be used in cement and/or brick manufacturing, construction of roads and embankments, etc. Straw fuels have proved to be extremely difficult to burn in most combustion furnaces, especially those designed for power generation. The primary issue concerning the use of rice straw and other herbaceous biomass for power generation is fouling, slagging, and corrosion of the boiler due to alkaline and chlorine components in the ash.

The Technology Spread

Although the technology for rice husk utilization is well-proven in industrialized countries of Europe and North America, such technologies are yet to be introduced in the developing world on commercial scale [See Table below]. In the past few years, though a large number of new plants have been set up in Thailand, Cambodia and India. These plants have been based on a mix of the technology options. Some such as the ones in Thailand and Cambodia have followed the steam turbine route and some such as the smaller scale Indian ones have adopted the gasification process.

The Technology of Husk Power

Rice husk can be used for power generation through either the steam or gasification route. For small scale power generation, the gasification route has attracted more attention since small steam power plants are difficult to maintain due to the presence of a boiler. Although it is changing, efficiencies of boilers in the small scale are lower and they need to be cleaned and maintained regularly. Moreover, now-a-days the technologies being employed have greater efficiencies with much improved performances. For instance, suspension - fired combustion technology which provides high efficiency in combustion, results in economy in fuel consumption for power generation and better control of consistent quality of ash which is a by - product so that ash with more quality benefits is produced.

Table VI-2: Rice Husk Power Plants Employing Furnace System

Project Owner Project Site	Generation Capacity Commencement Year	Fuel Type	Combustion Type	Project Details
Agrilectric Power Partners Lake Charles, Louisiana USA	13 MW Electricity 1984	Rice husks	Suspension-Fired	Rice husk-fired power plant
Agrilectric Research Lake Charles, Louisiana USA	1.5 MW Electricity 1995	Rice husks	Suspension-Fired	Rice husk-fired power plant and demonstration module
BK Energia Uruguaiana, Rio Grande del Sul, Brazil	8 MW Electricity 2001	Rice husks	Suspension-Fired	Rice husk-fired power plant
CDGE-Koblitz Dom Perdito, Rio Grande del Sul, Brazil	8 MW Electricity 2001	Rice husks	Suspension-Fired	Rice husk-fired power plant
CDGE-Koblitz Capo do Leo, Rio Grande del Sul, Brazil	8 MW Electricity 2001	Rice husks	Suspension-Fired	Rice husk-fired power plant
Operational Energy Corp. Williams, California USA	28.7 MW Electricity 1989	Rice husks	Suspension-Fired	Rice husk-fired power plant
Stanwell Corp. Deniliquin, New South Wales Australia	10 MW Electricity Under development	Rice husks	Suspension-Fired	Rice husk-fired power plant
Uncle Ben's Foods Houston, Texas USA	20 tons/hour 1978 (approx.)	Rice husks	Suspension-Fired	Firing rice husks for generating steam used in rice milling processes.
Uncle Ben's Foods Greenville, Mississippi USA	20 tons/hour 1978 (approx.)	Rice husks	Suspension-Fired	Firing rice husks for generating steam used in rice milling processes.

Generally, in a suspension - fired combustion system, the boiler furnace is designed for use with solid fuel, but employing the principle of liquid fuel combustion such as natural gas and oil. Combustion of liquid fuel occurs when the fuel flows upwards into the air which is achieved by the force of a fuel pump. This pump will atomize the liquid fuel from a burner in the form of mist or spray. When the atomized liquid fuel comes in contact with the heat in the furnace, it will ignite as a flame in the air or become burned in the air.

The technology of converting rice husk to electricity is pretty straightforward. When rice husk is heated, it releases gases that can be used to run modified diesel engines and to generate electricity. Under high temperature rice husk present in a gasifier comes in contact with air, hydrogenation and gasification reactions occur and the rice husk is converted into fuel gas, the main elements of the gasses being hydrogen and methane. Fuel gas after purification is routed to the generator. Or the fuel gas is combusted to produce high pressure steam in the boiler which is then fed into a turbine generator to produce electricity. Apart from these generation system, a plant must have a fuel handling system, ash handling and water supply systems. There is an ash handling device fixed on the bottom of the gasifier to collect the ash which can be used as fertilizer after cooling. In this process, the water used for fuel purification is recycled and is circulated through biochemical treatment. No excess water is discharged. The tar collected from the purification system can be sold as a chemical or mixed with coal to improve its calorific value. The steam boiler route is similar except that it burns the rice husk at relatively low temperatures usually 7 to 800 degrees and then uses the steam to drive engines or turbines.

Suggested Locations for the Power Plants

The Rice Mill Owners' Association of Bangladesh reports that there are over one hundred thousand rice mills located in a scattered manner all over the country with about four (4) 'cluster' area. Over ninety percent of these rice mills are reported to be in the smaller capacity ranges, i.e. < 20 - 25 MT/day of Paddy processing capacity. The number of lower to mid-sized rice mills (with paddy processing capacity range : > 25 - 50 MT/day) are reported to be about 490 and that of mid to large sized rice mills (30- 120 MT/day) are about 50 units. As already mentioned, primarily, there are about four (4) distinct areas where because of larger paddy productions there are many 'clusters' of mills i.e. there are a large number of rice milling plants in close proximity to each other. Plants located in these clusters could benefit from the potentially large quantities of rice husks that could offer. These clusters are mainly located in: (i) Dinajpur (North Bengal); (ii) Sherpur (near Bogra); (iii) Ishwardi; and, (iv) Kaliakoir (near Dhaka). Information from preliminary surveys (ref.: Bangladesh Rice Research Institute, BRRI and information from Rice Mill Owners' Association), indicate that typically there are over 500 rice mills located in sub-clusters in these districts. Taking an average (lower-mid) capacity range of about 100-200 kW, there is a 50-100 MW power market in these cluster areas.

Strategies for Entry into the Husk Power Market and Up-Scaling of the Initial "Flagships"

The study considers the demonstration and up-scaling of the rice husk based power generation for meeting the electricity requirements of the rice mills through two approaches : 'Flagship' (or demonstration) projects - (i) one in the national higher capacity range : 600 kW and another (ii) 200 kW average mid capacity range. The strategy should be to create first a confidence amongst the rice mill owners on the technology, its user-friendliness, as well as its financial viability from commercial / micro-economic considerations, as it was first done in India, China and Thailand. In fact, in developing countries, the 'Flagship Project' constitutes a very important strategy to make a market entry for new/emerging technologies. While it is important to establish the confidence of the rice mill owners on the techno-economic aspects of the rice husk based power plants to cater their power needs on routine, the next, or a rather a parallel, step could be to scale up the husk based power plants to nationally more beneficial, relatively larger central Renewable Energy IPPs (Capacities analyzed: 1 - 6 MW range), provided appropriate investors/entrepreneurs can be geared up for such an up-scaled plant sizes, even before or parallel to establishing such technologies through routine field operations. However, investments of such magnitude should be made with appropriate GoB Policies, proper feed-in tariffs (being a renewable IPP) etc. Such larger plants, as financial/economic analysis shows, will have better advantages, as these will enjoy a more advantageous economy of scale, real economic pricing of husk, fiscal and other incentives that can be or rather should be extended to such IPPs, including buy-back benefits for the Husk Ash produced by such large plants. These innovative approaches can lead to fast growth in the use of the technology and its sustainability can be ensured.

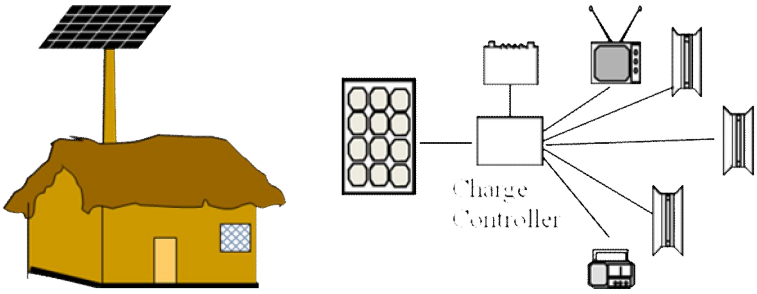
Annex VII: Details of Nano-Grid Concept

The following Concept is printed courtesy of the Center for Energy Research at the United International University, Dhaka.

1. A description of Solar Home System

A typical Solar Home System (SHS) has small sized solar PV panel (~50W) on the roof top or on a pole connected to a battery (~12V, 60AH) via a charge controller. During the day time output from the PV is stored in the battery. During the night hours loads like 2-3 lights and/or a TV is used. The output and the storage capacity of the SHS is designed to cater the basic need of lighting and TV. As there is serious limitation on the output, any gadget like electric fan that can consume significant energy is not allowed in the SHS. A SHS usually use oversized battery to ensure energy supply during rainy, cloudy or foggy days. A 3-day autonomy is usually sought for SHSs in Bangladesh.

Figure VII-1: Schematic diagram of a typical solar home system and its basic components



Limitations of SHS - Power output is too small to be used for any small scale essential application like irrigation. In summer months sunshine is significantly higher but there is no scope to use this excess energy. As for example a 50W panel SHS will produce 20% more energy than the annual average during the months of March-May. But this 20% is equivalent to only 45W-hr per day of excess energy that cannot be used for any practical cottage industry. However, if a number of SHSs could be connected together, the overall energy output would be much higher and could be put to more serious usage.

1. **Solar PV based irrigation in Bangladesh**

Irrigation is one of the major activities required for rural Bangladesh as Bangladesh is predominantly an agricultural country. Bangladesh is under monsoon climate where there is plenty of rainfall during the months from June to September. Sometimes there is too much rainfall and flooding takes place. The main cropping seasons are 'Aman' harvested during the month of November and 'Robi' harvested during the month of May. The 'Robi' season is predictably dry with plenty of sunshine and with proper irrigation this is the most important crop producing season for Bangladesh. However more than 60% of the rural area is not connected with the electricity grid lines and irrigation mainly depends on diesel based engines. The cost of diesel in the city areas is about Tk. 61 per litre and it is at least 20% higher in the rural areas as transportation and storage cost is added to it. Bangladesh imports USD 1bn worth of diesel for agricultural sector alone. Cost of diesel based irrigation at the field level is Tk. 21 per kW-hr

equivalent of electricity. The irrigation pump owners charge about 25% of the crop produced for irrigating the land for a season.

With this background scenario, our studies indicate that with the present price of PV and prevailing sunshine condition, solar PV based irrigation can be competitive diesel based irrigation. However, it is important to understand that irrigation requirement in any particular season varies with the rain fall and any dedicated irrigation scheme will not be cost effective as the PV energy will be wasted during the non-irrigating months (from June to September). So, it is very important to integrate the irrigation scheme along with rural grid so that PV energy will have alternative usage like energizing the households during the non-irrigating months. Another very important aspect is the month wise sun shine availability. During the irrigating months (February to May) the temperature is relatively low and household demand for electricity is also low as no cooling fan is needed. It may be mentioned here that the main household energy consumer is the cooling fan. So, the higher sunshine during the irrigating months can very effectively be utilized for irrigation without causing any shortage for the household consumption. On the other hand, during the months of June to September, there is plenty of rainfall and the sunshine is relatively low resulting in less production of PV energy. But this is the season when irrigation need is at a minimum level, and the PV output can be very effectively used for household purposes. So, if we consider the distribution of sunshine and the seasonal variation of the load including irrigation, net electricity requirement almost follows the sunshine condition. This ensures very effective usage of the PV output leaving the amount of energy unutilized to a minimum level.

As irrigation can be done during the day time, no battery backup is needed and the cost of electricity for irrigation can make the scheme commercially viable. It is worth mentioning that requirement of battery backup increases the cost of PV energy by more than 70%.

2. The Concept of nano-grid: Its feasibility in the context of rural Bangladesh

The basic of nano-grid is based on the fundamental concept of Solar Home System, where the basic necessity of the households are met, but at the same time some small scale agro-based applications like irrigation can also be incorporated. This concept takes the advantage of the fact that houses usually clustered together in rural areas in a group of 10-20 houses (within a diameter of less than 150m). A schematic diagram depicting the concept is shown in Figure VII-2. Roof top of one or two houses will be chosen for PV installation and the storage battery will be placed in a convenient location close to it.

In the proposed nano-grid system, a system like 1.5 to 3kWp PV system is installed in a small cluster of households within a radius of 60-70m and power is distributed to 10-20 households from this system. The typical household load in rural Bangladesh given in Table VII-1 and VII-2. Considering the typical load in a household, the expected summer time load is more than 3 times the expected winter loads. This is due to the fact that there is expected to be high usage of fans due to hot weather condition.

Figure VII-2: Schematic diagram for the nano-grid

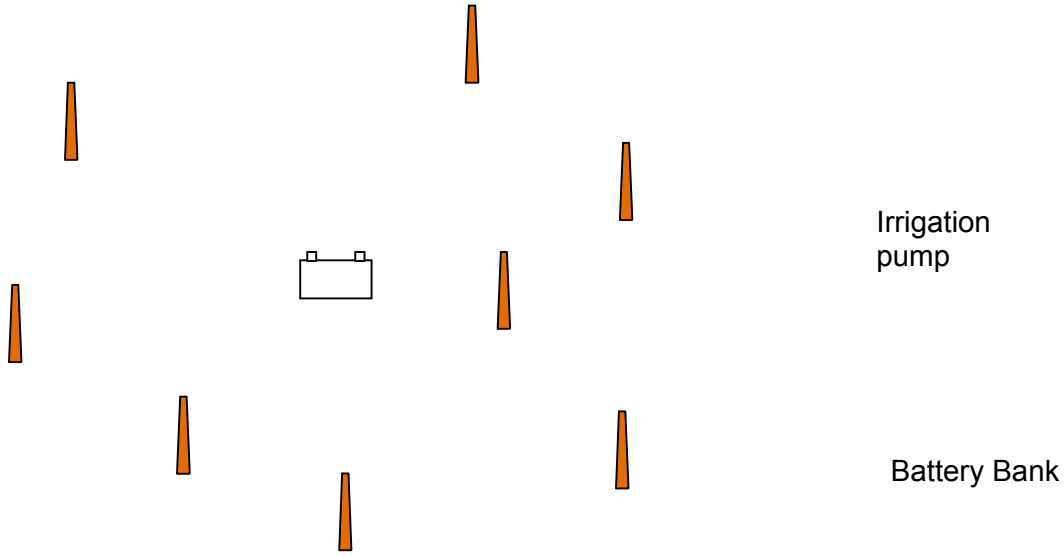


Table VI-1: Table for household consumption (summer months)

Connected load	% HH	No./HH	Watt/unit	Hrs of usage	Diversity	Energy, W-hr
Light	100	3	5	4.5	0.8	54
Fan	100	2	20	8	0.8	256
TV	25	1	30	8	0.8	48
Refrigerator	-	-	-	-	-	-
Water Pump	-	-	-	-	-	-
Total						358

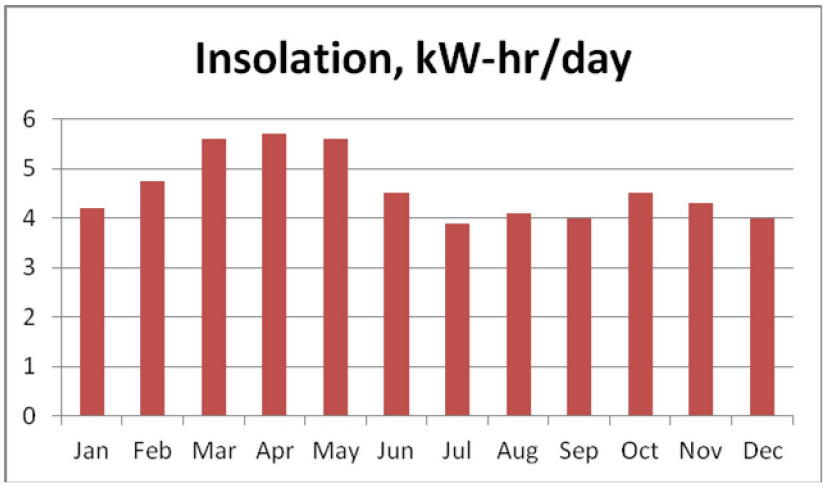
Table VI-2: Table for household consumption (winter months)

Connected load	% HH	No./HH	Watt/unit	Hrs of usage	Diversity	Energy, W-hr
Light	100	3	5	6	0.8	72
Fan	100	2	20	0	0.8	0
TV	25	1	30	10	0.8	60
Refrigerator	-	-	-	-	-	-
Water Pump	-	-	-	-	-	-
Total						132

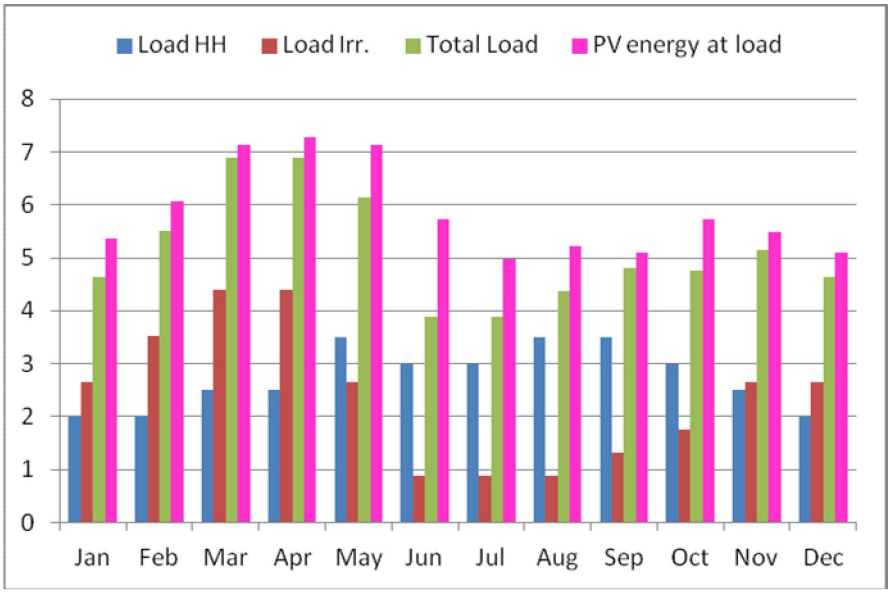
Figure VII-3 shows the average daily solar radiation on a horizontal flat surface in Bangladesh. The main irrigation season is from February to 1st week of May and the weather remains reasonably dry and cool till end of April. It is interesting to note that sunshine is relatively higher during these months and lees demand of fan in the house holds generates sufficient surplus energy to divert it for irrigation. Our preliminary calculations show that a small pump of 1.1 kW

(1.5 HP) can be easily run to irrigate the fields. Months after June, the rainy season starts and demand for irrigation is reduced to around 5-10%. Although the sunshine is lower during the rainy season (June-September), absence of irrigation makes the overall energy demand lower and a well-designed system can cope quite satisfactorily with the household demand. For a very small system, a 1.1 kW pump and 10 households can be supplied with the necessary primary energy needs using a 1.9 kWp PV system with 500AH, 12V battery as storage. During the day time the pump will run from 10.00am to 2.30pm. Rest of the time will be dedicated for battery charging. At the same time, the panel size is such that it can generate enough energy even in rainy, cloudy or foggy days to keep the battery size small compared to SHS. Under such condition, irrigation can be kept pending to supply enough energy for the storage battery.

Figure VII-3: Month wise average daily insolation (kW-hr/m^2) in Bangladesh



.**Figure VII-4: Month wise average daily energy budget (kW-hr/day) for a 1.9 kWp PV nano-grid supplying power to 10 households and an irrigation pump of 1.1 kW**



3. **A calculation on water delivery for a small irrigation pump**

A 1.1kW (~1.5HP) irrigation pump can run quite satisfactorily if the input power is within 1000-800W. A 1.1kW electric pump driven by an inverter, having an overall efficiency of 50% can pump around 90,000 litres of water per day (4 hours of run time) from an average head of 7m. In case of submersible deep tube well the figure will be significantly lower due to higher water head. Most of the irrigation pumps in Bangladesh use shallow tube wells not exceeding a depth of 6-7m. As rice is the most important crop in Bangladesh that needs irrigation during the dry months, 90,000 litres per day can irrigate about 6-7 acres of rice field for a whole season (3 months). In case of other crops like vegetable, wheat or maize the area of irrigated land will be much larger as they require much less water than rice cultivation.

4. **Cost of the system and electricity price**

The description of a model system is given below
Size of the PV – 1.9kWp
Size of the battery bank – 480 AH at 12V (16x30AH batteries connected in series)
One irrigation pump (AC) – 1.1kW (1.5HP)
Charge controller – 1 unit
No. of households – 10
Summer load per house hold – 360W-hr per day
Winter load per house hold – 135 W-hr per day

Estimated PV price with installation	Tk. 2,34,000
Estimated battery price	Tk. 65,000
Irrigation pump with inverter	Tk. 50,000
Wiring + Civil Eng'g. Cost	Tk. 50,000
Charge controller	Tk. 5,000
Energy meters	Tk. 25,000
Contingencies	Tk. 20,000
Total project cost	Tk. 4,49,000
Design + Consultation fee/project	Tk. 50,000
Top supervision/ project	Tk. 30,000
Report preparation	Tk. 10,000
Total cost per pilot project	Tk. 5,39,000

Based on IDCOL model of financing (50% grant, 30% loan at 6% interest rate for 8 years and 20% equity)
Estimated energy cost for house hold electricity - Tk. 28.00/kW-hr
Estimated energy cost for irrigation - Tk. 16.00/kW-hr

Considering a monthly connection charge of Tk. 50
Electricity bill for an average household for summer months - Tk. 353
Electricity bill for an average household for winter months - Tk. 165
Average monthly bill – Tk. 260

Irrigation energy cost per season – Tk. 12, 880
(Equivalent to 10.7% of the crop produced for rice fields)

5. **Procurement of project components**

So far the system components are concerned, they will be procured from the local market. There are local companies who assemble PV panels and manufacture batteries, two most important component for the nano-grid system. It may be mentioned here that there are a number of electronic companies who produce charge controllers for the IDCOL program. When contacted some of them, they readily agreed to provide the charge controllers of required specifications for nano-grid.

6. **Managing a nano-grid: Private ownership as a business model**

The basic business model for the nano-grid is based on private ownership. A person or a company will own and install the system and will be responsible for maintaining it. As every consumer will be metered, the owner of the system will set a tariff for the electricity and will sustain by collecting the bills at the end of each month. Although the proposed mechanism is different than the IDCOL funded Solar Home System, the IDCOL Partner Organizations (POs) are of the opinion that the proposal have good prospect and they will be interested to run the model on a pilot basis.

Annex VIII: UNDP-GEF Environmental and Social Screening Procedure (ESSP)

Annex VIII-A: Environmental and Social Screening Checklist

QUESTION 1:

Has a combined environmental and social assessment/review that covers the proposed project already been completed by implementing partners or donor(s)?

Select answer below and follow instructions:

X NO → Continue to Question 2 (do not fill out Table 1.1)

☐ **YES** → No further environmental and social review is required if the existing documentation meets UNDP's quality assurance standards, and environmental and social management recommendations are integrated into the project. Therefore, you should undertake the following steps to complete the screening process:

1. Use Table 1.1 below to assess existing documentation. (It is recommended that this assessment be undertaken jointly by the Project Developer and other relevant Focal Points in the office or Bureau).
2. Ensure that the Project Document incorporates the recommendations made in the implementing partner's environmental and social review.
3. Summarize the relevant information contained in the implementing partner's environmental and social review in Annex A.2 of this Screening Template, selecting Category 1.
4. Submit Annex A to the PAC, along with other relevant documentation.

Note: Further guidance on the use of national systems for environmental and social assessment can be found in Annex B.

TABLE 1.1: CHECKLIST FOR APPRAISING QUALITY ASSURANCE OF EXISTING ENVIRONMENTAL AND SOCIAL ASSESSMENT	Yes/No
1. Does the assessment/review meet its terms of reference, both procedurally and substantively?	**N.A.**
2. Does the assessment/review provide a satisfactory assessment of the proposed project?	**N.A.**
3. Does the assessment/review contain the information required for decision-making?	**N.A.**
4. Does the assessment/review describe specific environmental and social management measures (e.g. mitigation, monitoring, advocacy, and capacity development measures)?	**N.A.**
5. Does the assessment/review identify capacity needs of the institutions responsible for implementing environmental and social management issues?	**N.A.**
6. Was the assessment/review developed through a consultative process with strong stakeholder engagement, including the view of men and women?	**N.A.**
7. Does the assessment/review assess the adequacy of the cost of and financing arrangements for environmental and social management issues?	**N.A.**

Table 1.1 (continued) For any "no" answers, describe below how the issue has been or will be resolved (e.g. amendments made or supplemental review conducted).
N.A.

QUESTION 2:

Do all outputs and activities described in the Project Document fall within the following categories?

- ☐ Procurement (in which case UNDP's Procurement Ethics and Environmental Procurement Guide need to be complied with)
- ☐ Report preparation
- ☐ Training
- ☐ Event/workshop/meeting/conference (refer to Green Meeting Guide)
- ☐ Communication and dissemination of results

Select answer below and follow instructions:

X NO → Continue to Question 3

☐ **YES** → No further environmental and social review required. Complete Annex A.2, selecting Category 1, and submit the completed template (Annex A) to the PAC.

QUESTION 3:

Does the proposed project include activities and outputs that support *upstream* planning processes that potentially pose environmental and social impacts or are vulnerable to environmental and social change (refer to Table 3.1 for examples)? (Note that *upstream* planning processes can occur at global, regional, national, local and sectoral levels)

Select the appropriate answer and follow instructions:

☐ **NO** → Continue to Question 4.

X YES →Conduct the following steps to complete the screening process:

1. Adjust the project design as needed to incorporate UNDP support to the country(ies), to ensure that environmental and social issues are appropriately considered during the upstream planning process. Refer to Section 7 of this Guidance for elaboration of environmental and social mainstreaming services, tools, guidance and approaches that may be used.
2. Summarize environmental and social mainstreaming support in Annex A.2, Section C of the Screening Template and select "Category 2".
3. If the proposed project ONLY includes upstream planning processes then screening is complete, and you should submit the completed Environmental and Social Screening Template (Annex A) to the PAC. If downstream implementation activities are also included in the project then continue to Question 4.

TABLE 3. 1 EXAMPLES OF UPSTREAM PLANNING PROCESSES WITH POTENTIAL DOWNSTREAM ENVIRONMENTAL AND SOCIAL IMPACTS	Check appropriate box(es) below
1. Support for the elaboration or revision of **global- level** strategies, policies, plans, and programmes. *For example, capacity development and support related to international negotiations and agreements. Other examples might include a global water governance project or a global MDG project.*	
2. Support for the elaboration or revision of **regional-level** strategies, policies and plans, and programmes. *For example, capacity development and support related to trans-boundary programmes and planning (river basin management, migration, international waters, energy development and access, climate change adaptation etc.).*	
3. Support for the elaboration or revision of **national-level** strategies, policies, plans and programmes. *For example, capacity development and support related to national development policies, plans, strategies and budgets, MDG-based plans and strategies (e.g. PRS/PRSPs, NAMAs), sector plans.*	**X**
4. Support for the elaboration or revision of **sub-national/local-level** strategies, polices, plans and programmes. *For example, capacity development and support for district and local level development plans and regulatory frameworks, urban plans, land use development plans, sector plans, provincial development plans, provision of services, investment funds, technical guidelines and methods, stakeholder engagement.*	**X**

QUESTION 4:

Does the proposed project include the implementation of *downstream* activities that potentially pose environmental and social impacts or are vulnerable to environmental and social change?

To answer this question, you should first complete Table 4.1 by selecting appropriate answers. If you answer "No" or "Not Applicable" to all questions in Table 4.1 then the answer to Question 4 is "NO." If you answer "Yes" to any questions in Table 4.1 (even one "Yes" can indicated a significant issue that needs to be addressed through further review and management) then the answer to Question 4 is "YES":

X NO → No further environmental and social review and management required for downstream activities. Complete Annex VII-B by selecting "Category 1", and submit the Environmental and Social Screening Template to the PAC.

☐ **YES** → Conduct the following steps to complete the screening process:

1. Consult Section 8 of this Guidance, to determine the extent of further environmental and social review and management that might be required for the project.
2. Revise the Project Document to incorporate environmental and social

management measures. Where further environmental and social review and management activity cannot be undertaken prior to the PAC, a plan for undertaking such review and management activity within an acceptable period of time, post-PAC approval (e.g. as the first phase of the project) should be outlined in Annex A.2.

3. Select "Category 3" in Annex A.2, and submit the completed Environmental and Social Screening Template (Annex A) and relevant documentation to the PAC.

TABLE 4.1: ADDITIONAL SCREENING QUESTIONS TO DETERMINE THE NEED AND POSSIBLE EXTENT OF FURTHER ENVIRONMENTAL AND SOCIAL REVIEW AND MANAGEMENT		
1.	**Biodiversity and Natural Resources**	**Answer** (Yes/No/ Not Applicable)
1.1	Would the proposed project result in the conversion or degradation of modified habitat, natural habitat or critical habitat?	**No**
1.2	Are any development activities proposed within a legally protected area (e.g. natural reserve, national park) for the protection or conservation of biodiversity?	**No**
1.3	Would the proposed project pose a risk of introducing invasive alien species?	**No**
1.4	Does the project involve natural forest harvesting or plantation development without an independent forest certification system for sustainable forest management (*e.g. PEFC, the Forest Stewardship Council certification systems, or processes established or accepted by the relevant National Environmental Authority*)?	**No**
1.5	Does the project involve the production and harvesting of fish populations or other aquatic species without an accepted system of independent certification to ensure sustainability (*e.g. the Marine Stewardship Council certification system, or certifications, standards, or processes established or accepted by the relevant National Environmental Authority*)?	**No**
1.6	Does the project involve significant extraction, diversion or containment of surface or ground water? *For example, construction of dams, reservoirs, river basin developments, groundwater extraction.*	**No**
1.7	Does the project pose a risk of degrading soils?	**No**
2.	**Pollution**	**Answer (Yes/No/ Not Applicable)**
2.1	Would the proposed project result in the release of pollutants to the environment due to routine or non-routine circumstances with the potential for adverse local, regional, and trans-boundary impacts?	**No**
2.2	Would the proposed project result in the generation of waste that cannot be recovered, reused, or disposed of in an environmentally and socially sound manner?	**No**
2.3	Will the propose project involve the manufacture, trade, release,	**No**

TABLE 4.1: ADDITIONAL SCREENING QUESTIONS TO DETERMINE THE NEED AND POSSIBLE EXTENT OF FURTHER ENVIRONMENTAL AND SOCIAL REVIEW AND MANAGEMENT		
	and/or use of chemicals and hazardous materials subject to international action bans or phase-outs? *For example, DDT, PCBs and other chemicals listed in international conventions such as the Stockholm Convention on Persistent Organic Pollutants, or the Montreal Protocol.*	
2.4	Is there a potential for the release, in the environment, of hazardous materials resulting from their production, transportation, handling, storage and use for project activities?	**No**
2.5	Will the proposed project involve the application of pesticides that have a known negative effect on the environment or human health?	**No**
3.	**Climate Change**	
3.1	Will the proposed project result in significant[63] greenhouse gas emissions? *Annex E provides additional guidance for answering this question.*	**No**
3.2	Is the proposed project likely to directly or indirectly increase environmental and social vulnerability to climate change now or in the future (also known as maladaptive practices)? You can refer to the additional guidance in Annex C to help you answer this question. *For example, a project that would involve indirectly removing mangroves from coastal zones or encouraging land use plans that would suggest building houses on floodplains could increase the surrounding population's vulnerability to climate change, specifically flooding.*	**No**
4.	**Social Equity and Equality**	**Answer (Yes/No/ Not Applicable)**
4.1	Would the proposed project have environmental and social impacts that could affect indigenous people or other vulnerable groups?	**No**
4.2	Is the project likely to significantly impact gender equality and women's empowerment[64]?	**No**
4.3	Is the proposed project likely to directly or indirectly increase social inequalities now or in the future?	**No**
4.4	Will the proposed project have variable impacts on women and men, different ethnic groups, social classes?	**No**
4.5	Have there been challenges in engaging women and other certain key groups of stakeholders in the project design process?	**No**

[63] Significant corresponds to CO_2 emissions greater than 100,000 tons per year (from both direct and indirect sources). Annex E provides additional guidance on calculating potential amounts of CO_2 emissions.

[64] Women are often more vulnerable than men to environmental degradation and resource scarcity. They typically have weaker and insecure rights to the resources they manage (especially land), and spend longer hours on collection of water, firewood, etc. (OECD, 2006). Women are also more often excluded from other social, economic, and political development processes.

TABLE 4.1: ADDITIONAL SCREENING QUESTIONS TO DETERMINE THE NEED AND POSSIBLE EXTENT OF FURTHER ENVIRONMENTAL AND SOCIAL REVIEW AND MANAGEMENT	
4.6 Will the project have specific human rights implications for vulnerable groups?	**No**
5. Demographics	
5.1 Is the project likely to result in a substantial influx of people into the affected community(ies)?	**No**
5.2 Would the proposed project result in substantial voluntary or involuntary resettlement of populations? *For example, projects with environmental and social benefits (e.g. protected areas, climate change adaptation) that impact human settlements, and certain disadvantaged groups within these settlements in particular.*	**No**
5.3 Would the proposed project lead to significant population density increase which could affect the environmental and social sustainability of the project? *For example, a project aiming at financing tourism infrastructure in a specific area (e.g. coastal zone, mountain) could lead to significant population density increase which could have serious environmental and social impacts (e.g. destruction of the area's ecology, noise pollution, waste management problems, greater work burden on women).*	**No**
6. Culture	
6.1 Is the project likely to significantly affect the cultural traditions of affected communities, including gender-based roles?	**No**
6.2 Will the proposed project result in physical interventions (during construction or implementation) that would affect areas that have known physical or cultural significance to indigenous groups and other communities with settled recognized cultural claims?	**No**
6.3 Would the proposed project produce a physical "splintering" of a community? *For example, through the construction of a road, power line, or dam that divides a community.*	**No**
7. Health and Safety	
7.1 Would the proposed project be susceptible to or lead to increased vulnerability to earthquakes, subsidence, landslides and erosion, flooding or extreme climatic conditions? *For example, development projects located within a floodplain or landslide prone area.*	**No**
7.2 Will the project result in increased health risks as a result of a change in living and working conditions? In particular, will it have the potential to lead to an increase in HIV/AIDS infection?	**No**
7.3 Will the proposed project require additional health services including testing?	**No**
8. Socio-Economics	
8.1 Is the proposed project likely to have impacts that could affect women's and men's ability to use, develop and protect natural resources and other natural capital assets? *For example, activities that could lead to natural resources*	**No**

TABLE 4.1: ADDITIONAL SCREENING QUESTIONS TO DETERMINE THE NEED AND POSSIBLE EXTENT OF FURTHER ENVIRONMENTAL AND SOCIAL REVIEW AND MANAGEMENT		
	degradation or depletion in communities who depend on these resources for their development, livelihoods, and well-being?	
8.2	Is the proposed project likely to significantly affect land tenure arrangements and/or traditional cultural ownership patterns?	**No**
8.3	Is the proposed project likely to negatively affect the income levels or employment opportunities of vulnerable groups?	**No**
9.	**Cumulative and/or Secondary Impacts**	**Answer (Yes/No/ Not Applicable)**
9.1	Is the proposed project location subject to currently approved land use plans (e.g. roads, settlements) which could affect the environmental and social sustainability of the project? *For example, future plans for urban growth, industrial development, transportation infrastructure, etc.*	**No**
9.2	Would the proposed project result in secondary or consequential development which could lead to environmental and social effects, or would it have potential to generate cumulative impacts with other known existing or planned activities in the area? *For example, a new road through forested land will generate direct environmental and social impacts through the cutting of forest and earthworks associated with construction and potential relocation of inhabitants. These are direct impacts. In addition, however, the new road would likely also bring new commercial and domestic development (houses, shops, businesses). In turn, these will generate indirect impacts. (Sometimes these are termed "secondary" or "consequential" impacts). Or if there are similar developments planned in the same forested area then cumulative impacts need to be considered.*	**No**

ANNEX VIII-B: ENVIRONMENTAL AND SOCIAL SCREENING SUMMARY
(To be filled in after Annex VII-A has been completed)

Name of Proposed Project: "Development of Sustainable Renewable Energy Generation for Bangladesh" (SREPGen)

A. Environmental and Social Screening Outcome
Select from the following:

X Category 1. No further action is needed

☐ Category 2. Further review and management is needed. There are possible environmental and social benefits, impacts, and/or risks associated with the project (or specific project component), but these are predominantly indirect or very long-term and so extremely difficult or impossible to directly identify and assess.

☐ Category 3. Further review and management is needed, and it is possible to identify these with a reasonable degree of certainty. If Category 3, select one or more of the following sub-categories:

☐ Category 3a: Impacts and risks are limited in scale and can be identified with a reasonable degree of certainty and can often be handled through application of standard best practice, but require some minimal or targeted further review and assessment to identify and evaluate whether there is a need for a full environmental and social assessment (in which case the project would move to Category 3b).

☐ Category 3b: Impacts and risks may well be significant, and so full environmental and social assessment is required. In these cases, a scoping exercise will need to be conducted to identify the level and approach of assessment that is most appropriate.

B. Environmental and Social Issues (for projects requiring further environmental and social review and management)

In this section, you should list the key potential environmental and social issues raised by this project. This might include both environmental and social opportunities that could be seized on to strengthen the project, as well as risks that need to be managed. You should use the answers you provided in Table 4.1 as the basis for this summary, as well as any further review and management that is conducted.

C. Next Steps (for projects requiring further environmental and social review and management):

In this section, you should summarize actions that will be taken to deal with the above-listed issues. If your project has Category 2 or 3 components, then appropriate next steps will likely involve further environmental and social review and management, and the outcomes of this work should also be summarized here. Relevant guidance should be obtained from Section 7 for Category 2 and Section 8 for Category 3.

D. Sign Off

Project Manager	**Date**
PAC	**Date**
Programme Manager	**Date**