People's Republic of Bangladesh
Infrastructure Development Company Limited (IDCOL)

People's Republic of Bangladesh Preparatory Survey on Renewable Energy Development Project

Final Report

November 2012

Japan International Cooperation Agency

Mitsubishi Research Institute, Inc.

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“PREPARATORY SURVEY ON RENEWABLE ENERGY DEVELOPMENT PROJECT”

<Final Report>

Prepared for:
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
INFRASTRUCTURE DEVELOPMENT COMPANY LIMITED (IDCOL)

Prepared by:
MITSUBISHI RESEARCH INSTITUTE, INC.

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Acronyms

AC	Air Conditioner
ACEF	Asian Clean Energy Fund (ADB)
ADB	Asian Development Bank
ADF	Asian Development Fund (ADB)
AFD	L'Agence Française de Développement
ALM	Asset Liability Management
ASEI	Asia Solar Energy Initiatives
BADC	Bangladesh Agricultural Development Corporation
BAU	Business as Usual
BBS	Bangladesh Bureau of Statistics
BCS	Battery Charging Station
BCAS	Bangladesh Centre for Advanced Studies
BCCRF	Bangladesh Climate Change Resilience Fund
BEE	Bureau of Energy Efficiency
BERC	Bangladesh Energy Regulatory Commission
BFRS	Bangladesh Financial Reporting Standards
BIDS	Bangladesh Institute of Development Studies
BNBC	Bangladesh National Building Code
BOCM	Bilateral Offset Credit Mechanism
BOD	Biochemical Oxygen Demand
BOO	Build Own Operate
BOP	Base of Pyramid
BOS	Balance of System
BOT	Build Operate Transfer
BPDB	Bangladesh Power Development Board
BRAC	BRAC
BRESL	Barrier Removal to the cost-effective development and implementation of Energy efficiency Standards and Labeling
BSTI	Bangladesh Standards Testing Institute
BTK	Bulls trench kiln
BTS	Base Transceiver Station
BUET	Bangladesh University of Engineering and Technology
BTS	Base Transceiver Station
CaCO3	Calcium Carbonate
CCF	Climate Change Fund (ADB)
CCTF	Climate Change Trust Fund
CDM	Clean Development Mechanism
CEO	Chief Executive Officer
CES	Center for Energy Studies, BUET
CFL	Compact Fluorescent Light
CH4	Methane
CO2	Carbon Dioxide
COD	Chemical Oxygen Demand
CONTASA	Convertible Taka Special Account
COP	Coefficient of Power
CRAB	Credit Rating Agency of Bangladesh
DAC	Development Assistance Committee
DAE	Department of Agricultural Extension

DB	Dispute Board
DC	Designated Consumer
DESCO	Dhaka Electric Supply Company Limited
DfID	Department for International Development
DF/R	Draft Final Report
DOSA	Dollar Special Account
DPDC	Dhaka Power Distribution Company Limited
DPP	Development Project Proposal
DSCR	Debt Service Coverage Ratio
EC	Energy Conservation
EE&C	Energy Efficiency and Conservation
EEFP	Energy Efficiency Financing Platform
EIA	Environmental Impact Assessment
EIA	US Energy Information Administration
ELIB	Efficient Lighting Initiatives of Bangladesh
EMP	Environmental Management Plan
EPC	Engineering, Procurement and Construction
ERD	Economic Relations Department
ES&L	Energy Standards and Labels
ESCO	Energy Service Company
ESMAP	Energy Sector Management Assistance Program
ESMF	Environmental and Social Management Framework
ESMS	Environmental and Social Management System
FCK	Fixed chimney kiln
FEEED	Framework for Energy Efficient Economic Development
FI	Financial Institution
FIT	Feed-in Tariff
F/R	Final Report
F/S	Feasibility Study
FTL	Fluorescent Tube Light
FY	Fiscal Year
GEF	Global Environment Facility
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoB	Government of Bangladesh
GoJ	Government of Japan
GPOBA	Global Partnership on Output-Based Aid
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HFO	Heavy Fuel Oil
HHK	Hybrid Hoffman kiln
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
IAS	International Accounting Standards
ICC	Internal Control and Compliance
IC/R	Inception Report
ICT	Information & Communication Technology
IDA	International Development Association
IDB	Islamic Development Bank
IDC	Interest cost During Construction
IDCOL	Infrastructure Development Company Limited
IEA	International Energy Agency
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IFRS	International Financial Reporting Standards
IGCC	Integrated Coal Gasification Combined Cycle

IPP	Independent Power Producer
IRR	Internal Rate of Return
IT	Information Technology
IT/R	Interim Report
JFY	Japanese Fiscal Year
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JICS	Japan International Cooperation System
KfW	KfW Entwicklungsbank
KOICA	Korea International Cooperation Agency
L/A	Loan Agreement
LED	Light Emitting Diode
LFO	Light Fuel Oil
LGED	Local Government Engineering Department
LIBOR	London Inter-Bank Offered Rate
MDGs	Millennium Development Goals
MEPS	Minimum Efficiency Performance Standards
MFI	Microfinance Institutions
MIS	Management Information System
M/M	Minutes of Meeting
MoEF	Ministry of Environment and Forest
MOF	Ministry of Finance
MoPEMR	Ministry of Power, Energy and Mineral Resources
MTEE	Market Transformation for Energy Efficiency
N/A	Not Available
NASA	National Aeronautics and Space Administration
NBFI	Non-Bank Financial Institution
NDBMP	National Domestic Biogas and Manure Program
NEDO	New Energy and Industrial Technology Development Organization
NEP	National Energy Policy
NGO	Non-Governmental Organization
NMEEE	National Mission for Enhancing Energy Efficiency
NPV	Net Present Value
NSDS	National Sustainable Development Strategy
OCR	Ordinary Capital Resources (ADB)
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
O&M	Operation and Maintenance
PAT	Perform Achieve Trade
PBS	Palli Bidyut Samities (Rural Electricity Association)
PDCA	Plan – Do – Check – Act
PKSF	Palli Karma Shahayak Foundation
PMU	Project Management Unit
PO	Participating Organization
PPA	Power Purchase Agreement
PPIDF	Public-Private Infrastructure Development Facility
PRSP	Poverty Reduction Strategic Plan
PSMP	Power Sector Master Plan
PSR	Project Status Report
PSA	Pressure Swing Absorption
PV	Photovoltaics
RAPSS	Remote Area Power Supply Systems
RE	Renewable Energy

RERC	Renewable Energy Research Centre
RERED	Rural Electrification and Renewable Energy Development
RPC	Recruit and Promotion Committee
SARI	South Asia Regional Initiative
SED	(GIZ) Sustainable Energy for Development
SEDA	Sustainable Energy Development Authority
SHS	Solar Home System
SIDA	Swedish International Development Cooperation Agency
SME	Small and Medium Sized Enterprise
SNV	SNV
SOD	Secured Overdraft
SOW	Scope of Work
SREDA	Sustainable & Renewable Energy Development Authority
SSHS	Small Solar Home System
TOR	Terms of Reference
TSP	Technical Service Provider
UNDP	United Nations Development Programme
UNPAN	United Nations Public Administration Network
USAB	Upflow Anaerobic Sludge Blanket
USAID	United States Agency for International Development
VAT	Value Added Tax
VSBK	Vertical shaft brick kiln
WACC	Weighted Average Cost of Capital
WB	World Bank
WFP	World Food Programme
WRI	World Resources Institute
WZPDCL	West Zone Power Distribution Company

Units

Ah	Ampere Hour
cm	Centimeter
dBA	Decibel (A-filter)
GW	Gigawatts
GWh	Gigawatt Hour
ktoe	Kilo Ton Oil Equivalent
kWh	Kilowatt Hour
kWp	Kilowatt Peak
L	Liter
lm	Lumen
mg	Milligram
mho	mho = Siemens (Conductance)
MW	Megawatts
MWh	Megawatt Hour
Nm3	Normal Cubic meter
ton, t	Metric ton
toe	Ton Oil Equivalent
W	Watt
Wp	Watt Peak

Other Units Commonly Quoted in Bangladesh

Bigha	1/3 acre = 1,350 square meters
Decimal	1/33 bigha = 40.9 square meters

Currencies:

BDT	Bangladesh Taka
EUR	Euro
FRF	French Francs
JPY	Japanese Yen
KRW	Korean Won
USD	US dollar

Exchange Rate:

1 USD = 83 BDT

Fiscal Year in Bangladesh:

1 July – 30 June
e.g. Fiscal Year 1 July 2012 to 30 June 2013
= FY 2012/13

Note: Unless otherwise stated, indications of a year or an annual rate are all based on a calendar year.

EXECUTIVE SUMMARY

1. Overview of JICA-Renewable Energy Development Project in Bangladesh

Project Name:

- JICA "Renewable Energy Development Project" (JICA-REDP) in Bangladesh

Objective of JICA-REDP

- To promote the usage of RE and application of EE&C measures in Bangladesh, by extending Japanese ODA loan in the form of a two-step loan through IDCOL.

- JICA-REDP is expected to promote the diversification of energy source for electricity generation, and therefore contribute to the improvement of local living conditions and climate change mitigation.

- Further, the Project aims to develop the RE deployment capacity of IDCOL so as to enable the company to be capable of disseminating its know-how in to other developing countries.

Scope of JICA-REDP

- The Provision of a two-step loan for SHS Program Component: IDCOL accredits, through financial and technological appraisal results, the participating organizations that will sell new equipment for RE deployment and render after-sales services. The loan will be provided from IDCOL to these POs. This will enable microfinance facilities to be extended from the POs to the end-users of sub-projects.

- Provision of a two-step loan for Other RE Program Components: IDCOL accredits, through financial and technological appraisal of proposals, RE sub-projects to be conducted by sponsors. By utilizing the JICA two-step loan, sponsors will deploy and operate RE equipment.

- Capacity Development: The progress of JICA-REDP will be promoted and the capacity development for JICA-REDP's executing agency will be supported through dispatch of experts and facilitation for IDCOL's own capacity development activities.

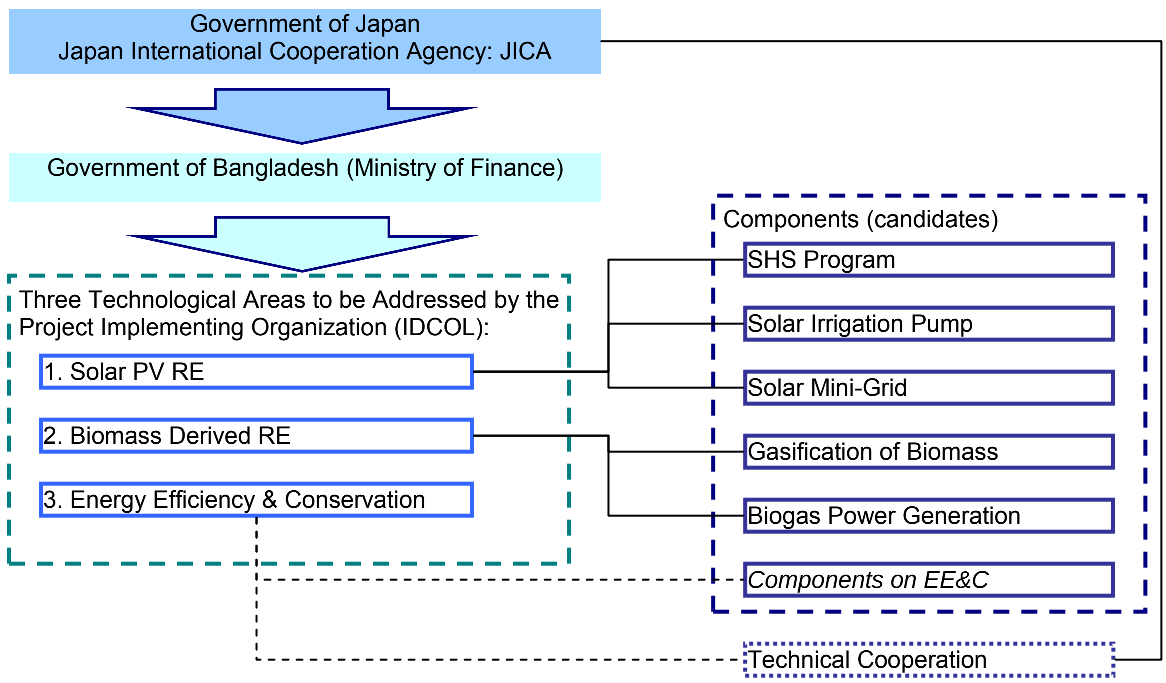
Target Geographical Area

- Applicable to the entire territory of Bangladesh

Executing Agency of JICA-REDP

- Infrastructure Development Company Limited (IDCOL)

Overall Structure of the Project:



Source: Survey Team

1) Background of JICA-REDP:

As of 2009, at 252 kWh, the annual electricity usage per capita of Bangladesh is one of the lowest in the world[1]. In response to the country's robust macroeconomic growth, the demand for electricity is on a sharp rise. As a consequence, it was determined that the country's current supply of electricity is not sufficient to meet such increased demand. Currently, according to Bangladesh Power Development Board (BPDB) data, Bangladesh generates a total load of 8,099 MW (as of May 2012) of electricity, and the country has an available generation capacity in the range of 5,500-6,500 MW. Note that during the summer period, 1,500 MW of the load shedding is common.[2]

As of May 2012, the household electrification rate at the national level is at 50 percent.[3] In the country, there are 95 million people without access to electricity. Next to India (405 million), this figure is the second largest in South Asia, The electrification rate in the urban area is at 90 percent and electrification rate in the rural area is at 35 percent. This implies that there is a significant potential demand for the electrification of rural areas.[4] Therefore, the top issues for the electricity and energy sector are: (i) the promotion of rural electrification by diversifying its source of energy, and (ii) the security of a stable supply of electricity. Some proposed solutions to these concerns are the introduction of renewable energy (RE), the development of new sources of electricity, and the efficiency adjustment of existing facilities.

In the Government of Japan's Country Assistance Program for Bangladesh (May 2006), the power sector is one of the priority sectors under the economic growth domain. Assistance to boost power generation capacity is positioned as an essential measure to narrow the supply–

[1] OECD/IEA (2011a)
[2] BPDB website information
[3] idem
[4] idem

demand gap of electricity. Within this framework, the Japan International Cooperation Agency (JICA) is committed to support the power sector through power/energy infrastructure development. This includes support for RE deployment as a part of its "Electricity Supply Stabilization Program" for economic infrastructure development.

The Solar Energy Program, currently called the SHS Program, is an initiative of IDCOL since 2003. The program is collaboration with Grameen Shakti, BRAC, and other Non Governmental Organizations (NGOs) as Participating Organizations (POs). It aims to disseminate Solar Home Systems (SHS) in rural areas in the country through micro-finance schemes. This is to relieve the initial cost of installation. As of June 2011, the program achieved the installation of approximately one million units (accumulated total). IDCOL, based on the experiences gathered through such program, is planning to expand the scope of RE dissemination to solar pumps for irrigation, photovoltaic mini–grid, and biomass gas power generation.

In June 2011, with reference to the above mentioned plan by IDCOL, a request for consideration of utilization of a Japanese Official Development Assistance (ODA) loan was submitted by the Government of Bangladesh (GoB). The proposed project will be implemented through the utilization of the Japanese ODA loan. It will be called the "Renewable Energy Development Project" in Bangladesh (hereinafter, it will be called the "JICA-REDP"). By extending Japanese ODA loan to end-users in the form of a two-step loan, the JICA-REDP is expected to promote the use of RE and the application of energy efficiency and conservation (EE&C) measures.

Within the context mentioned, this Survey was conducted with the aim to collect and analyze information required for the approval of JICA-REDP as a Japanese ODA loan project. The overall goal, target geographical area, scope, required cost, institutional formation for execution, management, maintenance and control structure, and environmental and social considerations will be included in the required output of the Survey.

2) Features of JICA-REDP:

Facilitation will be required to promote the RE and EE&C measures, just like most cases in other countries. These measures will be effective through available forms of subsidies, concessional loans, tax reliefs, and preferred purchase agreements, among other various forms of incentives. This is due to the tendency that energy from renewable sources are relatively expensive compared with conventional fossil-fuel energy. In addition, energy efficiency measures tend to be commercially marginal in terms of cost recovery. These disadvantages for RE and EE&C measures become prominent especially in the developing countries, where conventional fuel price is kept low. In this context, Bangladesh is no exception. Fuel price is kept at a low level to provide energy at an affordable rate.

This Survey aims to elaborate on the specifications of and requirements for the Japanese ODA loan project for RE deployment and EE&C measures application. This will be conducted through a two-step loan scheme whereby the fund is channeled to component implementing entities through IDCOL. The project implementation plan, which includes the project scheme, a list of potential components, the project cost, and financing arrangements and timetable, will be formulated as one of the outputs of from this Survey.

2. Renewable Energy and Energy Efficiency in Bangladesh

1) Power Sector in Bangladesh:

The population of Bangladesh is approximately 148,692,000 as of 2010, and the current GDP is USD 100 billion.[5] The country's current GNI is USD 700 per capita, and it is classified as a

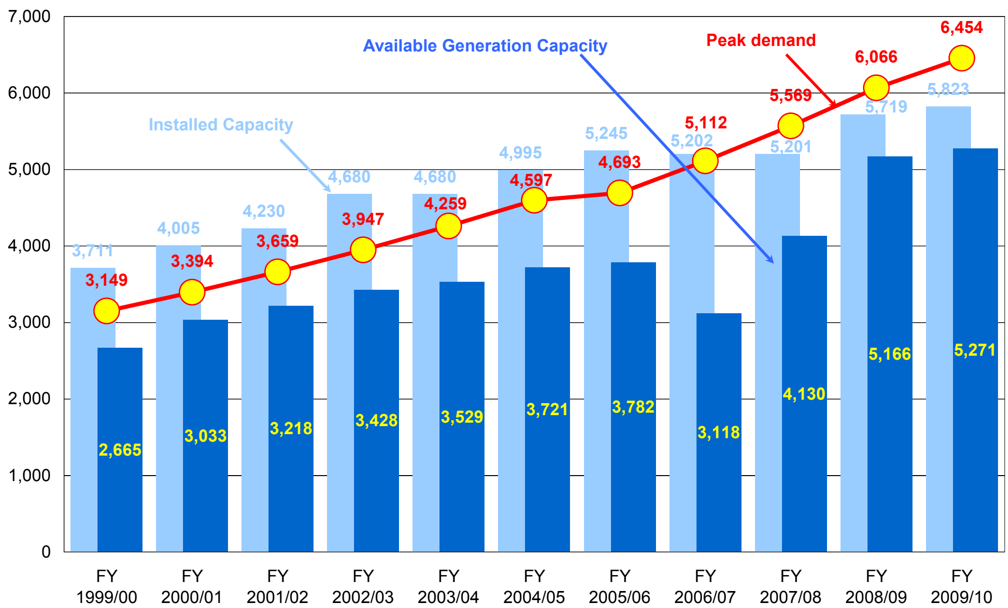
[5] World Bank (2011)

Low Income Country by the World Bank. Among the country's total population, 41 percent are offered an access to electricity (as of 2009). This access rate of population to electricity is the lowest in South Asian countries.[6]

Bangladesh's total electricity production is 37,862 GWh, and its per capita consumption is 252 kWh per year (as of 2009).[7] This figure is one of the lowest in Asia, next to Nepal, Myanmar and Cambodia, and is comparable to the figure of some of the sub-Saharan African countries.[8]

2) Electric Power Policy, Situation of Electricity Supply:

The Power Division of the Ministry of Power, Energy, and Mineral Resources (MoPEMR) is the responsible authority for making and implementing the policies for electricity. The department, in its vision statement, stated its goal of providing access to affordable and reliable electricity to the majority of the people of Bangladesh by 2020. The statement is backed-up by a plan to increase the country's electricity power generation capacity to 15,000 MW. However, the country's electricity power generation capacity has only increased slightly from FY 2000/01 to FY 2009/10. This resulted in a severe supply and demand gap. The current government, when it came to power, has a commitment in its election manifesto. This is to stabilize the electricity power supply by increasing the country's power generation capacity.



(Unit: MW)
Note: Fiscal Year in Bangladesh = 1 July – 30 June
Source: BPDB Annual Report 2010

Year-Wise Installed, Generation Capacity and Demand

The economic growth rate of Bangladesh from 2010 to 2011 was 6.7 percent, and was expected to be seven percent in 2011-2012. The target for 2015 is to attain eight percent annual growth.[9] Despite the target, the power generation capacity cannot catch up with the increasing demand of power consumption. As of 2010, the electricity generation capacity was 5,823MW.[10] From this figure, the available power generation capacity was 5,271MW, which is 90.5 percent of the total

[6] idem
[7] IEA (2011)
[8] idem
[9] Planning Commission (2010)
[10] BPDB website information

power generation capacity. The ratio of supply to demand of 6,454MW was 81.7 percent.[11] Since 2010, the current government has adopted the power generator capacity enhancement policy under notion that power shortage is the major bottleneck for economic development.

In 2010, the government purchased 520 MW capacity from the private sector and rental companies as emergency measures. This is to enhance the capacity by 775 MW, which includes the expansion by the BPDB. Enhanced power generation capacity in 2011 was 1,596 MW out of which 1,236 MW was the rental power generation. This comprised 77.4 percent of the total enhanced capacity. The enhancement plan from 2012 will be focused on the private sector, with a new expansion plan to reach 14,175 MW by the year of 2016.

2) Existing Policy Framework for Renewable Energy and Energy Efficiency:

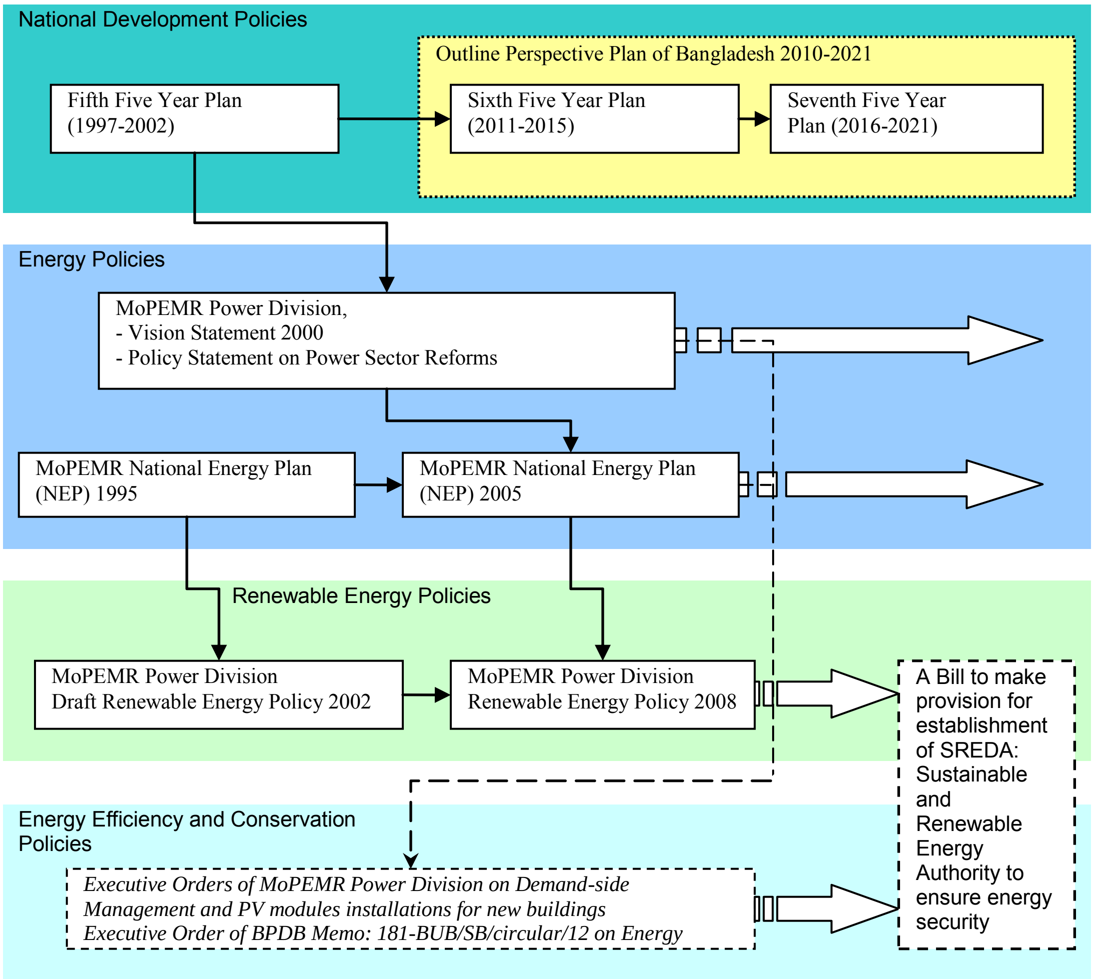
Bangladesh's superior development plan is on the mid-term plan document, entitled the five year plan. The current version of the five year plan is the "Sixth Five Year Plan (2011-2015)" which was adopted by the GoB in 2009. In June 2010, an "Outline Perspective Plan of Bangladesh 2010-2021-Making Vision 2021 a Reality" was issued as a strategic long term plan.[12] This Outline Perspective Plan is meant to embrace two consecutive five year plans, namely the sixth and seventh five year plans, to materialize what is stipulated as goals. The Outline Perspective Plan, refers to the desperate need to reinforce the country's energy infrastructure as well as to the need to promote the use of non-traditional renewable energy.

The current national energy policy is the 1995 National Energy policy (NEP)[13]. It was updated in 2005 to incorporate two newly established overall plans on power sector, namely the Vision Statement and the Policy Statement. In response to these NEPs, Renewable Energy Policies were prepared. The latest of the policy is the 2008 version, which reflects the update of NEP in 2005.[14] This Renewable Energy Policy 2008 sets out a concrete target for introduction of RE to five percent of the total power demand by 2015, and ten percent by 2020.

The Sixth Five Year Plan (2011 -2015), within the context of ensuring energy security, sets out orientations for energy efficiency and conservation, both in supply and demand sides of energy. The measures on the improving efficiency of the power sector and reducing system loss are mentioned in broad terms. On the other hand, the measures on the demand side are not stipulated in the plan.

Gob has issued executive orders to promote EE&C. An example of which is an order requiring market closure at 20:00 and staggered holidays, setting air conditioner temperature at 25 degrees centigrade, and limiting irrigation to nighttime. Another executive order requires new buildings to install solar PV modules to offset electricity consumption.

[11] idem
[12] Planning Commission (2010)
[13] MoPEMR (1995)
[14] MoPEMR Power Division (2008)



Source: Survey Team

Development Policies, Energy Policies and Renewable Energy Policies

There is also a policy for promotion of RE specialized on solar PV. The MoPEMR, with the support from Asian Development Bank (ADB), introduced the "500 MW Solar Power Program". This plan is in line with the Ministry's plan to develop the power generation capacity up to 16,000MW by 2015. Within this figure, 800 MW is expected to be the contribution of RE. Solar PV is intended to take 500 MW out of this figure.

The 500MW Solar Power Program, supported by ADB, forms a part of the bank's "Asia Solar Energy Initiatives" (ASEI). In this initiative, ADB aims to install 3,000 MW solar PV power generation capacity in the Asia Pacific region by 2013. GoB, with endorsement for ADB's ASEI, has embarked on this ambitions program to promote solar PV.

4) JICA-REDP Within the Context of the GoB Policy Framework

JICA-REDP to be executed by IDCOL, financed by the Government of Japan, is fully in line with the context of MoPEMR's 2008 Renewable Energy Policy. JICA-REDP promotes the technologies specified in the Policy, i.e., solar PV and biomass. These RE technologies are not only expected to promote sustainable growth of the rural economy. It is also expected to offset the use of conventional fossil fuels.

The Renewable Energy Policy of Bangladesh sets out an ambitious goal to deploy RE to reach ten percent of the total power generation capacity by 2020. JICA-REDP will contribute significantly to attain this goal by adding RE-based power generation capacity at grassroots level.

The JICA-REDP is also expected to contribute to the EE&C policy and action plans which are likely to be drafted and implemented once Bangladesh's authority for EE&C is formulated.

3. Project Executing Agency of JICA-REDP

The Infrastructure Development Company Limited (IDCOL) is a Government-Owned non-banking financial institution that was established in 1997. IDCOL is the largest local financier in private sector infrastructure and renewable energy financing. IDCOL is funded by the Government and International Development Partners, i.e. the World Bank (WB), ADB, KfW, Gesellschaft für Internationale Zusammenarbeit (GIZ), Islamic Development Bank (IDB), SNV, and others. IDCOL and its activities are under the supervision of the Economic Relations Department (ERD) of the Ministry of Finance (MOF).

The management structure of IDCOL takes the form of executive director governance, which is commonly used in corporations. Its top management body is the Board of Directors, under which an Executive Director and Chief Executive Officer (CEO) reports and serves. The Board is represented by members from both the public and private sectors. There are five sections under the management of the Deputy Executive Director, namely the Corporate Affairs & Finance Branch, the Legal Branch, the Loan Branch, the Investment Branch, and the Biogas and Environment and Social Safeguards Management Unit.

1) Interventions by Other Development Partners to IDCOL's RE Activities:

The interventions specific to RE and EE&C sub-sectors have been taking place with the support of various International Development Partners. IDCOL's Solar Home System (SHS) Program, which is supported by the WB Rural Electrification and Renewable Energy Development (RERED) project, is a representative example that has been sustained for several years. The support from some other developing partners, notably the KfW, ADB, and IDB, are mostly executed in harmony under RERED project arrangements.

Major Interventions in RE and EE&C Sub-Sectors

Development Partners	Project Name	Description	Amount	Period
World Bank (IDA)	RERED (Rural Electrification and Renewable Energy Development)	RERED Project includes supports to: 1) through IDCOL SHS program 2) through Power Cell: RAPSS (Remote Area Power Supply Systems) Guidelines 3) through REB: ELIB to distribute CFLs	Loan: 1)USD 55 million 2)USD 83 million 3)USD 172 million 4)USD128 million	2003-12 1)RERED 2)RERED additional-1 financing 3)RERED additional-2 2012-18 4) RERED 2 (proposed)
GIZ (Includes former GTZ activities)	SED (Sustainable Energy Development)	Support to IDCOL on SHS Program, Technical cooperation on: Biogas plant, improved cooking stove (ICS) Efficient rice parboiling, CFL distribution.	Grant: EUR 8.2 million	2006-12
KfW	Renewable Energy Project	Supports IDCOL activities mostly through grants.	Loan: EUR 0.1 million Grant: EUR 25.1 million	2007-12

ADB	PPIDF Public-Private Infrastructure Development Facility	Balanced supports to both infrastructure and RE development.	Loan: USD 83 million Technical Assistance: USD 0.5 million	2009-12
IDB,	Improving Rural Households Livelihood through Solar Energy Project	Supports SHS Program only	Loan: USD 14.5 million	2010-11
SNV	NDBMP (National Domestic Biogas and Manure Program)	Deployment of small scale biodigesters for households	Grant: EUR 4 million	2006-12

Source: Compiled by the Survey Team

2) Further Fund Requirement for IDCOL Renewable Energy Program up to 2016:

In July 2012, IDCOL revised its RE additional fund requirement up to 2016. The new requirement for implementation of RE Programs and RE Project from 2012 to 2016 amounts to USD 610 million. This amount is composed of a USD 92 million grant and a USD 518 million loan. From of the required USD 92 million, IDCOL claims that USD 72 million is already available and the remaining USD 20 million is yet to be sought. Similarly, from of the total of USD 518 million requirement of loan, USD 246 million is already available and the balance of USD 271 million is additionally required.

IDCOL's Fund Requirement for RE Programs and RE Projects

<table>
<tr><th rowspan="2"></th><th rowspan="2">Average Capacity</th><th rowspan="2">Number (2012-16)</th><th colspan="4">Grant (USD million)</th><th colspan="4">Loan (USD million)</th></tr>
<tr><th>Required</th><th>Total Requirement</th><th>Available (including proposed)</th><th>Additional requirement</th><th>Required</th><th>Total Requirement</th><th>Available (including proposed)</th><th>Additional requirement</th></tr>
<tr><td>Solar Mini-Grid</td><td>150 KW</td><td>50</td><td>15</td><td rowspan="6">50</td><td rowspan="6">43</td><td rowspan="6">7</td><td>9</td><td rowspan="6">44</td><td rowspan="6">18</td><td rowspan="6">26</td></tr>
<tr><td>Solar Water Pump for Irrigation</td><td>400m3/day</td><td>1,550</td><td>25</td><td>19</td></tr>
<tr><td>Solar PV Based Cold Storage</td><td>1000 m3</td><td>34</td><td>4</td><td>2</td></tr>
<tr><td>Solar dryer</td><td>80 kg</td><td>12,250</td><td>2</td><td>2</td></tr>
<tr><td>Biogas based Power Plant</td><td>20 KW</td><td>450</td><td>3</td><td>7</td></tr>
<tr><td>Biomass Gasification Based Power Plant</td><td>200 KW</td><td>28</td><td>2</td><td>5</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">IDCOL SHS Program</td><td><30 Wp + all sized SHS in 2012</td><td>1,268,562</td><td></td><td>28</td><td>17</td><td>10</td><td></td><td></td><td></td><td></td></tr>
<tr><td>For all sized SHS</td><td>2,679,732</td><td></td><td>-</td><td>-</td><td>-</td><td></td><td>458</td><td>225</td><td>233</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>IDCOL Biogas Program</td><td>2.4 m3</td><td>77,431</td><td></td><td>15</td><td>11</td><td>3</td><td></td><td>16</td><td>4</td><td>12</td></tr>
<tr><td>Total</td><td></td><td></td><td></td><td>92</td><td>72</td><td>20</td><td></td><td>518</td><td>246</td><td>271</td></tr>
</table>

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects Up to 2016 (July 2012)

With a total funding requirement amounting to USD 486 million, the SHS Program is the largest in scale in terms of funding requirement. From this amount, USD 458 million is the loan requirement. The grant requirement is USD 28 million, which is limited to small SHS installations.

4. Environmental and Social Considerations

IDCOL will follow the "Current Environmental and Social Conditions as the Baseline"; "Rules and Institutions on Environmental and Social Considerations"; "The Bangladesh Environment Conservation Act"; "The Environment Conservation Rules"; "Legislation and Policy on Battery Recycling"; "JICA Environmental Guidelines"; and "IDCOL Environmental Framework".

The components screening criteria, from the viewpoint of environmental and social considerations, are the:

- Potential Environmental and Social Impact and Mitigation Measures, and
- Environmental Monitoring Plan.

The capacity development requirements for the implementing organization on environmental and social considerations are the:

- Environmental Management Capacity,
- Recommendation on Capacity Development, and
- Reinforcing IDCOL's ESMF.

1) Screening Criteria for the Selection of Appropriate Sub-Projects

The component candidates will not include a component that has significant adverse impacts on the environment and society (Category A level of JICA Guidelines). In order to select the appropriate sub-projects in the components, from a viewpoint of environmental and social considerations, the Survey Team prepared the environmental and social criteria. The screening criteria are found below:

- The sub-project shall observe related environmental laws and regulations including "The Bangladesh Environment Conservation Act", "The Environment Conservation Rules, 1997", and "Lead Acid Battery Recycling and Management Rules (Statutory Regulatory Order No. 175-Act/2006)".
- The sub-project categorized as "Category A" in "JICA Guidelines" will be rejected in JICA-REDP.
- The sub-project requiring EIA in obedience to the "Environment Conservation Rules, 1997", including Red category projects, will be rejected in JICA-REDP.
- The sub-project shall not require physical relocation.
- The sub-project shall not require clearing of natural forest.
- The biomass gasification sub-project shall take proper counter-measures to prevent health disturbance derived from smoke and dust

IDCOL examines the potential positive and negative environmental impacts of each sub-project, and conducts the environmental screening in the appraisal stage.

2) Environmental Monitoring Plan:

IDCOL will supervise the environmental monitoring to comply with JICA Guidelines and will regularly report the results to JICA. The environmental monitoring items are shown in the following table. Note that the monitoring items will be revised or updated appropriately based on the monitoring outcomes and operating conditions.

Environmental Monitoring Item

Component	Category level of typical sub-project in JICA Guidelines	Monitoring Item
SHS Program	B	• Collection of expired battery • Distribution of new battery

		• Battery recycling plants
Solar Irrigation Pump	B	• Operation and maintenance condition of solar irrigation pump
Solar Mini-Grid	C	• Operation and maintenance condition of solar mini-grid
Gasification of Biomass	B	• Visual condition of smoke and dust from gasification • Condition of precipitation equipment • Health condition of worker and local people • Smoke quality (as needed)
Biogas Power Generation	C	• Biogas leakage during normal operation conditions

Source: Survey Team based on JICA Guidelines

5. Components of JICA-REDP:

Certain portions of IDCOL's five RE Programs and Projects can be considered as the subject of assistance through the JICA-REDP. Based on the latest fund requirement, availability of funds, and implementation timetable, these portions will be suggested by the Survey Team,

1) SHS Program Component

The total required cost for the 2,680,000 SHS sets to be added by 2015 is USD 788 million. The loan will cover USD 458 million of this amount, from which USD 233 million still needs to be procured. The Survey Team recommends to the Government of Japan that it offer a loan that would account for 21.8 percent of the total requested amount, i.e., USD 100 million (i.e. 21.8 percent of USD 458 million). This will contribute to the installing of 585,094 SHS sets (i.e. 21.8 percent of 2,679,732 sets), that will provide electricity to 1.82 percent of the households in Bangladesh. Should it be granted, the loan offer by Japan will increase Bangladesh's SHS electrification rate up to 12.5 percent.

Subject for Assistance through JICA-REDP: SHS Program Component

	SHS Program Total	(JICA Portion)
Targets	Additional **2,679,732 sets (100%)** From 2013 to 2015 Average size: 42 Wp	**585,094 sets (22%)** From 2013 to 2015.
Total required cost (USD million)	788 (USD 294 per set)	172
Equity portion (USD million)	302 (38% of the total cost) (Down payment + finance by POs)	65.9
Grant (USD million)	28 (4% of the total cost) (Buy down grant)	6.1
Loan (USD million)	458 (58% of the total cost)	**100 (JICA ODA Loan)**

Source: Survey Team based on IDCOL Funding Requirement and analyses

2) Solar Irrigation Pump Component

The installation of 1,550 Solar Irrigation Pumps requires a total cost of USD 62 million. The grant is expected to cover USD 25 million, while the loan of USD 19 million will be required. Five million USD is already available to IDCOL, while the remaining USD 14 million still needs to be secured. The Survey Team, with reference to Japan's strength and experience in solar PV pump facilities, recommends that the Japanese ODA loan should cover the total remaining USD 14.4 million. This will result in Japan's contribution through the installation of 1,200 sets of solar irrigation pumps.

Subject for Assistance through JICA-REDP: Solar Irrigation Pump Component

	Solar Pumps for Irrigation Total	(JICA Portion)
Targets	Additional **1,550 locations (100%)** From 2013 to 2016. Minimum pump capacity of 400 m3/day	**1,200 locations (77%)** From 2014 to 2016.
Total required cost (USD million)	62.0	48.0
Equity portion (USD million)	18.6 (30% of the total cost)	14.4
Grant (USD million)	24.8 (40% of the total cost)	19.2
Loan (USD million)	18.6 (30% of the total cost)	**14.4 (JICA ODA Loan)**

Source: Survey Team based on IDCOL Funding Requirement and analyses

3) Solar Mini-Grid Component

With regard to the Solar Mini-Grid, 50 installations are being targeted. A total loan of Nine million USD and a total grant of USD 15 million are being requested. A total grant of USD 15 million is expected to be offered from KfW and USAID, among other development partners. As such, the grant requirement is expected to be fully met. Considering Japan's technical strength in this field, the Survey Team recommends that the Japanese loan be directed to solar mini-grid installation in the remaining 29 locations. The loan to be allocated from JICA for this component will be USD 5.2 million.

Subject for Assistance through JICA-REDP: Solar Mini-Grid Component

	Mini-Grid Total	(JICA Portion)
Targets	Additional **50 locations (100%)** From 2013 to 2016 Average capacity of 150 kW at marketplaces	**29 locations (58%)** From 2014 to 2016
Total required cost (USD million)	30.0	17.4
Equity portion (USD million)	6.0 (20% of the total cost)	3.5
Grant (USD million)	15.0 (50% of the total cost)	8.7
Loan (USD million)	9.0 (30% of the total cost)	**5.2 (JICA ODA Loan)**

Source: Survey Team based on IDCOL Funding Requirement and analyses

4) Gasification of Biomass

The construction of the gasification facilities is expected to be completed in approximately one year. The disbursement for JICA-REDP sub-projects should be completed by the end of 2016. Under such constraint, the sub-projects, for which the loan will be disbursed, will have to be approved by end of 2015. This requirement should be met in order for such sub-projects to be applicable for JICA-REDP sub-projects. Out of the 28 facilities planned to be funded by IDCOL, 20 of them are expected to be approved by early 2015 and constructed by the end of 2016. The

JICA-REDP will therefore be applicable to these 20 facilities. The loan extended to IDCOL in this component will be USD 3.4 million.

Subject for Assistance through JICA-REDP: Gasification of Biomass Component

	Gasification of Biomass	(JICA Portion)
Targets	Additional **28 facilities (100%)** From 2013 to 2016 Average size of 200 kW.	**20 facilities (71%)** From 2014 to 2016
Total required cost (USD million)	8.0	5.7
Equity portion (USD million)	1.6 (20% of the total cost)	1.15
Grant (USD million)	1.6 (20% of the total cost)	1.15
Loan (USD million)	4.8 (60 % of the total cost)	**3.4 (JICA ODA Loan)**

Source: Survey Team based on IDCOL Funding Requirement and analyses

5) Biogas Power Generation

Furthermore, 450 facilities are planned to be installed under funding support from IDCOL by 2016. These are relatively small-sized equipment of average 20 kW capacity, which are suitable for poultry farms with approximately 5,000 heads or more. From the viewpoint of technical and financial viability, and after discussions with GIZ experts, the Survey Team recommends that support for relatively larger-scale facilities for poultry farms, with the size of at least 10,000 heads, should be prioritized. Narrowing the original denominator of approximately 12,000 poultry farms down to 1,600, the eligible poultry farms for support was calculated as 60 (3.8 percent of the denominator).

Subject for Assistance through JICA-REDP: Biogas Power Generation Component

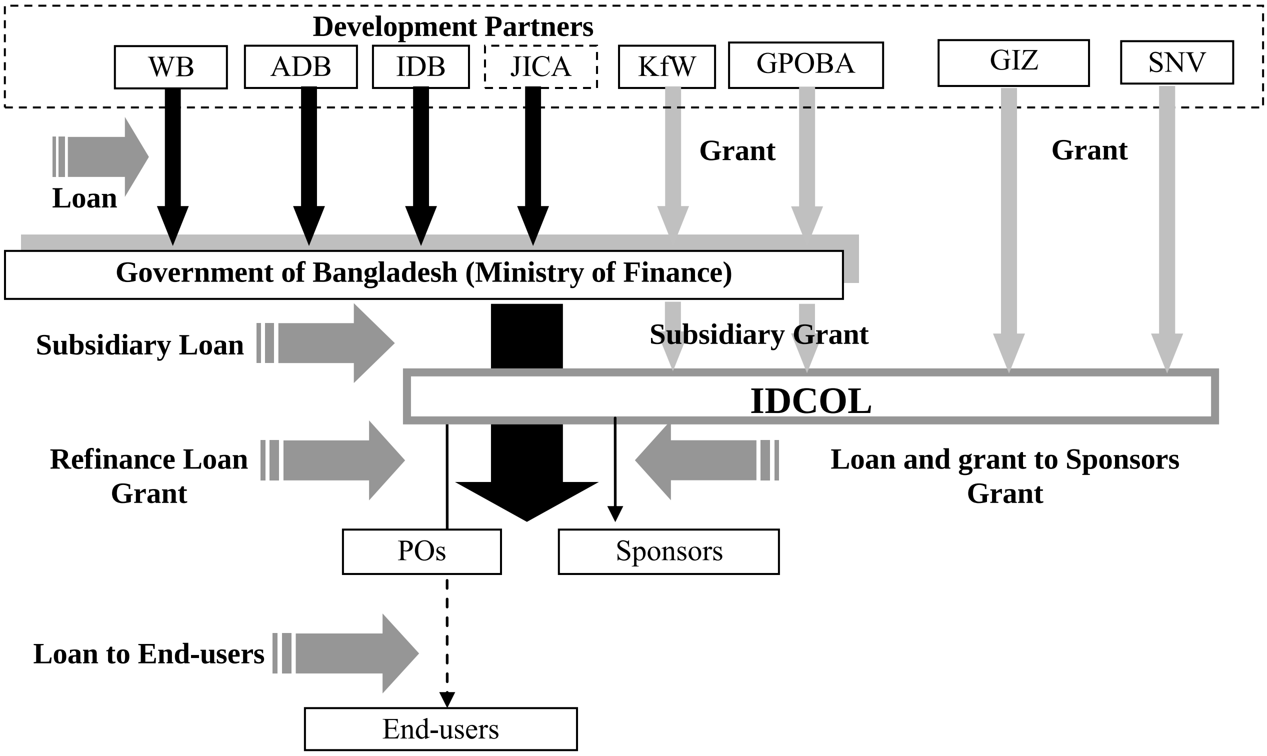
	Biogas Power Generation	(JICA Portion)
Targets	Additional installation of **450 facilities (100%)** From 2013 to 2016 Average facility size 20kW	**60 facilities (13%)** From 2014 to 2016
Total required cost (USD million)	14.4	2.0
Equity portion (USD million)	4.3 (30% of the total cost)	0.6
Grant (USD million)	2.9 (20% of the total cost)	0.4
Loan (USD million)	7.2 (50 % of the total cost)	**1.0 (JICA ODA Loan)**

Note (*): The total installations will become 451 with the already existing one Biogas Power Generation Project at the end of 2011.

6. Financial Arrangement

1) Outline of the Financial Arrangement:

The whole financial arrangement can be described in four main arrangement steps. The first step is loan from development partners to GoB, the second step is loan from the GoB to IDCOL loan, the third step is loan from IDCOL to sponsors (including POs), and the fourth step is loan from the Sponsors (POs) to the End-users. The first step is literally called as "Loan" or "Grant", the second step is called as "the Subsidiary Loan", and the third step is called as "Refinance Loan" as shown below:



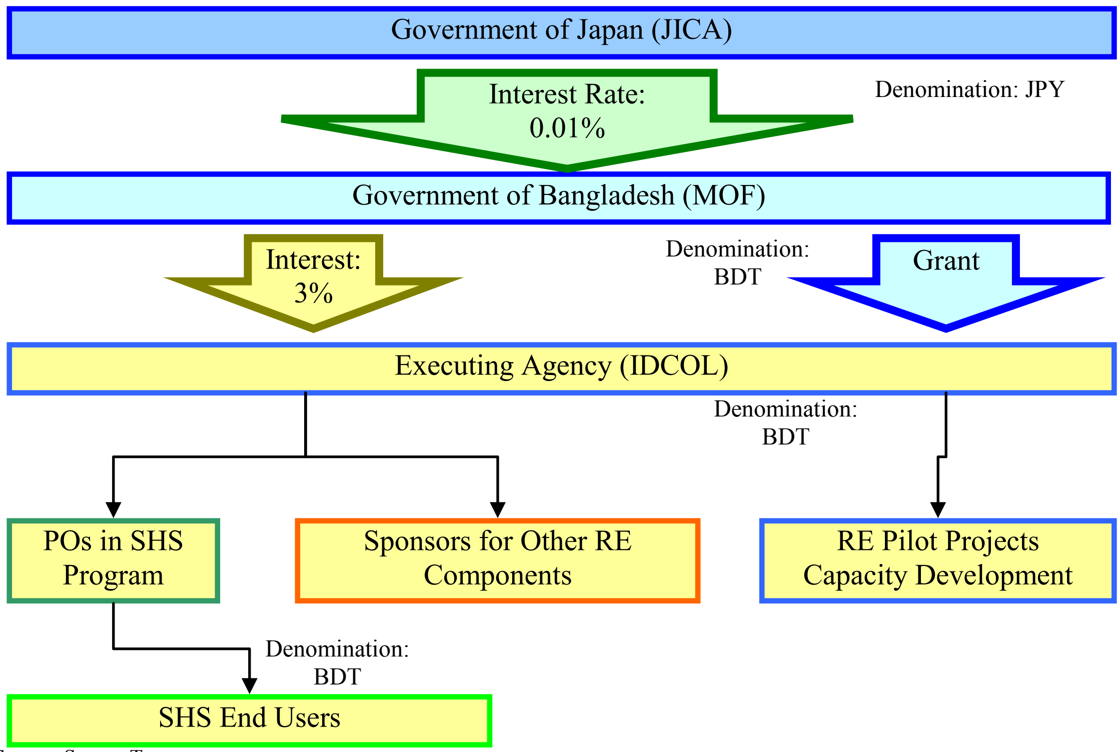
Source: Compiled by the Survey Team based on loan/grant agreement documents made between IDCOL and the World Bank, ADB, IDB, KfW, GTZ, GIZ and SNV

Financial Arrangements for IDCOL's RE Activities

2) Arrangements for Two-Step Loan:

The fund disbursed from the Government of Japan will be first received by the Ministry of Finance (MOF) of Bangladesh. The MOF will be directed to IDCOL as the "Subsidiary Loan". The terms and conditions of the subsidiary loan are yet to be negotiated and decided. With regards to the low loan interest rate from JICA to MOF (expected to be at 0.01 percent), a part of the fund to be extended to IDCOL is expected to be more concessional, e.g. in the form of grant, as with the case with the World Bank (IDA).

The JICA ODA loan can be utilized under two different conditions for three different purposes. First, a portion under the same concessionality with loan from other development partners can be introduced. This portion will be used for the SHS Program and other RE components that are required to harmonize the lending terms with the other development partners. Second, a grant portion in return to setting the first condition, can be set by the MOF. The grant is expected to be allocated to technical cooperation elements including the capacity development of IDCOL, sponsors, and other stakeholders.



Source: Survey Team

JICA ODA Loan to be Extended to IDCOL in the form of Loan and Grant

3) Lending Terms for Two-Step Loan:

With reference to the arrangements for the two-step loan described in the previous sub-section, conditions of funds for different purposes can be proposed. The Standard condition loan for the SHS Program and other components will require harmonization with the existing mechanism. Therefore, the lending terms will be broadly identical to the current settings.

Lending terms for the five components

Components	Denomination	Interest	Tenure	Grace Period
SHS (reference)	BDT	6 – 9%	5 – 7 years	0.5 – 1 year
Solar Pump	BDT	6%	10 years	1 year
Mini-Grid	BDT	6%	10 years	2 years
Gasification	BDT	6-10%*	7 years	1 year
Biogas	BDT	6-9%**	5 Years	1 year

Note: (*) Model case calculation was conducted on 200 kW plant which resulted in optimum interest rate of 4%, while existing example of larger scale plant (SEAL 400 kW) showed financial viability at the interest rate of 10%

Note: (**) Model case calculation was conducted for 20 kW plant which resulted in optimum interest rate of 4% while existing example of larger scale plant (Phoenix 400 kW) showed viability at the interest rate of 9%.

Source: Set by the Survey Team based on current stipulation by IDCOL

4) Credit Risk and Security:

IDCOL shall bear the credit risk of Sponsors. IDCOL requires full recourse security, which is the combination of the following means of guarantee up to full recourse of funding: 1) mortgage of land, 2) a letter of hypothecation, 3) personal guarantee of the directors, 4) corporate guarantee by affiliated companies, and 5) lien on project accounts. In case of defaults, security will be in favor of IDCOL.

5) Loan Agreement:

A loan agreement shall be signed between IDCOL and a Sponsor that requires the Sponsor to:

- Implement the subproject under the supervision of IDCOL;
- Be responsible for the operation and maintenance of the equipment;
- Furnish its quarterly financial statements and audited accounts for its financial year;
- Deliver certain portions of the subproject cost as base equity to the subproject;
- Provide sub-project securities; and
- Be responsible to meet the project cost overrun, if any, from its own resources..

7. Structure for Project Implementation

1) Project Scheme:

IDCOL, the Executing Agency for JICA-REDP, implements the project in harmony with the World Bank RERED (Rural Electrification and Renewable Energy Project). This is under coordination with the World Bank, ADB, IDB, KfW, GIZ, and other Development Partners that are contributing to the World Bank Project. The IDCOL will receive a loan from JICA via the MOF of Bangladesh in the form of a two-step loan. The loan will be utilized in a harmonized manner with the RERED Project for five components, which are: (i) the SHS Program Component, (ii) the Solar Pump Irrigation Component, (iii) the Solar Mini-Grid Component, (iv) the Gasification of Biomass Component, and (v) the Biogas Power Generation Component. These components are mostly based on the existing RE programs and projects (RERED Project) supported by the World Bank and executed by IDCOL.

In each of the components, IDCOL identifies the sponsors and sub-projects to which the two-step loan is extended. The financial and technical due diligence are conducted by IDCOL for the sub-project candidates. Due diligence is conducted only in the selection of the sponsors in case of SHS Program Component. The new branch is exclusively designated to RE Components, and is planned to be established within IDCOL. This new branch is expected to execute most operations of the JICA-REDP.

While each component will have to be implemented mostly under the existing institutional structure, there is also a need to set up a new arrangement to oversee the whole picture of the project. A JICA expert will be dispatched to pursue the function of overseeing the whole JICA-REDP. The expert will also support the capacity development of IDCOL by supporting the drafting of appraisal manuals and operational guidelines for the RE components. This task, after the initial period, will be handed over to IDCOL, which will hire professional consultants that will continue to acquaint the IDCOL staff with updated knowledge and skills on RE technology and business.

2) Stakeholders and Their Roles:

The stakeholders common to all of the sub projects are listed below. There will also be more indirect stakeholders, such as those who will benefit from the activities of the end-users.

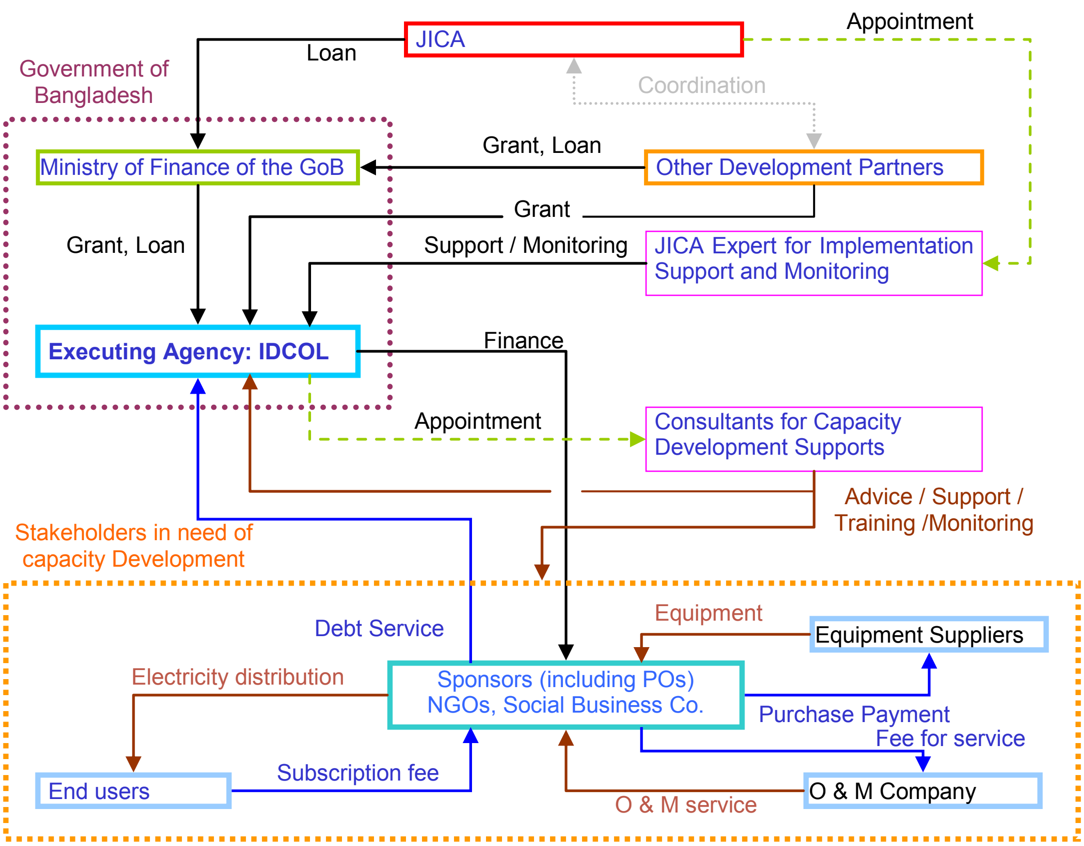
- End-Users (of electricity, water or any other products and by-products);
- Sponsors who implement sub-projects (includes POs who implement SHS Program);
- Equipment suppliers and other service providers;
- Executing Agency;
- Monitoring and advisory functions; and,
- Funding organization (JICA and other development partners).
- GoB

The roles and relations of the stakeholders in the project can be broadly be categorized into two patterns: one is the SHS Program type, and the second one is the project component type of structure. The major feature of the SHS Program is that the owner/user of the equipment will be end-users while the other components will be the sponsors.

If it is generalized and arranged into one Renewable Energy Development Program, the roles and the relations of the stakeholders can be illustrated in the following figure. The Overall Project will be supported and monitored by an expert appointed by JICA. The expert will be responsible to report to JICA the status of the Project. Such person will also facilitate IDCOL and other stakeholders to promote the project.[15] Furthermore, JICA may request IDCOL to conduct capacity development for the stakeholders who are in need of better skills and knowledge. Sponsors, especially those of small scale, equipment suppliers, O&M Company, and the end-users are possible subjects for these capacity development activities.[16]

3) Structuring the Relations among the Stakeholders:

IDCOL's SHS Program is an example of developing a structure where major stakeholders are fitted in. The POs are systematically given their functions to execute their roles. A similar structure can be sought for JICA-REDP's other components. It makes use of a mechanism that attracts sponsors to function proactively; and let them develop the business model. This will be required for the Solar Irrigation Pump, the Solar Mini-Grid, the Gasification of Biomass, and the Biogas Power Generation Components.



Source: Survey Team

Roles and Relations among the Stakeholders to the Project

[15] Consultants for monitoring and implementation support are similarly appointed by KfW. These consultants report not only to KfW but also to other development partners involved in IDCOL's RE activities (information from interviews with IDCOL and KfW).

[16] The World Bank similarly requires IDCOL to conduct trainings for the POs in conjunction with the Execution of Loan. Funding for these activities (technical assistance) was made as grant to IDCOL (information from interview with IDCOL).

The incentive scheme that is applied in the SHS Programs is an ideal mechanism for encouraging POs to implement their tasks, and to formulate an appropriate business model for each of the sub-projects. Another element that can help structure the key stakeholders firmly into the component is the training opportunities. IDCOL may offer training opportunities to the sponsors, suppliers, and service providers to improve their capacity to further implement their sub-projects. As can be seen from the example of the SHS Program, training opportunities function as a strong incentive to the sponsors, suppliers, service providers, and even the customers.

4) Role of IDCOL in JICA-REDP:

The JICA-REDP will be conducted by IDCOL under the responsibility of the Project Director. The New Deputy CEO will be nominated as the Project Director for the JICA-REDP. The Project Director will function as the official interface of the Project and will be fully accountable for it. IDCOL will not appoint a deputy director for the Project.

The Five components that will comprise the JICA-REDP are all IDCOL's existing RE Program and RE Projects. Among these five components, the SHS Program Component already has a well-established structure as the World Bank RERED Project. Other international development partners (ADB, IDB, KfW, GPOBA, and others) are contributing to the intervention by making use of the REREDP structure. The JICA-REDP, through its SHS Program Component, should similarly contribute to IDCOL's existing SHS Program, in line with, and making use of, the existing RERED Project structure.

The Solar Irrigation Pump Component, the Solar Mini-Grid Component, the Gasification of Biomass Component, and the Biogas Power Generation Components are JICA-REDP components that will be structured based on IDCOL's existing RE Projects framework. IDCOL's existing RE framework have been designed and conducted as the "other renewable energy" portion of the WB's RERED Project, and is different from the SHS Program, since that portion's implementation structure is not yet designed. The implementation structure for IDCOL for the JICA-REDP needs to be reinforced and defined with start of the Project.

5) IDCOL's RE Programs and RE Projects as Subject for Assistance

The SHS Program aims to install an accumulated number of four million sets by year 2015. The Solar Irrigation Pumps are targeted to be installed in 1,550 locations by 2016. These pumps have a minimum capacity of 400 m3/day. Solar mini-grids are targeted to be installed in 51 locations also by 2016 its average size being 150 kW. The facility for gasification of biomass, with the average size of 200 kW, is expected to be installed in 29 locations, and the Biogas Power Generation facilities are targeted to be installed in 451 locations. These targets are set in accordance with the availability of fund coming from the development partners. IDCOL claims that the targets can therefore be revised and increased once additional funds become available.

The SHS Program, as well as the Solar Irrigation Pump, the Solar Mini-Grid, the Biomass and the Biogas Power Generation components are expected to have a significant effect on the development of Bangladesh, and are found to be appropriate targets for financial assistance utilizing Japan's ODA two-step loan in JICA-REDP. The key information and figures for consideration of loan assistance such as gross investment, effects, and benefits from these components are disclosed in the following table:

IDCOL's RE Program and RE Projects as Subject for Assistance through JICA-REDP

	SHS Program	Solar Pump Irrigation	Solar Mini-Grid	Gasification of Biomass	Biogas Power Generation
Targets	Additional 2,679,732 sets by 2015. Average size: 42 Wp	Installation at 1,550 locations by 2016. Minimum pump capacity of 400 m3/day	Installation at 50 locations by 2016. Average capacity of 150 kW at marketplaces	Installation in 28 facilities by 2016. Average size of 200 kW.	Installation of 450 facilities by 2016. Average facility size 20kW
Total power generation capacity	112.5 MW (PV)	17.0 MW (PV)	7.5 MW (PV)	6 MW (Generator)	9 MW (Generator)
Total required cost (USD million)	788 (USD 294 per set)	62	30	8.2	14
Equity portion (USD million)	302 (38% of the total cost) (Down payment + Buy down grant)	19 (30% of the total cost)	6 (20% of the total cost)	1.6 (20% of the total cost)	4 (30% of the total cost)
Grant (USD million)	28 (4% of the total cost)	24.8 (40% of the total cost)	15 (50% of the total cost)	1.6 (20% of the total cost)	2.9 (20% of the total cost)
Already available	13.4	1.2	1.5	0.1	0.1
Proposed	4.0	23.6	13.5	1.5	1.7
Additional requirement	10	0	0	0	1.1
Loan (USD million)	458 (58% of the total cost)	18.6 (30% of the total cost)	9.0 (30% of the total cost)	4.8 (60 % of the total cost)	7.2 (50 % of the total cost)
Already available	130.4	0.6	0.7	0	0
Proposed	94.6	3.6	3.1	1.4	6.2
Additional requirement	233	14.4	5.2	3.4	1.0
Yearly Power Generation Volume (MWh/year)	103,562	18,637	6,900	26,796	26,338
Effect of the Reduction of Natural Gas	20.8 million m3/year	-	-	5.98 million m3/year	2.65 million m3/year
Effect of the Reduction of Diesel Oil	-	5,828 kL/year	2,155 kL/year	-	4,117 KL/year
Effect of the Reduction of CO2	59,548 t-CO2/year	15,600 t-CO2/year	5,800 t-CO2/year	15,408 t-CO2/yr	15,144 t CO2/yr
Social, economic and environmental benefits	Improvement In The Lives of BOP people, Expansion of Small Businesses, Contribution To Population Control Measures	Harvest 3 Times A Year (Increase In Farming Production), Contribution To Economic Development, Preservation of the Environment, Oil Reduction.	Electrification of the Market, Reduction In Electricity Costs, Contribution To Economic Development, Preservation of the Environment, Oil Reduction.	Job creation 261 persons. Efficient use of unused biomass.	Reduction of chemical fertilizer usage (806,388 kg/yr) Job creation 902 persons for operation.

Source: Compiled by Survey Team based on IDCOL Funding Requirement and analyses

6) New Implementation Arrangement at IDCOL for JICA-REDP:

IDCOL's Organizational capacity to implement the JICA-REDP is readily existent insofar as implementation of the ongoing RE Programs and RE Projects is concerned. With JICA-REDP, a new approach to encourage the execution of sub-projects under each of the components will be required. First, a newly designated branch to implement the RE Programs and RE Projects is planned to be established. The introduction of this RE branch, under which the RE component units will be placed, is expected to reinforce the capacity for execution of RE sub-projects, where designated staffs will be able to concentrate on RE topics. Second, support from the JICA expert and component management consultants are expected to strengthen IDCOL's ability to evaluate applications for sub-projects from technical aspects. Third, the establishment of the exclusive unit for social and environmental considerations will be an essential function to ensure that JICA-REDP will be implemented by IDCOL under sufficient considerations for the social and environmental aspects.

Comparison of the New Implementation Arrangement with the Current Arrangement

	Current Arrangement	JICA-REDP	Background
Implementation Structure	SHS Program and RE Projects are conducted under the Investment and Loans Branches. RE Programs and RE Projects do not have a designated implementing branch within IDCOL. Nearly all IDCOL staffs are involved in RE Programs and Projects.	A new designated branch for RE will be established in IDCOL. There will be three groups in the Unit, namely the SHS, the NDBMP and Other RE Projects.	The Survey Team observed that lending for the RE Projects are not conducted in a functional manner, with knowledge being accumulated by a limited number of people.
Consulting services	Technical consultants are hired for each RE project. IDCOL usually asks KfW and GIZ for technical advice.	Consultants will be hired by IDCOL to support the capacity development of through the conduct of the Project.	Even though IDCOL, as a financial institution does not require technical expertise, the Survey Team found that proposals for sub-projects cannot be pursued without basic understanding on RE technologies and business models.

Guidelines and Manuals	RE Projects are conducted on experimental basis by applying the project appraisal manual with flexibility.	New technical specifications and appraisal manual dedicated to RE Components (other than SHS Program Component) will be prepared and applied. A management system document that will enable IDCOL to sustainable improve IDCOL's capacity to execute JICA-REDP on its own capacity will be developed. JICA will extend advisory service through its long-term technical expert.	Lessons learned from current experimental trials should be systematically accumulated and shared among the stakeholders in the form of guidelines and manuals.
Environment and Social consideration	IDCOL relies on an in-house consultant for its Environment and Social Consideration tasks.	An exclusive unit for environmental and social consideration will be established. The unit will be able to oversee the whole picture of the Project.	Current social and environmental consideration function is pursued by one in-house consultant who is not in a position to give advice unless required.

Source: Survey Team

8. Required Amount for JICA-REDP

Having defined the contribution amount for each of the components, the total loan assistance amount of JICA-REDP is calculated at USD124 million. The loan is expected to contribute to 22 percent of the SHS Program target, 77 percent of the Solar Irrigation Pump Component, 58 percent of the Solar Mini-Grid, 71 percent of the Gasification of Biomass Component, and 13 percent of the Biogas Power Generation Component targets.

Subject of Japanese ODA loan Assistance

	SHS Program	Solar Irrigation Pump	Solar Mini-Grid	Gasification of Biomass	Biogas Power Generation
Installation numbers (sets)					
Total installation target	2,680,000	1,550	50	28	450
Allotment for JICA-REDP	585,094	1,200	29	20	60
Share among the total target	22%	77%	58%	71%	13%
Loan amount (USD million)					
Total loan requirement	458	18.6	9.0	4.8	7.2
Allotment for JICA-REDP	100	14.4	5.2	3.4	1.0
Share among the total requirement	22%	77%	58%	71%	13%

Source: Survey Team

1) Loan

The loan allotted for the JICA-REDP will contribute to the following components:

SHS Program Component: USD 100 million
(22 percent of the total requested loan) for the SHS Program Component;
Solar Irrigation Pump Component: USD 14.4 million

(77 percent of the total requested loan) for the Solar Irrigation Pump Component;
Solar Mini-Grid Component: USD 5.2 million
(58 percent of total requested loan amount) for the Solar Mini-Grid Component;
Gasification of Biomass Component: USD 3.4 million
(71 percent of the total requested loan) for the Gasification of Biomass Component; and,
Biogas Power Generation Component: USD 1.0 million
(13 percent of the total requested loan) for the Biogas Power Generation Component.

2) Grant to Match the JICA-REDP Loan

Most of the sub-projects to be conducted under the JICA-REDP require grant funds to match certain portion of initial investment cost. The grant support for IDCOL's RE Programs and Projects are funded by other development partners.

Comparing the grant demand to match the sub-projects to be financed by JICA-REDP with the current availability of grant for IDCOL, it can be considered that the grant to match JICA-REDP loans is readily available for all of the components.

Grant Requirement to Match JICA REDP

	SHS Program	Solar Irrigation Pump	Solar Mini-Grid	Gasification of Biomass	Biogas Generation
Grant to Match JICA-REDP (USD million)	6.1	19	8.7	1.1	0.4

Source: Compilation by the Survey Team based on information from IDCOL

Current Grant Status

Donors	SHS Program	Solar Irrigation Pump	Solar Mini-Grid	Gasification of Biomass	Biogas Generation
KfW		0.3	0.6		
IDA (5013)	7.0	0.2			
GPOBA (DFID)		0.5	0.6		
GPOBA (SIDA)	4.4				
ADB Grant	2.0	0.2	0.3	0.1	0.1
BCCRF (Proposed)		23.0			
USAID (Proposed)	2.4	0.3	3.0	0.6	0.4
KfW (Proposed)		0.3	10.5	0.9	1.3
GIZ (Proposed)	1.6				
TOTAL	17.4	25	15	1.6	1.8*

Note: Unit: USD million
Note (*): Biogas Power Generation Component still requires another USD 1.1 million to attain the target of USD 2.9 million

9. Expected Effect of the Project

The beneficiary of the project will mostly be rural people and the poor, who will directly benefit from their livelihood. This project will improve their socio-economic condition. In addition, this will also impact the country's per capita income. On the other hand, the Renewable Energy components that comprise the JICA-REDP, and that was suggested in this report are commonly significant in their effect to reduce the greenhouse gas emissions by offsetting the use of fossil fuels. Further, the SHS Program has more significance in bringing electricity to non-electrified rural areas.

By implementing the five RE components, as identified in Chapter 4, the major quantitative direct expected effects are: the power to be generated, the effect of fuel usage reduction, and the reduction of greenhouse gas emissions. These effects are calculated, and are aggregated, in the following table:

Effect and Indicators of JICA-REDP by Baseline and Target

Effect	Indicator	Baseline and target	Effect of JICA-REDP
Power Generation Capacity from Renewable Energy Sources	Installed Generation Capacity (MW)	Baseline	0
		Target: [Two years after the Project Completion]	41
Energy saved through utilization of RE equipment	Yearly Power Generation Volume (MWh/year)	Baseline	0
		Target: [Two years after the Project Completion]	62,879
	Electricity Available for Use (MWh/year)	Baseline	0
		Target: [Two years after the Project Completion]	56,290
Emissions offset by utilization of RE equipment	Effect of the Reduction of CO_2 (t-CO_2/year)	Baseline	0
		Target: [Two years after the Project Completion]	34,516
Beneficiaries (*)	Number of units deployed times average number of users	Baseline	0
		Target: [Two years after the Project Completion]	2,949,200

* Beneficiaries are counted by multiplying the number of facilities by average users (SHS = 5, Solar irrigation pump = 15, Solar Mini-Grid = 400. Beneficiaries for Gasification and Biogas facilities could not be quantified as number of users for each facility is unable to be defined.

Source: Compiled by the Survey Team based on IDCOL Funding Requirement and analyses

Through the implementation of the JICA-REDP, the country would also experience other indirect effects that would contribute to the development of its economy and society. These indirect effects include the promotion of local economic activities, by relieving burden of diesel/kerosene procurement; improvement of the working environment, by eliminating exhaust gas from fuel usage; and also by reducing the risk of fire and other accidents. In the case of the SHS Program, which brings electricity to rural households, there are also benefits to the users by offering a power source for television sets and mobile phones that connects them to other information and communication tools. Working hours can be also extended, which would result to more income, and children would also be able to study for longer hours after dark.

Some of these expected effects can simply be calculated. Other effects cannot be quantified without the structuring of a quantifying methodology. Direct effects that can be quantitatively evaluated are calculated. Expected indirect effects, which are mostly described qualitatively, are also analyzed.

10. Implementation Timetable

The implementation of the JICA-REDP is expected to start in 2013. The current assumption for the conclusion of the Loan Agreement (L/A) between JICA and IDCOL is on March 2013, which is the last timing before the end of Japanese fiscal year 2012/13. First disbursement of the loan is expected to be made in May 2013 for some of the readily approved sub-projects. The plans for execution of the sub-projects by components are set according to IDCOL assumptions.

The disbursement of the loan for the components will start from Bangladeshi Fiscal Year 2013/14, except for a number of biomass-derived RE sub-projects, which will commence prior to such date. Disbursement of the loan is expected to be completed by early Bangladeshi Fiscal Year 2016/17, therefore, during calendar year 2016.

JICA-REDP Implementation Timetable

Calendar Year	2012	2013				2014				2015				2016				2017		Total
Bangladesh Fiscal Year				BFY 2013/14				BFY 2014/15				BFY 2015/16				BFY 2016/17				
Japan Fiscal Year			JFY 2013/14				JFY 2014/15				JFY 2015/16				JFY 2016/17					
	10-12	01-03	04-06	07-09	10-12	01-03	04-06	07-09	10-12	01-03	04-06	07-09	10-12	01-03	04-06	07-09	10-12	01-03	04-06	
Preparation																				
Prior Notification																				
Signing of Loan Agreement(L/A)																				
Component Management Support Consultants																				
Procurement of Consultants																				
Service Rendering and Trainings																				
JICA Disbursement for RE Conponents																				
SHS Program Component (1,000)				180 K				195 K				210 K								585K
Solar Irrigation Pump Component				160				240				400				400				1200
Solar Mini Grid Component				5				6				8				10				29
Gasification of Biomass Component				4				4				5				7				20
Biogas Power Generation Component				4				14				21				21				60
Project Completion																				

Notes:
Final application for SHS Program Component Refinancing: September 2015
Final appraisal for Solar Irrigation Pump Component: December 2015
Final appraisal for Solar Mini Grid Component: December 2015
Final appraisal for Gasification of Biomass Component: December 2015
Final appraisal for Biogas Power Generation Component: June 2016
BFY: Bangladesh Fiscal Year (July - June)
JFY: Japanese Fiscal Year (Apr - Mar)

Source: Compiled by the Survey Team

MAIN TEXT

1. Overview of JICA-REDP

1.1. Background

As of 2009, at 252 kWh, the annual electricity usage per capita of Bangladesh is one of the lowest in the world[17]. In response to the country's robust macroeconomic growth, the demand for electricity is on a sharp rise. As a consequence, it was determined that the country's current supply of electricity is not sufficient to meet such increased demand. Currently, according to Bangladesh Power Development Board (BPDB) data, Bangladesh generates a total load of 8,099 MW (as of May 2012) of electricity, and the country has an available generation capacity in the range of 5,500-6,500 MW. Note that during the summer period, 1,500 MW of the load shedding is common.[18]

Bangladesh resorts heavily to its own production of natural gas as the source of energy for electricity generation. The natural gas supplies to gas-fired power plants, which contribute to 89 percent of the country's total electricity generation, are locally produced natural gas in Bangladesh. Hence, diversification of energy source for electric power generation is desired for the sake of energy security.

As of May 2012, the household electrification rate at the national level is at 50 percent.[19] In the country, there are 95 million people without access to electricity. Next to India (405 million), this figure is the second largest in South Asia, The electrification rate in the urban area is at 90 percent and electrification rate in the rural area is at 35 percent. This implies that there is a significant potential demand for the electrification of rural areas.[20] Therefore, the top issues for the electricity and energy sector are: (i) the promotion of rural electrification by diversifying its source of energy, and (ii) the security of a stable supply of electricity. Some proposed solutions to these concerns are the introduction of renewable energy (RE), the development of new sources of electricity, and the efficiency adjustment of existing facilities.

Under such circumstance, the GoB presented the "Policy Statement on Power Sector Reform 2000", which sets out the following long term goals: a) to make electricity available for all; b) to ensure reliable and quality supply of electricity; and c) to provide electricity at a reasonable price. The "Renewable Energy Policy" was then introduced in December 2008. It sets the goal of increasing the share of RE within the total power generation capacity from the current one percent to five percent by 2015 and then to ten percent by 2020.

Under the economic growth domain, the power sector is one of the priority sectors for assistance in the Country Assistance Program for Bangladesh (May 2006) of the Government of Japan. The assistance to boost power generation capacity is positioned as an essential measure to narrow the supply–demand gap of electricity. Within this framework, JICA is committed to support the power sector through power/energy infrastructure development, including support for RE deployment as a part of its "Electricity Supply Stabilization Program" for economic infrastructure development.

An example of assistance by other development partners include loan and grant assistance to the IDCOL. This is for the promotion of SHS and is conducted by the International Development

[17] OECD/IEA (2011a)
[18] BPDB website information
[19] idem
[20] idem

Association (IDA) of the World Bank, ADB, IDB, KfW, and GIZ, among others. With regards to RE technology, GIZ also provides technical assistance for pilot projects on solar pumps, and biomass power generation mini-grid in remote areas.

The Solar Energy Program, currently called the SHS Program, is an initiative of IDCOL since 2003. The program is collaboration with Grameen Shakti, BRAC, and other Non Governmental Organizations (NGOs) as Participating Organizations (POs). It aims to disseminate Solar Home Systems (SHS) in rural areas in the country through micro-finance schemes. This is to relieve the initial cost of installation. As of June 2011, the program achieved the installation of approximately one million units (accumulated total). IDCOL, based on the experiences gathered through such program, is planning to expand the scope of RE dissemination to solar pumps for irrigation, photovoltaic mini–grid, and biomass gas power generation.

In June 2011, with reference to the above mentioned plan by IDCOL, a request for consideration of utilization of a Japanese Official Development Assistance (ODA) loan was submitted by the Government of Bangladesh (GoB). The proposed project will be implemented through the utilization of the Japanese ODA loan. It will be called the “Renewable Energy Development Project” in Bangladesh (hereinafter, it will be called the “JICA-REDP”). By extending Japanese ODA loan to end-users in the form of a two-step loan, the JICA-REDP is expected to promote the use of RE and the application of energy efficiency and conservation (EE&C) measures.

Within the context mentioned, this Survey was conducted with the aim to collect and analyze information required for the approval of JICA-REDP as a Japanese ODA loan project. The overall goal, target geographical area, scope, required cost, institutional formation for execution, management, maintenance and control structure, and environmental and social considerations will be included in the required output of the Survey.

1.2. Features of JICA-REDP

Facilitation will be required to promote the RE and EE&C measures, just like most cases in other countries. These measures will be effective through available forms of subsidies, concessional loans, tax reliefs, and preferred purchase agreements, among other various forms of incentives. This is due to the tendency that energy from renewable sources are relatively expensive compared with conventional fossil-fuel energy. In addition, energy efficiency measures tend to be commercially marginal in terms of cost recovery. These disadvantages for RE and EE&C measures become prominent especially in the developing countries, where conventional fuel price is kept low. In this context, Bangladesh is no exception. Fuel price is kept at a low level to provide energy at an affordable rate.

This Survey aims to elaborate on the specifications of and requirements for the Japanese ODA loan project for RE deployment and EE&C measures application. This will be conducted through a two-step loan scheme whereby the fund is channeled to component implementing entities through IDCOL. The project implementation plan, which includes the project scheme, a list of potential components, the project cost, and financing arrangements and timetable, will be formulated as one of the outputs of from this Survey.

Overview of JICA-REDP to be conducted following this preparatory survey is as follows:

(1) Project Name:
- JICA "Renewable Energy Development Project" (JICA-REDP) in Bangladesh

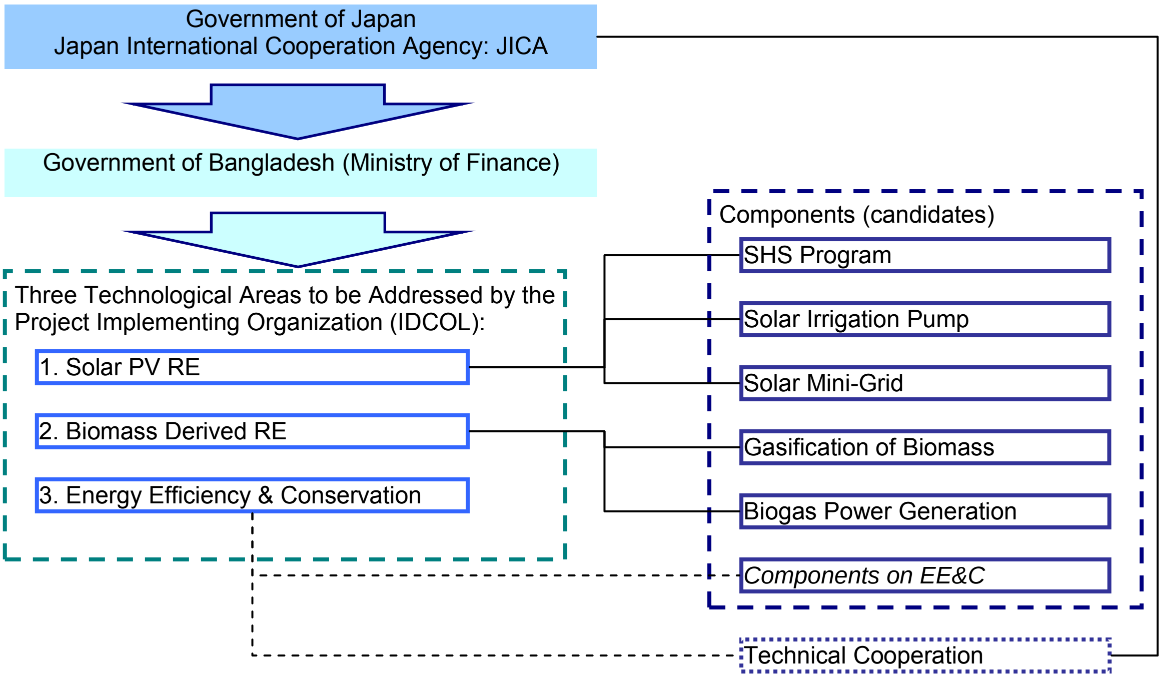
(2) Objective of JICA-REDP
- To promote the usage of RE and application of EE&C measures in Bangladesh, by extending Japanese ODA loan in the form of a two-step loan through IDCOL.
- JICA-REDP is expected to promote the diversification of energy source for electricity generation, and therefore contribute to the improvement of local living conditions and climate change mitigation.
- Further, the Project aims to develop the RE deployment capacity of IDCOL so as to enable the company to be capable of disseminating its know-how in to other developing countries.

(3) Scope of JICA-REDP
- The Provision of a two-step loan for SHS Program Component: IDCOL accredits, through financial and technological appraisal results, the participating organizations that will sell new equipment for RE deployment and render after-sales services. The loan will be provided from IDCOL to these POs. This will enable microfinance facilities to be extended from the POs to the end-users of sub-projects.
- Provision of a two-step loan for Other RE Program Components: IDCOL accredits, through financial and technological appraisal of proposals, RE sub-projects to be conducted by sponsors. By utilizing the JICA two-step loan, sponsors will deploy and operate RE equipment.
- Capacity Development: The progress of JICA-REDP will be promoted and the capacity development for JICA-REDP's executing agency will be supported through dispatch of experts and facilitation for IDCOL's own capacity development activities.

(4) Target Geographical Area
- Applicable to the entire territory of Bangladesh

(5) Executing Agency of JICA-REDP
- Infrastructure Development Company Limited (IDCOL)

(6) Overall Structure of JICA-REDP



Source: Survey Team

Figure 1.2-1 Overall Structure of the JICA Renewable Energy Development Project

The proposed implementation organization, IDCOL is Bangladesh's Non-Bank Financial Institution (NBFI) that was established in 1998. It is wholly owned by the GoB. The company boasts of being the world's top organization that deploys RE, notably to rural areas to reduce poverty. It has so far succeeded in deploying more than 1.2 million sets of SHS in various parts of Bangladesh. The company's track record suggests that IDCOL is the most experienced organization for promoting the use of RE. Moreover, IDCOL being a financial institution, has the capacity to handle loans. Therefore, IDCOL is the most appropriate organization to be appointed as the implementing organization for JICA-REDP, especially when the fund is meant to take the form of a two-step loan.

Other than IDCOL, there are also other governmental organizations that are positively engaged in the penetration of RE. Some of the examples are: the Rural Electrification Board (REB), the Local Government Engineering Department (LGED), the Center for Energy Studies (CES, BUET), and the Bangladesh Center for Advance Studies (BCAS). Among these various bodies, IDCOL is the only institution that is experienced in lending loans extended from international development partners. Its track record on renewable energy activities and experience in handling project funds makes it appropriate as the executing agency of the project.

2. Deployment Status of Renewable Energy (RE) and Energy Efficiency and Conservation (EE&C) Technologies in Bangladesh

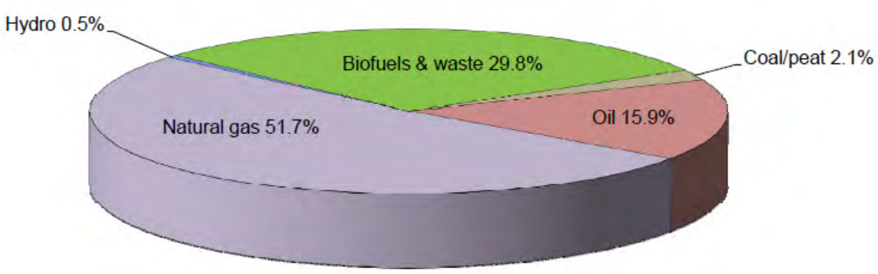
2.1. Overview of Energy Sector in Bangladesh

2.1.1. Energy Balance

The population of Bangladesh is approximately 148,692,000 as of 2010, and the current GDP is USD 100 billion.[21] The country's current GNI is USD 700 per capita, and it is classified as a Low Income Country by the World Bank. Among the country's total population, 41 percent are offered an access to electricity (as of 2009). This access rate of population to electricity is the lowest in South Asian countries.[22]

Bangladesh's total electricity production is 37,862 GWh, and its per capita consumption is 252 kWh per year (as of 2009).[23] This figure is one of the lowest in Asia, next to Nepal, Myanmar and Cambodia, and is comparable to the figure of some of the sub-Saharan African countries.[24]

According to IEA's 2009 data, Bangladesh's total primary energy supply is 29,599 ktoe, among which 15,321 ktoe, or 51.7 percent is the supply from domestically produced natural gas. 5,126 ktoe, or 18 percent of the total supply is from imported oil, oil products, and coal.

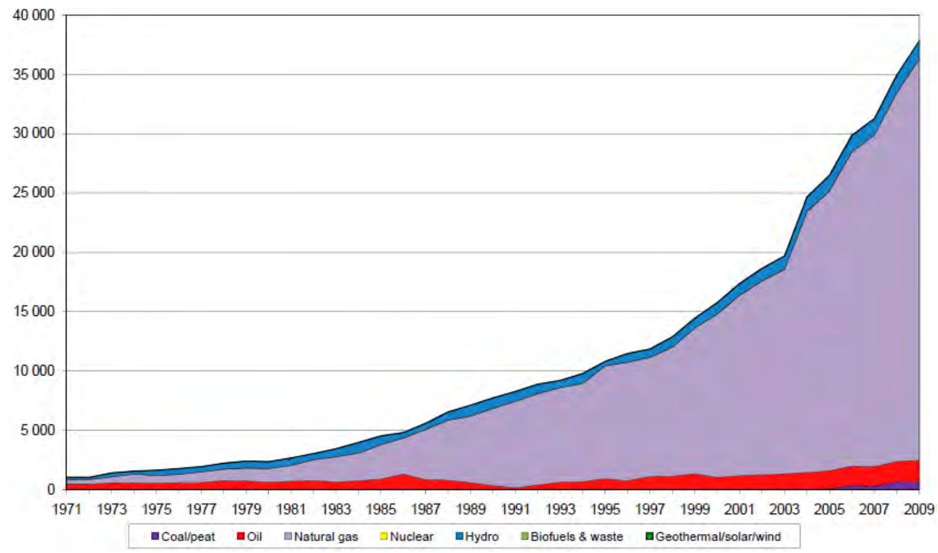


Source: IEA, Statistics and Balances, 2009 data

Figure 2.1-1 Share of Total Primary Energy Supply

The striking feature of fuel composition in the country is that Bangladesh is almost totally dependent on its natural gas for fueling electricity power generation. Among the country's 37,862 GWh production, 33,840 GWh (89 percent of the total) is generated from natural gas. This trend of high dependency on natural gas is increasingly becoming evident as generation from other source of power, i.e. hydro and imported oil have been stagnant for the past decades.

[21] World Bank (2011)
[22] idem
[23] IEA (2011)
[24] idem



Source: IEA, Statistics and Balances, 2009 data

Figure 2.1-2 Electricity Generation by Fuel

The main characteristics of energy sector in Bangladesh can be summarized as follows:

- Low rate of population access to electricity;
- Low per capita consumption;
- High dependency on its natural gas for electricity generation; and
- Moderate dependency on imported fuel.

2.1.2. Power Generation

(1) Power Utility Structure

The industrial structure of power utilities is as follows. BPDB is vertically integrated. REB also has some generation capacity. The unbundling of generation and distribution is already completed. Distributors function as retailers and the liberalization of the retail business has not been carried out. The structure of electricity industry is shown below.

Table 2.1-1 Electricity Utility Industry Structure

Layer	Company name
Generation	BPDB, IPP, Captive
Transmission	Power Grid Company (covering the entirety of Bangladesh)
Distribution & retail	Dhaka: DESCO (Northern half of Dhaka), DPDC (Southern half of Dhaka), WZPDCL (Selected areas of Dhaka), Other areas: BPDB WZPDCL REB Areas not covered by above: Local PBSs

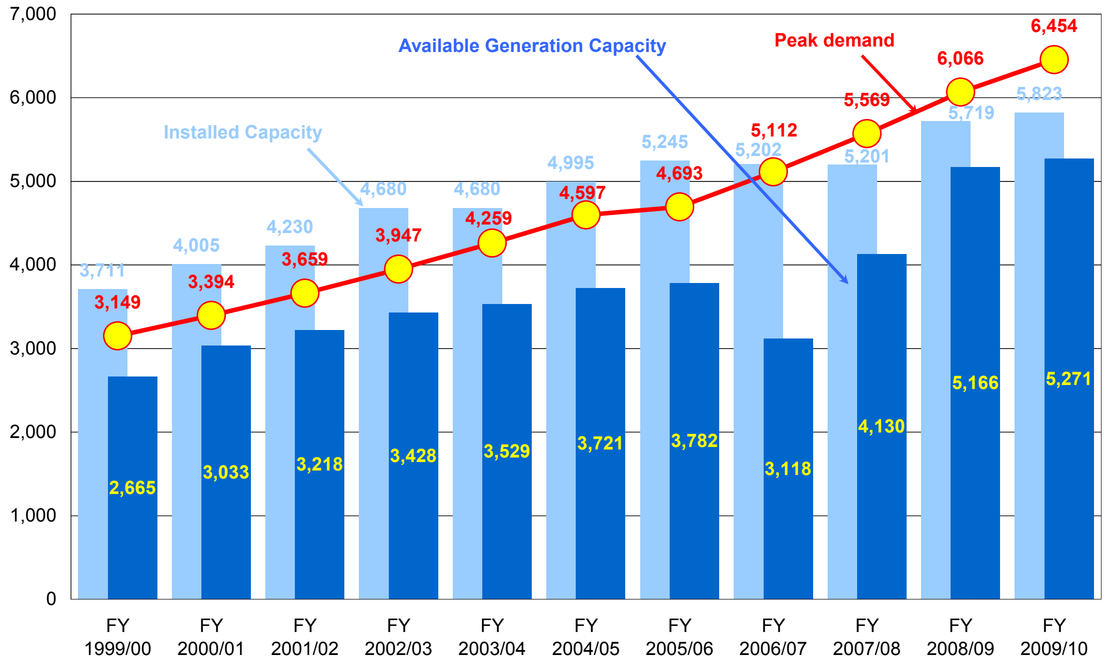
Source: Survey Team

The generation capacity shares are distributed as follows: BPDB, with approximately 60 percent; independent power producers (IPPs) with approximately 40 percent; and captive power generators account with approximately 1000 MW. With natural gas being its main constituent, IPP operate with a 20 year Power Purchase Agreement (PPA). With the aim of decreasing IPP businesses' risk, the IPP businesses are allowed to pass over the price of fuel increase onto the PPA price. There are also plans for new coal-fired power plants. As a joint venture between BPDB and NTPC (India's largest power company), construction of a 1,350 MW installation for Khulna is planned. Furthermore, several coal-fired IPP power stations are planned to be tendered.

(2) Policies and Trends of Power Sector

1) Electric Power Policy, Situation of Electricity Supply

The Power Division of the MoPEMR is the responsible authority for making and implementing policies for electricity. The department states, in its Vision Statement, that the goal is to provide access to affordable and reliable electricity, to the majority of the people of Bangladesh, by 2020. The statement is backed by a plan to increase the country's electricity power generation capacity to 15,000 MW. However, electricity power generation capacity has only increased slightly from FY 2000/01 to FY 2009/10, resulting in a severe supply and demand gap. The current government when it came to power made a commitment in its election manifesto, to stabilize electricity power supply by increasing the country's power generation capacity.



(Unit: MW)
Note: Fiscal Year in Bangladesh = 1 July – 30 June
Source: BPDB Annual Report 2010

Figure 2.1-3 Year-Wise Installed, Generation Capacity and Demand

The economic growth rate of Bangladesh from 2010 to 2011 was 6.7 percent, and is expected to be seven percent in 2011-2012. The target for 2015 is to attain an eight percent annual growth.[25] Despite this growth target, the power generation capacity cannot catch up with the increasing demand of power consumption. Electricity generation capacity, as of 2010, was 5,823MW, out

[25] Planning Commission (2010)

of which the available power generation capacity was 5,271MW, i.e., 90.5 percent of the total power generation capacity.[26] The ratio of supply to demand of 6,454MW was 81.7 percent. Since 2010, the current government has adopted the power generator capacity enhancement policy under the notion that power shortage is the major bottleneck for economic development.

In 2010, the government purchased 520 MW capacity from private sector and rental companies as emergency measures. This was made to enhance the electrical capacity by 775 MW, which includes the expansion by the Bangladesh Power Development Board (BPDB). The enhanced power generation capacity in 2011 was 1,596 MW. From this figure, 1,236 MW was the rental power generation, which is 77.4 percent of the total enhanced capacity. The Enhancement plan from 2012 is going to be focused on the private sector, with a new expansion plan to reach 14,175 MW by 2016.[27]

2) Power generation capacity expansion plans by BPDB

In 2011, BPDB, as an emergency measure, decided to increase generation capacity by 1,236 MW mostly through rental power generation. The fuel for these rental facilities are mainly diesel oil. Furthermore, during 2012 BPDB plans to boost 1,314 MW of generation capacity by IPPs. Note, however, that the fuel for most of these IPPs are heavy oil and diesel oil.

Due to the difficulty for BPDB to enhance the power generation capacity by itself to meet the demand of the country, the GoB has announced various incentives to power business entrants. This is to attract both national and international potential power businesses. Approximately 60 percent of the expected increase in power generation capacity is based on the contribution by the private sector power generation businesses, as can be seen on the following table. The power generation capacity on Rental Companies from year 2012 to 2016 was not confirmed.

Table 2.1-2 Power Enhancement Plan of BPDB

Year	2010	2011	2012	2013	2014	2015	2016	Total
Public	255	255	838	1,040	1,270	450	1,500	5,608
Private	270	105	1,319	1,134	1,053	1,900	1,300	7,081
Rental	250	1,236						1,486
Total	775	1,596	2,157	2,174	2,323	2,350	2,800	14,175

(Unit: MW)
Source: BPDB Annual Report 2010

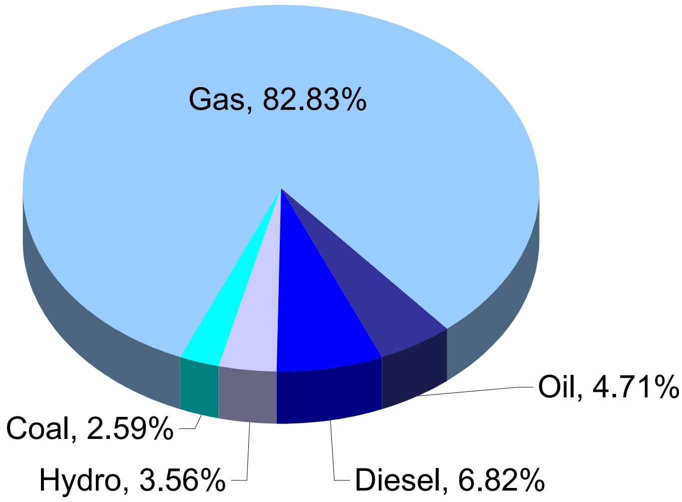
3) Available Power Generation Capacity

There are differences between installed power generating capacity and available power generation capacity. The following figures show the installed power generation capacity and available power generation capacity, together with the demand from 2000 to 2010. It shows that the available power generation could not meet the demand during these ten years. The gap was especially outstanding in 2007. The reason for the difference between installed capacity and available capacity is due to the performance of the generators that will not avail 100 percent performance due to the lack of maintenance. Furthermore, shortage of gas as fuel had brought some of the facilities to halt. Eighty-nine percent of the fuel for electricity power generation by BPDB is natural gas from domestic source. The bottleneck for power generation in the last few years was the shortage of gas, which was caused by the decrease of the production of natural gas. Diversification of fuel for electricity power generation is an issue of utmost urgency.

[26] BPDB website information
[27] idem

4) Power Generation Amount by Kinds of Fuels

The following graph shows the percentage of power generation by BPDB from different kinds of fuels. 82.83 percent of the total is from gas power generation.

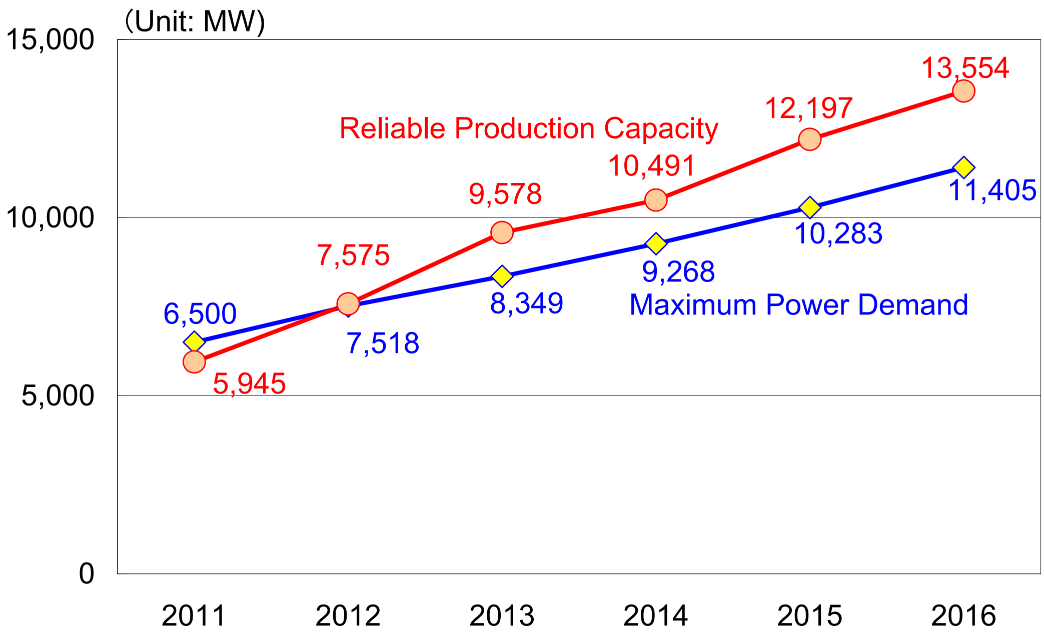


Source: Figures from Power and Energy Sector Road Map: An Update June 2011, Ministry of Finance

Figure 2.1-4 Electricity Production from Different Fuel Sources

(3) Power Supply and Demand

The MOF has issued the Power and Energy Sector Road Map: An Update June 2011.[28] According to the road map, the power generation capacity (reliable production capacity) is expected to surpass the maximum power demand from 2012. This excess in capacity is expected to be realized mostly by further introduction of rental power stations and IPPs.



Source: Ministry of Finance, Power and Energy Sector Road Map: An Update June 2011

Figure 2.1-5 Power Supply and Demand Plan

[28] MOF (2011)

As of 2012, frequent planned power outages still occur in most areas of the country. This discrepancy between the plan in the road map and actuality is presumably due to the negative effect of high fuel price, which has forced BPDB to apply for tariff increase and stop purchasing electricity generated by fuel oil. Agreements to further introduce rental power generation units and to conclude PPA from IPPs are also being delayed due to high price of fuels.

2.1.3. Renewable Energy and Energy Efficiency & Conservation Promotion Policies

(1) Existing Policy Framework

Bangladesh's superior development plan is the mid-term plan document, named the five year plan. The current version of the five year plan is the "Sixth Five Year Plan (2011-2015)", which was adopted by the GoB in 2009. In June 2010, an "Outline Perspective Plan of Bangladesh 2010-2021 - Making Vision 2021 a Reality" was issued as a strategic long-term plan.[29] This Outline Perspective Plan is meant to embrace two consecutive five-year plans, namely the sixth and seventh five year plans. This is to materialize what is stipulated as goals. The Outline Perspective Plan refers to the desperate need to reinforce the country's energy infrastructure as well as the need to promote the use of non-traditional renewable energy.

Current national energy policy is the 1995 National Energy policy (NEP)[30]. It was updated in 2005 to incorporate two newly established overall plans on the power sector, namely the Vision statement, and the Policy Statement. In response to these NEPs, Renewable Energy Policies were prepared. The latest of the policy is the 2008 version, which reflects the update of NEP in 2005.[31] This Renewable Energy Policy 2008 sets out a concrete target for the introduction of RE to five percent of the total power demand by 2015, and ten percent by 2020.

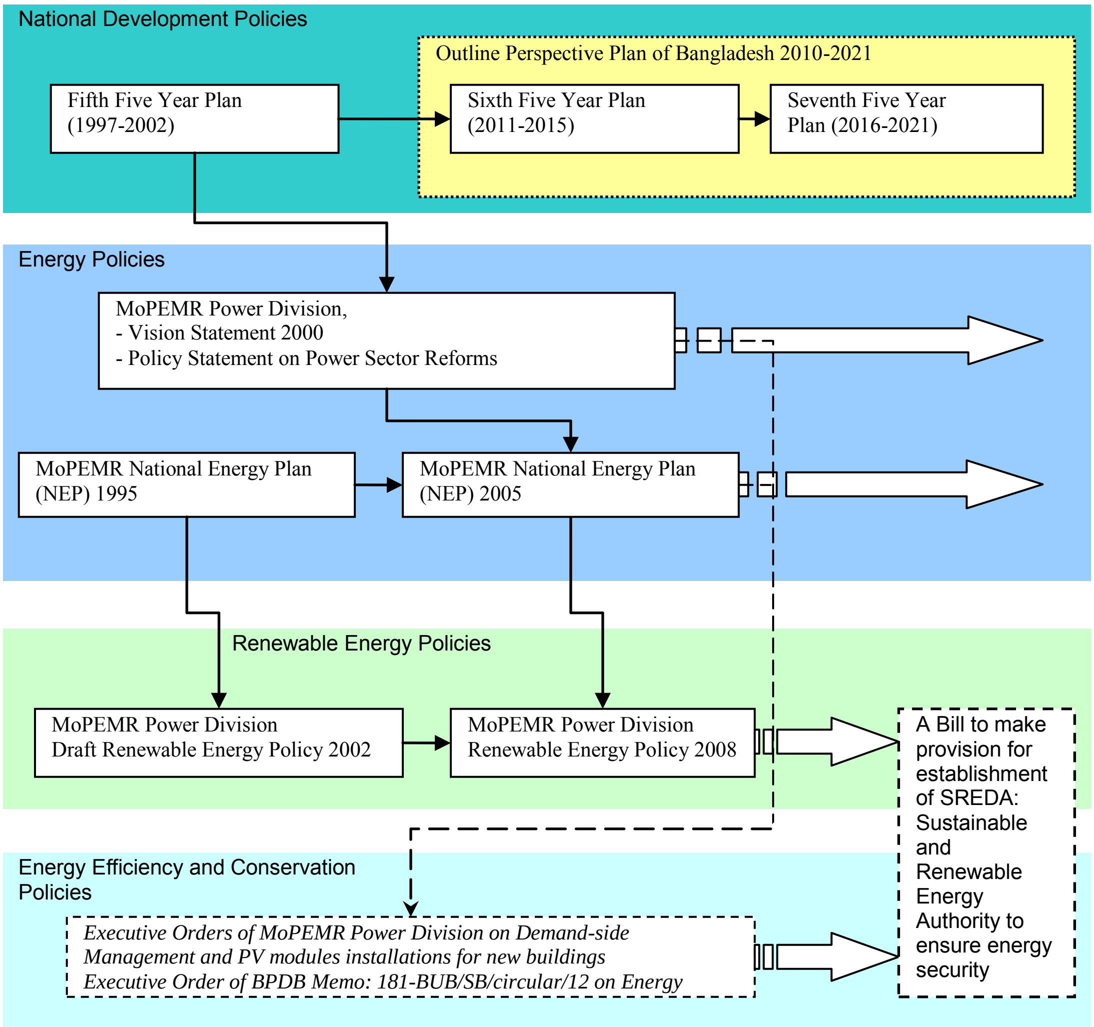
The Sixth Five Year Plan (2011 -2015), within the context of ensuring energy security, sets out orientations for energy efficiency and conservation, both in supply and demand sides of energy. Measures on the improving efficiency of the power sector and reducing system loss are mentioned in broad terms. Measures on the demand side are not stipulated in the plan.

MoPEMR has issued few executive orders to promote energy efficiency and conservation. One of which is an order requiring market closure at 20:00 and staggered holidays, setting air conditioner temperature at 25 degrees centigrade, and irrigation at nighttime. There is another executive order requiring new buildings to install solar PV modules to offset electricity consumption.

There is also a policy for promotion of RE specialized on solar PV. The MoPEMR, with support from ADB, introduced the "500 MW Solar Power Program". This plan is in line with the Ministry's plan to develop the power generation capacity up to 16,000MW by 2015. Within this figure, 800 MW is expected to be the contribution of RE. Solar PV is intended to take up 500 MW out of this figure.

[29] Planning Commission (2010)
[30] MoPEMR (1995)
[31] MoPEMR Power Division (2008)

The 500MW Solar Power Program is supported by ADB forms a part of the bank's "Asia Solar Energy Initiatives" (ASEI).[32] In this initiative, ADB aims to install 3,000 MW solar PV power generation capacity in Asia Pacific region by 2013. GoB, with endorsement for ADB's ASEI, has embarked on this ambitions program to promote solar PV.



Source: Survey Team

Figure 2.1-6 Development Policies, Energy Policies and Renewable Energy Policies

(2) Rationale of the Renewable Energy Development Project within the Context of the GoB Policy Framework

In line with the context of MoPEMR's Renewable Energy Policy 2008, JICA-REDP to be conducted by IDCOL will be financed by the Government of Japan.

The JICA-REDP promotes the technologies specified in the Policy, i.e., solar PV and biomass. Both of these RE technologies are expected not only to promote sustainable growth of rural economy but also to contribute in offsetting the use of conventional fossil fuels.

[32] In May 2010, ADB announced the Asia Solar Energy Initiative (ASEI) to catalyze generation of 3,000 MW of solar PV over the next three years. ADB plans to provide $2.25 billion in finance to the initiative, which is expected to leverage an additional $6.75 billion in investments from others over the same period.

The Renewable Energy Policy of Bangladesh sets out an ambitious goal to deploy RE to reach ten percent of the total power demand by 2020. The JICA-REDP will contribute significantly to the attainment of the goal by adding RE-based power generation capacity at the grassroots level.

The JICA-REDP is also expected to contribute to the EE&C policy and action plans, which are likely to be drafted and implemented once Bangladesh's authority for EE&C is formulated.

2.1.4. Interventions by Other Development Partners

Interventions specific to RE and EE&C sub-sectors have been taking place with the support of various international development partners. IDCOL's Solar Home System (SHS) Program, which is supported by the WB Rural Electrification and Renewable Energy Development (RERED) project, is a representative example which has been sustained for several years. Support from KfW, ADB, IDB, and partly GIZ, are executed in harmony, and under the arrangement of RERED Project.

RERED comprises a significant portion of support for IDCOL's RE activities. RERED consists of three main activities, which are: (i) the SHS Program through IDCOL, (ii) the RAPSS (Remote Area Power Supply Systems: an initiative to promote rural electrification through RE) through MoPEMR and IDCOL (as other RE Projects), and (iii) ELIB to distribute CFLs through REB.

Table 2.1-3 Major Interventions in RE and EE&C Sub-Sectors

Development Partners	Project Name	Description	Amount	Period
World Bank (IDA)	RERED (Rural Electrification and Renewable Energy Development)	RERED Project includes supports to: 1) through IDCOL SHS program, 2) through Power Cell: RAPSS (Remote Area Power Supply Systems) Guidelines 3) through REB: ELIB to distribute CFLs	Loan: 1)USD 55 million 2)USD 83 million 3)USD 172 million 4)USD128 million	2003-12 1)RERED 2)RERED additional-1 financing 3)RERED additional-2 2012-18 4) RERED 2 (proposed)
GIZ (Includes former GTZ activities)	SED (Sustainable Energy Development)	Support to IDCOL on SHS Program, Technical cooperation on: Biogas plant, improved cooking stove (ICS) Efficient rice parboiling, CFL distribution.	Grant: EUR 8.2 million	2006-12
KfW	Renewable Energy Project	Supports IDCOL activities mostly through grants.	Loan: EUR 0.1 million Grant: EUR 25.1 million	2007-12

Development Partners	Project Name	Description	Amount	Period
ADB	PPIDF Public-Private Infrastructure Development Facility	Balanced supports to both infrastructure and RE development.	Loan: USD 83 million Technical Assistance : USD 0.5 million	2009-12
IDB	Improving Rural Households Livelihood through Solar Energy Project	Supports SHS Program only	Loan: USD 14.5 million	2010-11
SNV	NDBMP (National Domestic Biogas and Manure Program)	Deployment of small scale biodigesters for households	Grant: EUR 4 M	2006-12

Source: Compiled by the Survey Team

2.2. Solar PV

2.2.1. Environment for Penetration of Solar PV Technologies

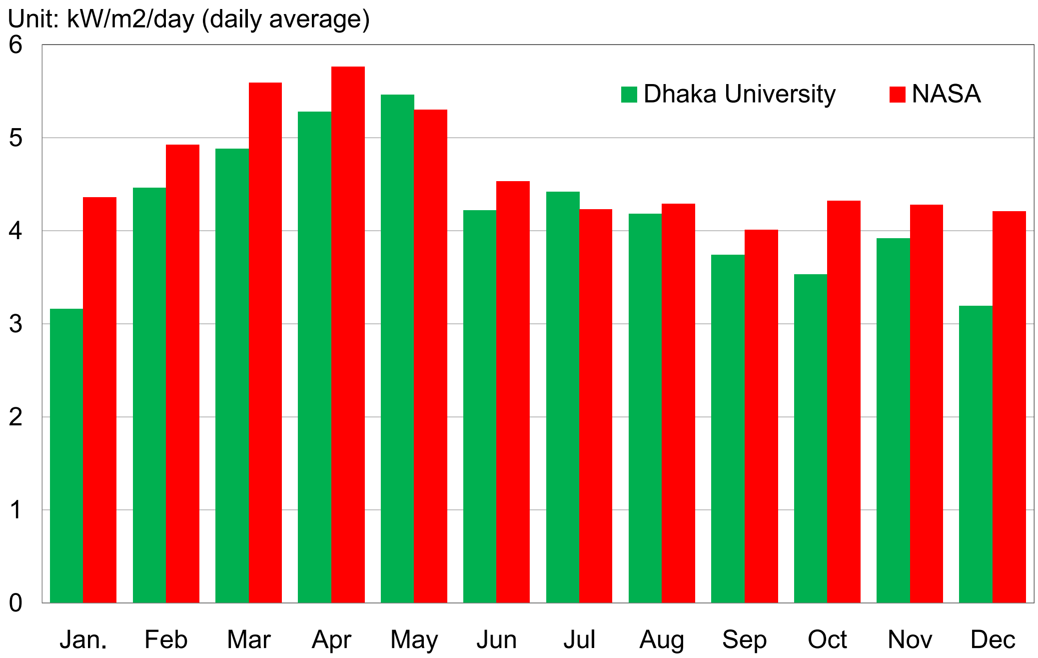
(1) Natural Conditions as the Potential for Deployment of Solar PV Technologies

1) Solar Radiation Amount

Performance of photovoltaic power generation is dependent on the intensity of solar radiation that reaches the ground. Theoretical solar radiation intensity up to the outer atmosphere is approximately 1,370 W per square meter. It is then scattered or absorbed by the substance in the air as it passes through the atmosphere. This will reach the ground at the intensity of approximately 1,000 W per square meter. Daily solar radiation (insolation) amount varies from region to region, depending on their latitudes that affects the duration of daytime. Therefore, average daily amount of solar radiation in Dhaka, located at latitude of N23°45', is larger than that of Tokyo, which is located at higher latitude of N35°41'.

When comparing the data from the Dhaka University and NASA, that of NASA is showing higher values for all of the months, with the overall average difference being is 9.5 percent. This difference is due to the condition of measurement, in which the Dhaka University employs ground measurement while that of NASA is satellite based.[33] Referring to the fact that ground measured insolation, in general is between 90 percent to 90.5 percent of satellite measurement data, the Dhaka University data is seen to be reflecting the actual insolation condition. Therefore, the data from Dhaka University, with an annual average horizontal solar radiation of 4.2 kWh/m2/day in Dhaka is adopted as the referential data, as it is deemed to reflect the actual gain of solar radiation by PV equipment.

[33] NASA (2012)



Source: Compiled by the Survey Team from NASA and Dhaka University Data

Figure 2.2-1 Insolation of Dhaka by Dhaka University and NASA

2) Hours of sunshine

The following table refers to the monthly average sunshine hours of each Division in Bangladesh.

Table 2.2-1 Average Sunshine Hour

Division	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
Barisal	6.7	7.9	8	7.5	7.3	3.6	4.8	3.4	4.2	6.9	7.7	5.6	6.2
Chittagong	6.2	7.8	8.2	7.6	6.9	3.9	5.5	3.8	4.9	6.8	8.5	5.9	6.4
Dhaka	4.9	7.5	7	6.8	5.5	3.5	4.1	2.5	5.1	6.1	6	4.4	5.3
Khulna	6.8	8.2	8.2	7.7	7.1	4	5.1	3.3	4.3	7.3	7.6	5.1	6.3
Rajchahi	5.6	7.3	8.6	7.6	7	5.1	5	3.8	5.8	7.5	7.1	4.8	6.3
Sylhet	5.9	7.9	6.8	7.4	5.1	3.8	3.8	4.5	5.7	8.2	7.8	7.1	6.2

Source: Bangladesh Meteorological Department Climate Division

Though there are less sunshine hours during the rainy season, which is between June and August, daily solar radiation is relatively constant throughout the year. This can be said to be a favorable condition for solar PV power generation.

3) Other weather conditions

The average lowest temperature in Dhaka is 21.3 degrees centigrade, while the average highest temperature is 30.6 degrees centigrade. The relative humidity is high throughout the year at 54 to 70 percent. Precipitation is limited during the dry season which is from November to February. On the contrary, the significant portion of the annual rainfall, which is 1,776 mm, is concentrated in the rainy season. In most parts of the territory, solar radiation amount is relatively stable. As such, it is assured that there will be solar PV power generation, even during the rainy seasons. Therefore, the natural conditions, including the solar radiation, air temperature, and sunshine hours can be said to be suitable for effective use for solar PV power generation.

The seasons in Bangladesh affect the agricultural production. The existence of the long dry season necessitates irrigation facilities if crops were to be produced throughout the year. Precipitation during the dry season tends to drop significantly, even to zero in some places.

Wind power generation is almost nonexistent, and inland wind condition is deemed to be unfavorable for power generation. The Bangladesh Meteorological Department currently does not possess accurate wind data for Bangladesh. There is, however, a study paper from the East West University, which suggests that wind power generation can be commercially viable under certain environments. This case was noted for some of the areas along the coast line.[34] There is a test plant for the solar – wind hybrid system in St Martins Island under the aid of the UNDP. A wind map of Bangladesh is currently under preparation by the UNDP and other international development partners.[35]

Wind mapping together with environmental characteristic, and special climate phenomena (gust of wind, sand wind, etc.) will be essential for considering wind power generation. Due to the absence of the information, wind power generation is unlikely to become a subject of Japanese loan under JICA-REDP.

(2) Social and Economic Environment for Promotion of Solar PV Technologies

1) Renewable Energy Targets

The Renewable Energy Policy of Bangladesh states the target to have five percent of the total electricity amount by 2015, and ten percent by 2020 from renewable energy sources (MoPEMR, 2008). Bangladesh, as already mentioned, is heavily reliant on gas as fuel for power generation. It is also conscious of the depletion trend of its gas source. Despite efforts by the BPDB, the currently installed capacity is not sufficient. MoPEMR stated in its Vision / Mission Statement, and Major Functions, that the government realizes the importance of coal, oil, and renewable energy (RE) after its consideration of the urgent need for diversification of fuel for power generation. The Ministry also stresses that among these alternative fuels, RE is the only domestically available energy.

On one hand, IDCOL among others, has been playing an essential role in promoting Solar Home System (SHS). A total of 1,233,886 sets have been deployed since 2003 to the year-end of 2011. IDCOL aims to deploy a total of 4,000,000 sets (approximately total capacity of 174 MW) by the end of 2015. Apart from SHS, IDCOL has also installed ten sets of solar water pump for irrigation (solar pump), and one set of solar mini-grid (mini-grid). The mini-grid is at operational status while the solar pumps are expected to be in operation from July 2012. IDCOL is planning to enhance these two components as programs with the SHS.

Hence, the principal components utilizing solar PV are SHS, solar pump, and mini-grid. As for mini-grid, it is expected to lighten some of the non-electrified local markets. Out of 8,000 marketplaces located throughout the country, around 6,000 are without electricity. Mini-grid is seen to be the solution to meet such requirements. With the Power Division of the MoPEMR being the executing authority for mini-grid deployment, IDCOL may play the role of the financing body. IDCOL is currently preparing a plan to fund the installation of mini-grids at 50 local markets, each with a 150 kW equipment.

[34] East West University (2010)
[35] UNDP's Wind Map is expected to be completed by end 2014.

Further, IDCOL plans to convert some of the 8,000 diesel-driven irrigation pumps nationwide to solar pumps. For this plan, IDCOL is requesting international development partners to support funding for 400m3/day's solar pump in 1,550 locations.

2) Environmental Policy

The Ministry of Environment and Forests has issued an environmental strategy in its National Sustainable Development Strategy (NSDS) for Bangladesh November 2008. In this strategy, it stated that the promotion of RE is relevant for poverty reduction and sustainable economic development. Nevertheless, specific environmental policy relating to deployment of RE is yet to be prepared.[36]

3) Preferential Policies for RE Power Generation

GoB, in its Renewable Energy Policy of Bangladesh 2008, sets out the following preferential policies for RE power generation:

- The government purchases power generated from RE equipment up to 5MW;
- Regardless of domestic of foreign products, 15 percent VAT is exempted for RE-related products; and
- RE business owners will have a five-year exemption of the corporate income tax.

4) Promotion of RE Business and Attracting Foreign Investments.

GoB offers various preferential policies to foreign companies to promote inward investment. Currently, there are no foreign investments into the RE projects in Bangladesh. The following four incentives are stipulated in the Renewable Energy Policy of Bangladesh December 2008:[37]

- To promote renewable energy in the power sector, all renewable energy equipment and related raw materials in producing renewable energy equipment will be exempted from charging 15 percent VAT.
- Renewable energy project investors in public and private sectors shall be exempted from corporate income tax for a period of five years from the date of notification of this policy in the official gazette and it will be extended periodically following impact assessment of tax exemption on renewable energy.
- An incentive tariff may be considered for electricity from renewable energy sources, which may be 10 percent higher than the highest purchase price of electricity by the utility from private generators.
- Sustainable Energy Development Authority (SEDA) (now to be established as SREDA) will consider providing subsidies to utilities for installation of solar, wind, biomass, or any other renewable / clean energy project.

Incentives and preference specific to RE-related businesses are yet to be introduced. However, the lack of financial resources impedes the GoB to introduce such incentives and preferences.

2.2.2. Solar Home System (SHS)

The Solar Home System (SHS) is the main form of solar PV technologies, which is being deployed in Bangladesh. SHS is a set of simple and affordable equipment which can bring about the benefit of electricity usage, even in remote areas. Electricity generated is commonly used for lighting, powering television sets, and for recharging mobile phone batteries.

[36] MOEF (2008)
[37] MoPEMR Power Division (2008)

The SHS Program, as implemented by IDCOL, is the representative example of the SHS deployment. The program has been successful enough to realize the electrification of more than 1.2 million households nationwide in remote, off-grid areas.

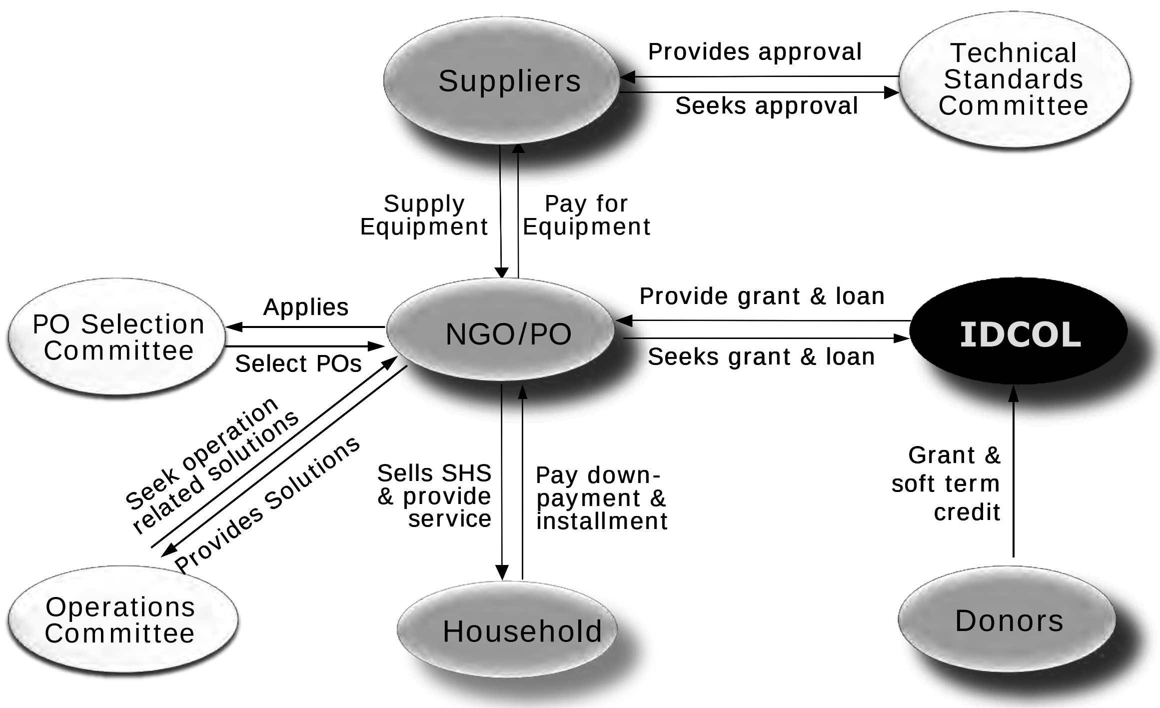
Target locations to which SHS are offered by IDCOL are the non-electrified villages, where grid connections are not expected within the foreseeable future (at least five to ten years). Although profiles of the SHS customers are not available in data, majority of them are middle class dwellers in the villages.

(1) IDCOL SHS Program

1) SHS Program Structure

IDCOL is the provider of funds for SHS Program, backed by funding from development partners. The sponsors, in principle, are NGOs who are accredited as the participating organizations (POs). The Technical Standard Committee approves the specification of the technologies and products that are applied to the SHS. This specification approval scheme plays an essential role to maintain certain quality standards of the SHS to be deployed. Apart from the approval scheme, there is also an inspection mechanism that assures the quality of goods and services provided in the program. IDCOL comes up with an inspection team comprised of six persons that conducts the inspection of solar PV instruments. If a defect is found, responsible POs will be contacted to have repairs arranged.

The maintenance fee is free of charge for end-users during the loan period (one to three years) except for the cost of repairing or exchanging parts. After the loan period, maintenance will be conducted for BDT 300 per year. Replacement costs of parts after the warranty period will have to be borne by the end-users.[38]



Source: IDCOL

Figure 2.2-2 IDCOL's SHS Program Structure

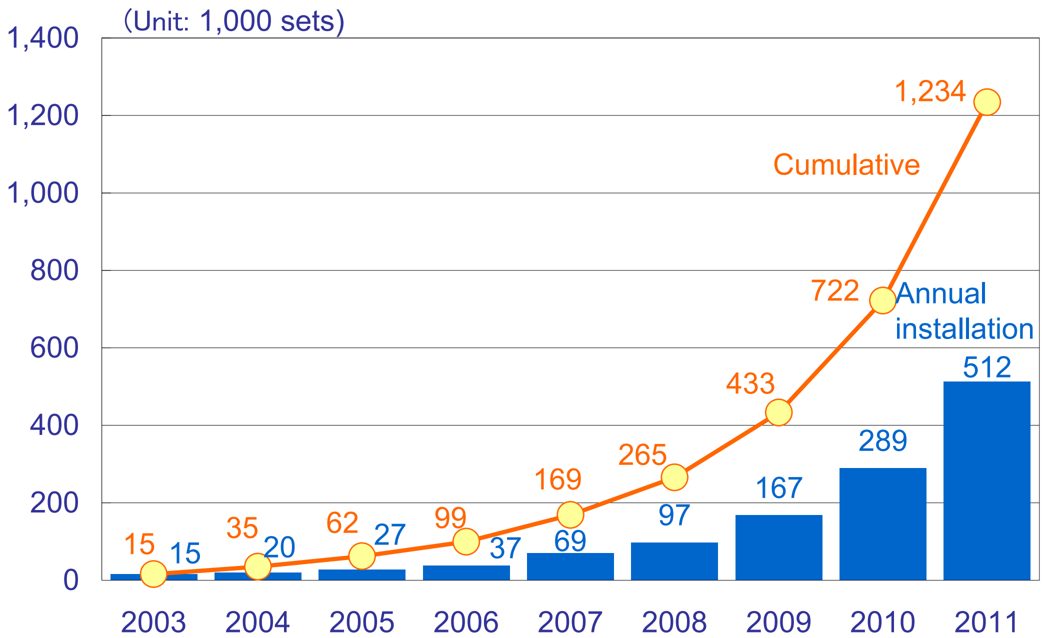
[38] Warranty periods are: Solar PV modules = twenty years, batteries = five years, controllers = three years.

As shown in the program structure chart, there are two committees for the Program, which are the PO selection committee and the operations committee. The PO selection committee is in charge of the qualification investigation of NGOs and other organizations that apply to take part in the SHS Program. The operations committee functions to share information among the stakeholders through monthly meetings held at IDCOL, where all POs as well as the funding development partners are invited.

2) Achievement of IDCOL's SHS Program

By the end of 2011, a total of 1,233,886 sets have been deployed by making use of the loan of IDCOL. IDCOL is planning to increase the deployment to 2,500,000 sets by the end of 2014. The cumulative SHS deployment, and annual installation in the following figure shows that the installation number has grown rapidly since 2008.

The average capacity of the implemented SHS by IDCOL is 50W. Therefore, the total accumulated capacity of the deployed SHS is approximately 62 MW.



Source: IDCOL

Figure 2.2-3 Achievement of IDCOL's SHS Program

Table 2.2-2 Division-wise SHS Installation

	Number of households 1)	Number of SHS Installation 2)	Electrification by SHS （%）
Division	2011		
Barisal	1,837,700	229,023	12.5
Chittagong	5,604,700	240,598	4.3
Dhaka	10,802,100	323,341	3.0
Khulna	3,740,500	136,738	3.7
Rajshahj	8,297,400	173,054	2.1
Sylhet	1,785,300	131,132	7.3
Total	32,067,700	1,233,886	3.8

Source: *1) Bangladesh Statistical Bureau、
*2) Division-wise Installation of SHS under IDCOL Program

The number of households, SHS installations, and the percentage of implementation against the total household are shown in the table above. The table shows that approximately 3.8 percent of the households in Bangladesh have obtained SHS. The penetration rate is high in the Barisal Division with 12.5 percent.

Solar PV modules of various makes are utilized for SHS. The share of Japanese mark modules among the total has been decreasing year on year. The percentage of the Japanese brand modules, at the time when the 858,805 sets were installed, was at 47 percent.

SHS, in principle, was only offered to households that are out of the reach of grid electricity. There are, however, cases when electrification is achieved earlier than expected. In such case, SHS will be existent under the electrified environment. With consideration for the end-users who might want to surrender using their SHS once they are electrified, the SHS is systematically offered with a buyback guarantee. Such guarantee allows the end-user to return the equipment when grid connection becomes available. The money paid back to the end-user is the residual value after depreciation. However, so far, there have been no cases of buyback. This is because the end-users choose to keep using SHS, to cope with the low reliability of grid electricity under frequent load shedding.

3) Unit Price of SHS

The Price Break down of the SHS by size specification is as shown in the following table. The price of a most common specification, 40Wp system is approximately BDT 22,800 (USD 275). If grant support of BDT 1,960 were not available, the cost will amount to BDT 24,760 (USD 298).

Table 2.2-3 Price Breakdown of SHS

	20 W	40 W	50 W	65 W
Solar Panel	2,640	5,760	7,200	9,360
Battery	3,850	6,240	8,675	10,700
Charge Controller	550	550	800	850
Light Set	1,700	2,550	3,400	4,250
Other Accessory	1,350	1,500	1,600	1,700
Transportation Cost	150	200	250	300
Installation Cost	300	350	400	500
Seles Commission	500	620	720	850
Operational Cost	3,130	5,600	5,700	5,900
Sub-total	14,170	23,550	28,745	34,410
Less: Grant	(1960)	(1,960)	(1,960)	(1,960)
Balance	12,210	21,590	26,785	32,450
Add: Margin*	390	1,210	1,715	2,550
Package Price	12,600	22,800	28,500	35,000

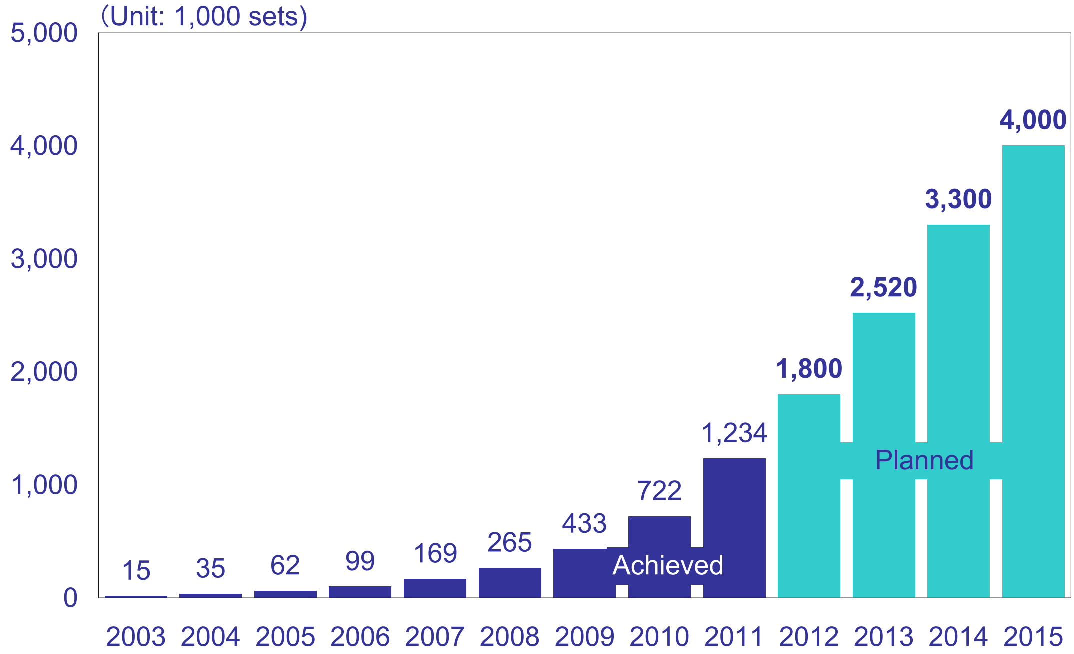
Note: 30 Wp models are not commonly offered.
Note: * Commercial margin for POs
Source: IDCOL

4) Future Directions of IDCOL's SHS Program

IDCOL's initial target, as of early 2012, was to deploy 2,500,000 sets (125 MW equivalent) by the end of 2014. In this initial plan, the annual installation target figures for 2012 and 2013 were both 610,553 sets. The annual installation target figure for 2014 is 45,008 sets. When this target is met, households with SHS will amount to 7.8 percent of the total 32,067,700 households in Bangladesh, i.e., to be electrified by SHS.

IDCOL claims to have the capacity to provide approximately 600,000 SHS sets per year even after 2013, subject to the availability of fund source. With regard to the persisting demand for SHS in various areas of the country, IDCOL has been seeking for funding sources that will enable its SHS promotion capacity to be utilized in full.

IDCOL, therefore in May 2012, announced its new target to add further 1,500,000 sets by 2015, which will add up to 4,000,000 sets by the end of 2015. The average capacity of SHS to be newly installed is planned to be 40-43 W, which is smaller than the average of already installed sets (50 W). This is due to IDCOL's plan to enable population with less purchasing power to become new target customers.



Source: Additional Fund Requirement under IDCOL Renewable Energy Programs

Figure 2.2-4 New Plan for SHS Installation up to 2015

5) Development Partners Supporting IDCOL in Deployment of SHS

International development financial institutions such as the WB and ADB have provided funding and technical assistance so as to support the deployment of SHS by IDCOL. The development partners and their funding amounts（in loan and grant) are shown in the following:

Table 2.2-4 Loan and Grant Received under IDCOL Solar Program

Source	Loan/Grant	Currency	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
IDA 3679	Loan		1.8	3.4	5.3	8	13.4	21.2	1.1				54.2
IDA 4643	Loan									29.6	47		76.6
IDA 50130	Loan											7.4	7.4
ADB REP	Loan								3.1	23.6	4.2	40.6	71.5
ADB SMIP	Loan								4.9				4.9
IDB BD151	Loan	USD								1.6	5	7.9	14.5
IDA 50130	Grant	(million)											0
ADB Grant	Grant												0
GEF TF	Grant		1	1.7	2	1.2	0.7	0.4		0.1			7.1
GPOBA-DFID	Grant										7.2		7.2
GPOBA-SIDA	Grant											1.6	1.6
KfW	Loan						0.1						0.1
GIZ	Grant	EURO				1.1	0.5	0.1	1.9	3.4	0.7		7.7
KfW	Grant	(million)					0.4	4	0.9	3.6	4.1	1.7	14.7

Source: IDCOL

(2) Other SHS Programs

There have been various projects to promote the use of SHS by entities other than IDCOL. Among these activities, projects conducted in relatively large scale are those conducted by REB, LGED, and BPDB.

1) REB

The REB, in parallel with IDCOL's SHS Program, also conducted Solar PV technology popularization activities. The GoB embarked on the RERED Project in 2002, funded by the WB. The SHS installed under the REB are mostly offered to the locals, They were provided with the equipment on a "fee-for-service" basis, being different from IDCOL's "hire-purchase" or "buy-and-own using micro-finance" patterns. The merit of a "fee-for-service" is that a customer is not required to pay the initial cost and can use electricity by paying electricity cost every month.

Table 2.2-5 SHS Installation by REB

Project name	Implementing Period (Year)	Project Cost	SHS Installation
Diffusion of RE Technologies I	FY 1993/94 to FY 1997/98	Total: USD 1.77 million Aid: USD 1.14 million (AFD) GoB: USD 0.63 million	806 SHSs and 3 BCS
Diffusion of RE Technologies I	FY 1993/94 to FY 1997/98	Total: USD 1.77 million Aid: USD 1.14 million (AFD) GoB: USD 0.63 million	806 SHSs and 3 BCS
World Bank (IDA) RERED Project	FY2002/03 to FY 2007/08	Total: USD 7.12 million Aid: USD 4.78 million (WB) Aid: USD 1.05 million (GEF) GoB: 1.29mill.	12,402 SHS installed by 6 PBSs.
Diffusion of RE Technologies III	FY 2009/10 to FY 2014/15	Total: USD 24.27 million Aid: USD 15.4 million GoB: USD 8.87 million	25,000 SHS have been installed by 22 PBSs.
Solar Irrigation & SHS	FY 2009/10 to FY 2014/15	Total: USD 3.036 million Aid: 1.96 mill. (KOICA) GoB: USD 1.076.ll.	20 Solar pump & 2,000 SHS

Source: REB, Project Wise Progress Report of PV, SHS Installation (up to June, 2009)

REB also installed 49 kW solar PV system on the rooftop of its headquarters building. This system is not grid connected but battery equipped. Electricity generated is stored in the battery and utilized for lightings and ceiling fans that is dedicated on the building. This "urban type SHS" functions during power cut conditions. The equipment was installed by Rahimafrooz, Renewable Energy Ltd.

2) BPDB

BPDB is said to have installed 21 kW Solar PV modules within the Prime Minister's office terrain. According to the interview with Rahimafrooz, Renewable Energy Ltd., the installer of the equipment, the system is not grid connected but is a switching type, i.e. an urban type SHS, which is identical to the system on REB rooftop.

BPDP has installed similar kinds of urban type SHS in various locations and in various sizes. According to the Rahimafrooz, Renewable Energy Ltd. website information, small scale urban SHS are of 100W in size. Large scale facilities are also existent in Chittagong (11 kW), and Rajshahi (1 MW).

3) LGED

The LGED has implemented 38 small scale RE promotion projects under the "Sustainable Environment Management Program" funded by UNDP. The program was conducted from 1999 to 2006. Three small projects were concerned with the SHS installations. In all of the cases, the installed equipments were donated to the local residents after completion.

Table 2.2-6 SHS Installation by LGED

Name of Projects	Implemented Year	Cost
SHS for Cluster Village (Asrayan Project for landless people)	1999	BDT 1,200,000
SHS for Tribal Community	2001	BDT 730,000
LED based SHS	2006	BDT 3,085,000

Source: LGED/UNDP, Sustainable Rural Energy – Achievement of Sustainable Rural Energy

(3) Expected Effect of SHS

The Solar Home Systems (SHS) are being marketed as a way for those living off-grid to lighten their home, charge their mobile phones, and power their television sets. Grants and low interest loans from international development partners and the formation of a payment system (microfinance) has lowered the prices of SHS. After about nine years since the commencement of the program, 1,233,886 sets have been sold. Through efficient maintenance, almost 100 percent of all installed systems are operating, according to IDCOL. The total cumulative generation capacity of SHS introduced under IDCOL program, up to the end of 2011 is approximately 61.7 MW, i.e., comparable to that of a power plant of the same capacity. By the end of 2015, the number of sets in use is expected to reach 4,000,000 with a total capacity of 174 MW powering 12.47 percent of the households in Bangladesh.

1) Development Factor of SHS installation

Hiroshima University conducted a survey on the reasons for introduction of SHS into Bangladeshi homes.[39] The reason given for installing the system was usually one of followings:

[39] Hiroshima University (2011)

- Giving children more time to study;
- To charge mobile phones;
- To watch TV;
- To power electric lights; and
- To continue working after dark.

After the introduction of SHS, almost all of these households acquired mobile phones. Although the report has shown that the main reason for introducing SHS is to improve the home environment, SHS can also benefit business activities by increasing their operation hours and expand their businesses. Since a household can improve their living environment with merely 50 W sized SHS, the development effect of its introduction is significant (Hiroshima University).

2) Annual Energy Production

Electricity generated from 61.7 MW capacity of SHS could have contributed to saving fossil fuel. Calculations based on the theoretical power production capacity of SHS solar PV modules, facing south with tilt angle of 23 degrees under irradiation condition in Dhaka is carried out. The result shows that the total annual output of 70,997 MWh could have been expected.

It should be noted that electricity generated by solar PV modules of SHS is commonly charged into battery for use during the dark. Taking into account the battery efficiency, assumed to be approximately 80 percent, the actual available electricity is calculated as 56,798 MWh per year (70,997 × 0.8 = 56,798 MWh).

Table 2.2-7 Power Generation from Total Installed SHS

		Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Dhaka	HRZ	3.16	4.46	4.88	5.28	5.46	4.22	4.42	4.18	3.74	3.53	3.92	3.17	
	T/23°	3.9	5.23	5.19	5.13	5.07	3.88	4.22	3.96	3.77	3.88	4.86	4.02	
Loss of dust	Kd	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
Ave. max. temp.	°C	23.4	28.7	32	33.4	33.4	33	32.3	31.1	32.4	32.6	29.7	24.9	30.6
	Tm	41.8	47.1	50.4	51.8	51.8	51.4	50.7	49.5	50.8	51	48.1	43.3	
	Kt	0.92	0.90	0.89	0.88	0.88	0.88	0.88	0.89	0.88	0.88	0.90	0.92	
Total Loss (L	Kt*Kd	0.74	0.72	0.71	0.70	0.70	0.70	0.71	0.71	0.71	0.71	0.72	0.73	
(L) * T/23		2.88	3.77	3.68	3.61	3.57	2.74	2.99	2.82	2.67	2.74	3.48	2.95	
	Days	31	28	31	30	31	30	31	31	30	31	30	31	
61.7MW	MWh/day	177.95	232.48	226.90	222.68	220.07	168.76	184.21	173.92	164.48	169.11	214.95	182.09	
	MWh/M	5,516	6,509	7,034	6,680	6,822	5,063	5,710	5,391	4,934	5,242	6,449	5,645	70,997

Note: HRZ: Horizontal radiation kWh/m2/day
T/23: The sun radiation at the tilt angle 23

Calculation Method:

$Ep = (\Sigma Ha / Gs) \times K \times P$

Whereas:

Ep: Estimated generating power (kWh/year)

Ha: Ave. monthly solar radiation (kWh/m2/day)

Gs: Standard solar radiation (1kW/m2)

K: Loss rate ($Kd \times Kt \times \varepsilon$)

Kd: Including dust on the module, loss of solar radiation change and module characteristic (normally 0.8)

Kt: Temperature increase adjustment rate $Kt = 1 + \alpha(Tm - 25)/100$

α: Temperature coefficient (% / °C), Crystalline silicon = -0.45

Tm: Module temperature (°C) $Tm = Tav + \Delta T$

ΔT = Back of panel is open system : 18.4

Tav = Average max. monthly temperature

ε: Inverter efficiency

P: Solar PV capacity

Source: Calculation by the Survey Team

3) Effects of the Kerosene Reduction

A typical household in Bangladesh uses 50 liters of kerosene per year.[40] Average monthly consumption of kerosene at a household is therefore 4.2 liter (or 3.4 kg) per month. Light available from a kerosene wick lamp is 1.15 klm-h/kg of kerosene.[41] A typical household is enjoying the lighting of 126 lm-h/day. Average light available from a SHS exceeds this daily figure. SHS, therefore, can be said to be saving all of the kerosene consumption. Total kerosene saving, by introducing SHS can be calculated as 61,694 kL (Total sets of SHS installed by IDCOL = 1,233,886 x 50 liters).

(4) Bottlenecks for SHS deployment

The popularization of SHS is an activity encouraged by the GoB. There has been no existence of bottlenecks, despite the fact that laws, standards, and conventions are yet to be established. One issue on the environmental aspect is that there is a necessity to establish a system to collect and exchange batteries after a certain number of SHS sets have been installed. Although battery collection system does exist, the system still requires improvement to become effective.

2.2.3. Solar Irrigation Pump Project

Due to the necessity to increase food production in Bangladesh, electric pumps are employed for irrigation in electrified areas, while diesel-powered pumps are utilized in the non-electrified environment. The diesel pumps takes up a percentage of approximately 76 percent of total irrigation pumps in Bangladesh. The electricity tariff system enables the users of electricity pumps to consume electricity at low unit prices, especially designated for agricultural purposes. As a consequence, the cost of energy for diesel driven irrigation pumps amounts to approximately 2.5 times of that of electric pumps.

Although rainfall becomes sparse in the winter dry season, irrigation equipment will enable production of Aman and Boro strains of rice. The common method of producing Aman and Boro rice is to use electric and diesel pumps for irrigation. The GoB intends to cut the usage of diesel oil, which powers 76.2 percent of the irrigation pumps in the country[42]. This is expected to contribute to reducing oil imports. Promoting solar pumps is deemed to be the optimal way to achieve this goal, at the same time, as reducing the cost of farming.

(1) IDCOL's Solar Irrigation Pump Sub-Project

IDCOL has so far approved loans for 15 solar irrigation pump sub-project by two major initiatives. One is conducted by 4SL, and another by NUSRA. IDCOL plans to install total of 100 solar irrigation pump sub-projects during 2012.

1) Installations by 4SL

In ten districts in the three northern divisions, a total of ten solar irrigation pump sub-projects are being installed. The owner of the sub-project is a PV system integrator named "Survivor's - Sancred Solar System Limited (4SL) Solar Pump System". The total construction cost amounts to BDT 29,537,687. The total irrigated area adds up to 280 hectares, with farmers' benefit reaching to 215 households. The form of funding was granted at 40 percent, (from GPOBA via

[40] Condition employed by IDCOL
[41] World Bank (2010)
[42] BADC/DAE (2011)

IDCOL), loan at 30 percent (from IDA via IDOCL), and the remaining 30 percent will be covered by a self-financing equity portion.

With pump capacities of 3.5kW and 5.5kW, the water flow is 468 to 504 tons per day. Installation was conducted by two EPC contractor companies, RREL and EPGL.

Table 2.2-8 Key Sub-Project Information of Solar Pump for Irrigation Conducted by 4SL

Particulars				
Plant Capacity, Location, and EPC Contractor				
Location	Pump capacity	Solar Panel	Water flow (later/day)	EPC Contractor
Thakurgaon Sadar, Thakurgaon	3.5 KW	5.76 KW	467,540	RREL
Pirganj, Thakurgaon	5.5 KW	6.48 KW	504,000	EPGL
Ranisongkoil, Thakurgaon	3.5 KW	5.76 KW	467,540	RREL
Baliadangi, Thakurgaon	3.5 KW	5.76 KW	467,540	RREL
Horipur, Thakurgaon	5.5 KW	6.48 KW	504,000	EPGL
Panchagar Sadar, Panchagar	5.5 KW	6.48 KW	504,000	EPGL
Dabiganj, Panchagar	5.5 KW	6.48 KW	504,000	EPGL
Atoari, Panchagar	5.5 KW	6.48 KW	504,000	EPGL
Tetulia, Panchagar	5.5 KW	6.48 KW	504,000	EPGL
Birganj, Panchagar	5.5 KW	6.48 KW	504,000	EPGL
Services	Irrigation facility for paddy, potato, cucumber, maize, wheat, jute and vegetable cultivation to minimum 2,088 bighas of land in three seasons.[43]			
Major equipment	EPGL: Submersible solar water pump from Grundfos Holding A/S, Denmark and Solar PV modules & controlling system from Rich Solar, China. RREL: Submersible solar water pump and Solar PV modules from BERNT LORENTZ GmbH & Co., Germany.			
Equipment supplier and EPC contractor	Energypac Power Generation Limited (EPGL) and Rahimafrooz Renewable Energy Limited (RREL)			

Source: IDCOL "Solar Pump for Irrigation Appraisal Report by 4SL"

The price of the already existing solar pump systems for Irrigation provided by 4SL, and funded by IDCOL is available from an appraisal report. Each plant cost approximately BDT 3 million, and the total amount of the 10-systems amount to BDT 29.54 million.

Table 2.2-9 Initial Cost of Solar Pump System

Costs Items	Cost per plant (BDT) (3 locations)	Cost per plant (BDT) (7 locations)	Total Cost (BDT)	(%)
Land & land development	65,000	65,000	650,000	2.20%
Fencing	35,000	35,000	350,000	1.18%
Solar panel	921,600	980,800	9,630,400	32.60%
Water pump	319,306	290,000	2,987,918	10.12%
Controlling system		300,000	2,100,000	7.11%
Auto-tracking system	350,000	250,000	2,800,000	9.48%
Module mounting structure	399,225	250,000	2,947,675	9.98%

[43] Number of farmers per system is 10 ~ 20.

Costs Items	Cost per plant (BDT) (3 locations)	Cost per plant (BDT) (7 locations)	Total Cost (BDT)	(%)
Earthing rod and other safety devices	75,232	50,000	575,696	1.95%
Borehole piping with necessary fittings	60,282	140,000	1,160,846	3.93%
Buried pipe	200,000	200,000	2,000,000	6.77%
Water tank	60,000	60,000	600,000	2.03%
Band, elbow, circuit breaker etc.	2,615	30,000	217,845	0.74%
Supply, installation, testing & commissioning	215,769	410,000	3,517,307	11.91%
Total	2,704,029	3,060,800	29,537,687	100.00%

Source: IDCOL, 4SL solar pump Appraisal Report

The amount of one set of the 3.5 W Solar Pump is about 2.70 million BDT while the amount of the 5.5 kW system is about 3.06 million. The result of the financial analysis of the sub-project (to install, own, and operate 10 solar irrigation pump sub-projects) is shown in the table below. Sub-Project IRR is expected to be just above 12 percent.

Table 2.2-10 Summary of the financial analysis results for 4SL's solar irrigation sub-project

Ratio	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
DSCR	2.03	1.29	1.44	1.42	1.58	1.56	1.7	1.72
Average	1.60							
Minimum	1.29							
NPV	13,159,863							
Sub-Project IRR	12.27%							
ROE	15.81%							

Source: IDCOL "Solar Pump for Irrigation Appraisal Report by 4SL"

As for the funding structure of IDCOL-funded solar irrigation pump sub-projects, the proportion of the loan to grant is set based on the farmers ability to pay for the irrigation water. The unit cost of water is set at BDT 100 per bigha less than the cost of water currently charged with the use of diesel pumps.

2) Installations by NUSRA

NUSRA is a Non-Governmental Organization registered as a PO for both the SHS Program and NDBMP. It has applied for finance to IDCOL to install five solar irrigation pump sub-projects. Installation work is currently being conducted in few of the sites.

The example of a solar irrigation pump system is the one already installed at Dhamrai, the system is comprised of solar PV modules, a 7.5 kW submersible AC pump, and a controller. The pump is installed by hanging it on the well from the shelter ceiling. The facility is expected to irrigate a total area of 672 bighas. The installation at the Dhamrai also includes buried irrigation pipes to distribute water to irrigation sites within the radius of a few hundred meters.

Table 2.2-11 Key Sub-Project Information of Solar Pump for Irrigation Conducted by NUSRA

Location	Solar Panel (kWp)	Water flow (liter/day)	Pump capacity (kW)
Dhamrai, Dhaka	8.4	384,000	7.5
Sailkupa, Jhenaidah	8.4	432,000	7.5
Kumarkhali, Kushtia	8.4	384,000	7.5
Kaharole, Dinajpur	4.2	328,000	3.5
Bogra Sadar, Bogra	5.04	324,000	3.5

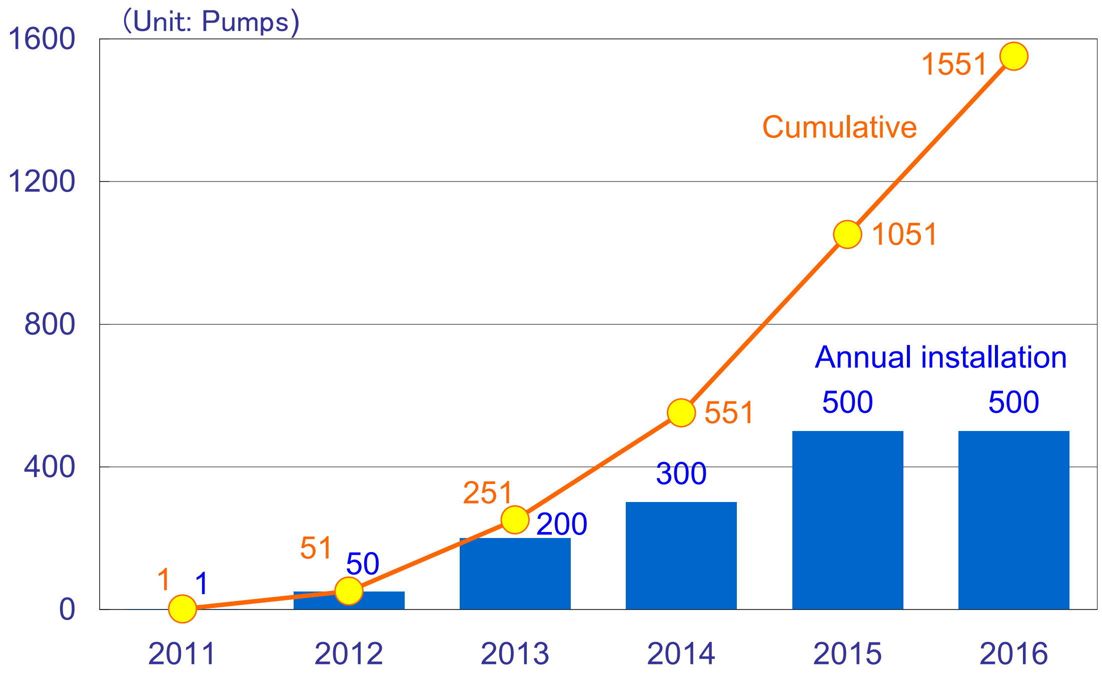
Source: IDCOL "Appraisal Report: Solar Pump for Irrigation by NUSRA"

The form of funding was composed of grants at 40 percent, (from KfW via IDCOL), loans at 30 percent (from IDA via IDOCL), and the remaining 30 percent was based on a self-financing equity portion.

3) Planned Facilities

According to IDCOL's "Additional Fund Requirement under IDCOL Renewable Energy Programs", the company is planning to set up solar irrigation pump systems that can provide 400 cubic meters of water per day in 1,551 locations by 2016. When installed, these solar pumps will most likely replace current diesel-run irrigation pumps.

The potential sponsors which are preparing to participate in the sub-projects are those NGOs such as RSF, NUSRA, GHEL, Grameen Shakti and BRAC. The proposals from these potential sponsors are evaluated for each RE project.



Source: IDCOL

Figure 2.2-5 IDCOL's Plan for Solar Irrigation Pump Installation

(2) Installation of Solar Pump for Irrigation by REB

REB, under funding from the Climate Change Trust Fund and the GoB, is installing 20 solar irrigation pumps. The unique feature of the equipment is that the power generated can be used not only for irrigation but also for household lightings. The sub-project started in 2010 and is expected to be completed in 2012. Equipment is transferred from REB to PBSs once they are installed.

Table 2.2-12 Solar Irrigation Pump Installation by REB

Project name	Introduction of Solar Powered Irrigation Pump as well as Power Management and Distribution System to Mitigate Energy Crisis and Climate Change
Implementing organization	REB
Ownership	REB / PBS
Financing	Climate Change Trust Fund (CCTF) Government of Bangladesh
Project cost	BDT 111,147,000
Project period	April 2010 – June 2012
Target	Installation of 20 solar irrigation pumps and to supply power to 300 households.

Source: REB

In parallel with the above mentioned project, REB has another project funded by the grant from the Korean government. REB, in liaison with KOICA, is currently conducting a project to install 20 solar irrigation pumps under Korea's KRW 200 billion "East Asia Climate Partnership Program". The project started in 2011, and installations will be completed in 2012.

(3) Effect of Solar Pump for Irrigation

For a diesel powered irrigation pump, routine maintenance and fuel is needed. Due to the fact that Bangladesh imports all of its oil supply, the rise in the international oil price is causing a hard blow to the economy. Solar pump, which will cut the demand for oil, is expected to contribute to avoid such a blow to the rural economy.

The pumps installed in ten locations with finance from IDCOL include seven pumps of 5.5 kW capacity, and three pumps with 3.5kW capacity. The total installed capacity adds up to 49 kW.

1) Solar PV Output and Diesel Pumps

The diesel fuel required pump up water for irrigation was calculated. In parallel, the power generated from the solar PV, with the capacity that can subsidize the diesel engine, was also calculated under the same method as with SHS calculation method.

Table 2.2-13 PV Generation & Oil Equivalent

Pump Capacity	Working Capacity	PV Capacity	Generated Electricity	Diesel Oil Consumed
3.5 kW	467.5 m3/day	5.76 kW	6,628 kWh	2,071 L
5.5 kW	504 m3/day	6.48 kW	7,456 kWh	2,330 L

Source: Calculation by the Survey Team

The values in the above table are for solar PV modules, each with a capacity of 5.76kW and 6.48kW. Such modules will be suitable to replace the existing diesel engines for 3.5 kW and 5.5 kW pumps.

2) Effects of the Reduction of Diesel Oil

In the case of a solar pump system with 5.76 kW solar PV modules the total annual electricity generated will add up to 6,628 kWh. A diesel generator with an equivalent performance (Diesel Oil Cal. 9,200 kcal/L, Efficiency of Diesel Engine Generator: 30 percent), will use 2,071 liters of diesel oil in a year [6,628/{9,200/(860/0.3)}}=2,071][44]. A solar pump system with a 6.48 kW solar PV panel will generate 7,456 kWh per year, while a comparable diesel generator will require 2,330 liters of diesel oil in a year.

The total required diesel oil, assuming that all ten solar pumps were powered by diesel engine, was calculated. Assuming that the demand factor is 0.86 (calculated from IDCOL's appraisals reports), the total annual requirement was calculated as 19.3 kL.

Table 2.2-14 Total Diesel Oil Requirement

Solar Pump Capacity (kW)	No. of Units	Diesel Oil Requirement (kL)		
		Liter/pump	Total	Demand (0.86)
5.76	3	2.07	6.2	5.3
6.48	7	2.33	16.3	14
Total	10		22.5	19.3

Source: Calculation by the Survey Team

The annual output of these solar PV panels can be said to be equal to a diesel generator that uses 19.3 kL of fuel per year. The current market price of diesel fuel, being BDT 61 per L as of March 2012,, means that an annual cost of BDT 1.177 million would be saved due to the introduction of solar pump irrigation system. Since diesel oil price for farming purposes is artificially kept low from time to time, the actual cost reduction might become lower.

3) Effects of the Emissions Reduction

The total electricity generated by solar PV modules installed for solar pump system will add up to 72,076 kWh (6,628 x 3 + 7,456 x 7 = 72,076 kWh). This energy generated was equivalent to electricity generated from 19.3 kL of diesel fuel. Applying 2.7 kg-CO2/L for diesel oil as the emission intensity of diesel oil,[45] then the annual emission from diesel oil saved will become 52 ton-CO2.

4) Effect to Promote Irrigation

The water demand in the locations where IDCOL financed solar pumps are installed is shown in the table below. The demand is at its lowest in June and September, with July demand down to zero in some of the locations. The water demand differs from location to location, mainly due to precipitation, hydrology, and agricultural conditions. Nonetheless, water demand is existent during most of the time throughout the year.

[44] 1kW = 860 kcal, Efficiency of diesel engine generator: 30%
[45] US Energy Information Administration, Emission Factors and Global Warning Potentials- Fuel and Energy Emission Factors

Table 2.2-15 Volume of Water Required (Monthly)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Water requirement (m3/hectare/month)											
Sadar, Thakurgaon	2,387	2,482	2,430	3,254	990	54	-	3,676	484	3,009	2,314	2,256
Pirganj, Thakurgaon	2,387	2,410	2,430	3,254	990	54	2,394	3,676	484	3,009	2,244	2,256
Ranisongkoil, Thakurgaon	2,125	2,664	2,312	3,542	1,998	616	2,556	3,676	484	3,009	2,314	2,082
Baliadangi, Thakurgaon	2,387	2,482	2,430	3,398	1,710	54	1,585	3,576	204	3,150	2,454	2,256
Horipur, Thakurgaon	2,125	2,664	2,312	3,542	1,998	616	2,556	3,676	484	3,009	2,314	2,082
Sadar, Panchagar	2,387	2,482	2,430	3,254	990	54	-	3,676	484	3,009	2,314	2,256
Dabiganj, Panchagar	2,387	2,482	2,430	3,254	990	54	-	3,676	484	3,009	2,314	2,256
Atoari, Panchagar	2,300	2,491	4,160	4,627	2,010	223	-	3,705	146	3,066	2,389	2,115
Tetulia, Panchagar	2,387	2,482	2,430	3,398	1,710	54	-	3,676	484	3,009	2,314	2,256
Birganj, Dinajpur	3,064	7,310	4,122	4,742	3,516	508	2,664	4,987	2100	2,031	2,314	2,082

Source: IDCOL, 4SL Solar Pump Appraisal Report

Water obtained by irrigation is used for various crops under seasonal rotation, even within the same field. For example, in Panchagar Sadar, one might plant cucumbers during the season 1, Aman rice in season 2, and potatoes in season 3. This allows up to three harvests on the same field.

Table 2.2-16 Minimum Cultivable Land

Location	Minimum Land area to be covered with Buried Pipe (bigha*)					
	Season 1		Season 2		Season 3	
	Crop	Area	Crop	Area	Crop	Area
Thakurgaon Sadar	Cucumber	83.30	Aman	51.77	Potato	77.30
Pirganj, Thakurgaon	Cucumber	84.59	Aman	55.75	Wheat	83.23
Ranisongkoil, Thakurgaon	Maize	73.57	Aman	51.76	Cauliflower	75.57
Baliadangi, Thakurgaon	Cabbage	79.76	Aman	53.21	Potato	77.28
Horipur, Thakurgaon	Maize	79.23	Aman	55.75	Cauliflower	81.38
Panchagar Sadar	Cucumber	89.70	Aman	55.75	Potato	83.23
Dabiganj, Panchagar	Cucumber	89.70	Aman	55.75	Potato	83.23
Atoari, Panchagar	Jute	63.08	Aman	55.31	Wheat	86.38
Tetulia, Panchagar	Cabbage	85.90	Aman	55.75	Potato	83.23
Birganj, Dinajpur	Boro	30.60	Aman	41.32	Potato	65.88
Total		759.43		532.12		796.71
Minimum Land Area Coverage in 3 seasons (bigha)	2088.25					

Source: IDCOL, 4SL solar pump Appraisal Report

Through the use of irrigation, up to three crops can be grown in one year. Improving agricultural productivity per land has a significant development impact, especially when taking into account the country's limited availability of arable land and high population density.

Although initial investment issues remain, usage of the solar pump results in lowered dependency on oil, a lower environmental impact (noise, oil pollution, and air pollution), reduced operating costs, and increased crop yields .

(5) Bottleneck for the Solar Pump dissemination

There are currently no major legal or technical restrictions. However, some of the common issues in implementation of the project are as follows:

- Given the large number of farmland owners involved in one sub-project, decision making, and consensus building may be time consuming;

- Due to the trend that land area owned by each farmer is small, locating an open area to install PV modules can be difficult;
- Setting water tariff and collecting the fees in timely manner may become difficult; and
- Continuous operation will not be available depending on location and constraints, leaving the equipment idle for some months during a year.

To overcome these issues, an organization that will implement the sub-project is required to possess an ability to coordinate interests and intentions among the concerned farmers (e.g. location for installing the PV modules, etc.). The sponsors are required to operate and manage the plants, including collecting water fee from the farmers. Some of the well-established NGOs claim that they are experienced and capable of such stakeholder coordination. The NGOs, such as 4SL, RSF, NUSRA, GHEL, and Grameen Shakti,, are already prepared to embark on the solar irrigation project, and are currently negotiating with IDCOL. Furthermore, the expertise on agricultural engineering with regard to assessment of water reserve and availability of the wells, climate conditions, nature of soil, irrigation water, and agricultural crops will also be essential for the project. For example, 4SL, a company who has installed ten facilities with the financial support from IDCOL, has voluntarily formed a committee of experts and conducted survey for their projects to overcome these issues.

Funding organizations are required to assess the cases not only from technical viewpoints but also from the capability of the sponsors, who will be implementing the sub-projects. NGOs rooted in the community for a long period of time and well accepted locally are in good position to overcome these issues. The appraisal of the sub-projects should therefore be conducted with an emphasis on the capability of the sponsors.

2.2.4.Mini-Grid

(1) IDCOL's Solar Mini-Grid

1) Existing Facilities

IDCOL has implemented a pilot project to install a solar mini-grid at a marketplace on Sandwip Island in Chittagong Division. The fund to install a 100 kW solar PV mini-grid was provided by IDCOL. Before the introduction of this solar PV mini-grid, a diesel generator powered the marketplace. The cost of diesel fuel to run the generator was approximately BDT 50 to 60 per kWh.

Table 2.2-17 Sandwip Island Solar Mini-Grid: Key Sub-Project Information

Particulars	
Plant Capacity	100-kW
Location	Sandwip Island, Chittagong
Project Land Area	8,700 sq. ft.
Design	SMA Technologies AG
Major equipment	Solar Modules (poly crystalline), Batteries (48V, 18000 AH), Grid Tie, SI inverter, Backup Diesel Generator (40 kW)
Equipment Manufacturers	Solar Modules: KYOCERA, Japan Battery: Hoppecke, Germany Grid Inverter: SMA Solar Technology AG of Germany
Engineering, Procurement and Construction (EPC) contractor	Asantys Systems
Integrator / Maintenance	Prokousoli Sangshad Limited (PSL)

Source: "PGEL 100kW Solar Mini-Grid at Sandwip Island Appraisal Report" Prepared by IDCOL Dec. 2009

The total construction cost of the mini-grid was BDT 55.37 million of which 50 percent was grant (from KfW via IDCOL), 30 percent was loan (from IDA via IDCOL), and 20 percent was equity. For the total of 400 users (390 shop and stalls, five schools, and five clinics), the unit electricity cost at the time of inauguration was BDT 30 per kWh, while the tariff has increased to BDT 32 per kWh as of July 2012. Although the tariff is more expensive compared with the unit price of grid electricity, it is still reasonable when compared with the unit power generation cost of BDT 65 per kWh.[46] The result of the financial analysis of the sub project is shown in the following table.

Table 2.2-18 Summary of the financial analysis results for IDCOL's solar mini-grid sub project in Sandwip Island

Ratio	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
DSCR	3.58	4.75	1.59	1.90	1.94	2.01	2.29	2.36	2.46	2.80
Average DSCR	2.57									
Minimum DSCR	1.59									
Average ROE	11.43%									
IRR	13.91%									
NPV	BDT 45,163,220									

Source: "PGEL 100kW Solar Mini-Grid at Sandwip Island Appraisal Report" Prepared by IDCOL Dec. 2009
Note: Calculated at tariff BDT 36/kWh

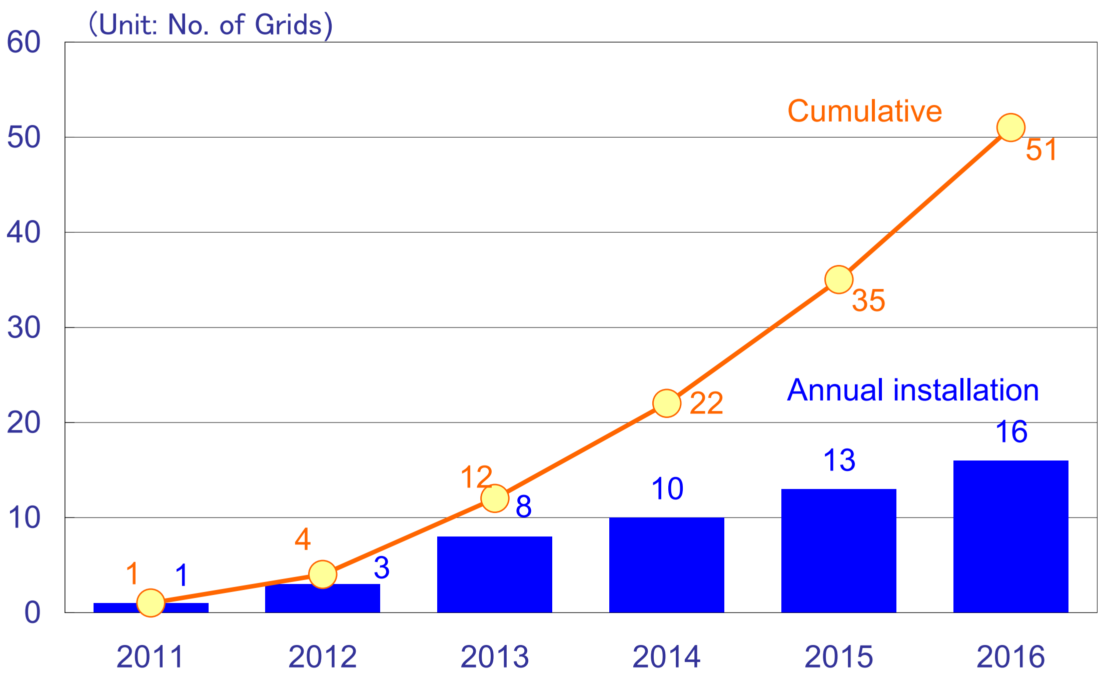
Structure of the fund, i.e. the proportion of grant to loan was fixed based on the ability to pay of the electricity users, and also with reference to the electricity tariff at nearby electrified village.

Repayment of the initial investment is not easy under the current project financing scheme. Nevertheless, the sub-project has demonstrated that a mini-grid can be used to supply electricity to a market with a commercially-viable return.

2) IDCOL's Further Installation Plan

Out of the 8,000 marketplaces located throughout the country, around 6,000 are without electricity[47]. The diesel power generators are mainly used for lights and ceiling fans. The Solar PV is seen as an effective solution to relieve the burden of rising cost of diesel fuel. The mini-grid system project at Sandwip Island Marketplace has shown that these systems may become commercially viable, if initial cost can be cut without downgrading the featured performance of the system. The mini-grid system therefore has a potential to be deployed in many locations. IDCOL has a plan to further install 150kW systems in50 different marketplaces.

[46] Information from interview with the PGEL staff.
[47] World Bank (1996) and BBS (2010)



Source: IDCOL

Figure 2.2-6 IDCOL's Plan for Mini-Grid Installation

(2) Effect of Solar Mini-Grid

Sandwip Island (300,000 habitants) is an island located away from the mainland. A diesel engine had been in use to power electrical appliances in the marketplace on the island including lights and ceiling fans. With the rising cost of oil, electricity cost went up to approximately BDT 50 to 60Tk per kWh. The introduction of a 100 kW solar PV mini-grid led to 50 percent decrease in electrical costs, which is currently at BDT 30 per kWh (this cost, mostly to cover O&M costs, will be reviewed every three years). The marketplace has a total of 400 users including 390 shops & stalls, five schools, and five clinics. Although the energy costs are four to five times higher when compared to the BPDB grid tariff, the solar PV electricity is still, by far, affordable than the diesel oil-based power.

1) Annual Power Output and the Effects of the Reduction of Diesel Oil

Irradiation data of Dhaka was employed for calculation as data on Sandwip Island was not available. Tilt angle of 23 degrees for the solar PV panel was assumed in the calculation. Other conditions and methodology of calculation is described in 2.2.2. (3) of this report Furthermore, inverter efficiency of 94 percent was assumed.

The calculation result shows that 109,061 kWh of power is generated annually. If this amount of electricity were to be generated by a diesel engine (Efficiency of Diesel Engine Generator:30 percent), it would require 34.08 kL of fuel annually, and the cost of the fuel would amount to BDT 2.08 million (1L = BDT 61).

Table 2.2-19 Solar PV Generation

Solar PV Capacity	Generated Electricity
100 kW	109,061kWh/year

Source: Calculation by the Survey Team

2) Effects of the Emissions Reduction

Since the power generated by solar PV mini-grid generation is equivalent to electricity generated from 34.08 kL, it may also be assumed that emission due to the use of 34.08 kL of diesel oil was avoided. Applying an emission intensity factor of 2.7 kg-CO_2/L for diesel oil (EIA), the yearly emission would then be 92 ton-CO_2 per year.

Although an issue remains on how initial cost could be further slashed, both mini-grids and solar pumps bring about significant economic effects. Such effects would relieve dependence on oil, reduction of noise, oil pollution, air pollution, and lower the operating costs. Introduction of these systems would not have been possible without concessional funding, in terms of grants and low interest loans from international support organizations. Marketplaces in areas without power or in places, such as remote islands, number to around 5,000. Further deployment of solar mini-grid to these marketplaces can be expected to have profound effects to local economic activities.

(3) Bottleneck for Mini-Grid Dissemination

There are currently no restrictions or standards from the government. GoB is anticipating the widespread use of these systems. However, the following matters should be taken into account when installing solar mini-grid systems:

- Marketplaces are usually located in populated areas, such as in the center of villages. There is a possibility that area for solar PV modules installation may not be available within the vicinity.
- Elevation level is low in most of the area in Bangladesh. As such, a large portion of the territory is flooded during the rainy seasons. Obtaining a piece of land that is safe from flood, for installing the equipment, may turn out to be difficult for some of the marketplaces.
- With the application of a metered tariff system, users may be discouraged to consume the electricity. This would result in low revenue financial viability of the project. An optimum tariff structure, whereby minimum charge is applied up to certain level of usage could be sought and applied.

To overcome the issues mentioned above, the sponsor will have to select sites where enough space, safe from flood is available. The sponsor also has to be capable of selecting locations where potential customers are willing to pay for the service. An optimum subscription and tariff structure will have to be introduced with recommendations from RE business experts. The funding organization should conduct due diligence with emphasis on the appropriateness of location, from both technical and business environment viewpoints.

2.2.5.Grid Connected Solar PVs

(1) Existing Facilities

Currently, the examples of grid connected solar PV systems are few. Most of the solar PV modules installed in relatively large scale are the urban type SHS, which are designed to operate during power outages due to avoidance of load shedding.

(2) Planned Facilities

BPDB is planning to develop five MW solar PV grid connected power plant at Kaptai. The project will become the country's first mega-solar power plant connected to the grid. Project cost is estimated to be USD 29.64 million.

REB is planning to apply for an authorization to install three to five kW solar PV system on the roofs of Palli Bidyut Samities (PBSs) buildings throughout the country. This will total to 278 kW as the capacity.

(3) Bottleneck for Grid Connected Solar PV System

There are currently neither regulatory nor technical restrictions for the deployment from either government or standards. As an incentive to promote grid-connected solar PV system, the government has announced a policy to purchase electricity generated from renewable sources of less than five MW. Implementation of this policy may not be effective due to the following reasons:

- Given the large number of power outages, it would be difficult to harness the system's full potential. On the other hand, installing a system that includes a battery would significantly increases the cost to make the system unviable.[48]
- The system requires feeding electricity back into the grid by means of reverse flow. The capacity and protection system of the grid to allow this reverse flow will have to be cleared;
- Feed-in tariff (FIT) does not exist. Government's purchasing tariff is low and is not fixed for a long term.

2.2.6. Summary of Expected Effects from Existing Solar PV Programs and Projects

The summary of the three kinds of equipment, SHS, solar pump, and mini-grid may be found in the following table. The benefits which can be expected are also indicated in quantitative terms (volume of solar electric generation, the effects of fuel reduction, and CO2 emissions reduction).

Table 2.2-20 Expected Effects from IDCOL's Existing Solar PV Program and Projects

Items	Unit	SHS	Solar Irrigation Pump	Solar Mini-Grid	Total
Solar PV Capacity		61.7 MW	62.6 kW	100 kW	
		50W x 1,233,886	17.28+45.36 Total 10 pumps	1 Marketplace	
Generated Electricity	MWh/ year	56,798	72	109	56,979
Reduction of CNG	M3	14,310,000			14,310,000
Reduction of Diesel Oil	Kl/year		19.3	34	56.3
Reduction of CO2	Ton/year	46,337	51	90	46,478
Benefits and Effects		Improvement in the living environment of about 1,234,000 households. Study time of children increased. Makes it possible for	Harvest of crops 3 times a year had been possible. (Food Increase) Improvement in the farm environment. Reduction in labor for	Increase in economic affects. Marketplace electricity costs became 50 %. Maintenance becomes smooth.	

48 For example, the peak demand of in DPDC (Dhaka Power Distribution Company) network as of May 22, 2012 was 1,142 MW, while its supply capacity is 636MW (55.7% of the peak demand). Power outages are repeated hourly from 8:00 to 20:00.
A garment factory in Gazipur, outside Dhaka, receiving power from REB explains that electricity is available for only a total of 4 hours out of 24 hours, in random timing of a day.

Items	Unit	SHS	Solar Irrigation Pump	Solar Mini-Grid	Total
		night work. Contributes to the country's population control measures.	engine maintenance. Reduction of water costs.	Improvement in the marketplace environment.	

Source: Survey Team

The total electricity generated from all of the equipment mentioned above will amount to 71,178 MWh. This is calculated as reduction of 14.3 million m3 of CNG equivalent. At the same time, light oil is reduced by 56.3 KL. CO2 emission is also reduced by 46,478 tons.

2.2.7. Other Components Candidates

SHS, solar pump, and mini-grids were identified as technologies that are potentially suitable for components to be financially assisted through JICA-REDP. Other than these three technologies, battery charging station (BCS), solar-wind hybrid power generation, and solar LED Lantern were also considered as candidates as components.

(1) Battery Charging Station (BCS)

BCS have been installed in three areas in Bangladesh, as a pilot project conducted under France's financial aid in 1988. The amount of aid assistance was FRF 6.4 million (BDT 26.3 million). The capacities of the solar PV panel were as follows: No.1 BCS: 14.72 kW, No.2 BCS: 7.36 kW, and No. 3 BCS: 7.36 kW. The total capacity adds up to 29.44 kW. Together with BCS, 806 sets of SHS were also installed. Later, the villages in which BCS and SHS were installed became grid connected and electrified. The equipment were taken off and displaced to universities, research facilities, and government offices.

After the installation of the BCS by under French assistance, there was also a BCS installed in Patuakhali District by Local Government Engineering Department (LGED) through the aid of the United Nations Development Programme (UNDP). The solar PV modules capacity was 1.6 kW with capacity to charge 16 different batteries connected. Its actual condition (operation, maintenance structure, costs, conditions of current usage, and charging costs etc.) will be confirmed in the next field survey. BCS was installed in 2004 supported by UNDP and transferred to the local NGO, Energy System after its completion.

As the price of the Solar PV modules was previously high, the benefit of installing BCS, as a way to share the modules, was notable. However, as the Solar PV modules are recently much cheaper, merits brought by BCS is now limited. This applies to Bangladesh, especially since controllers and batteries for SHS are domestically manufactured to offer SHS at an affordable price. According to the data on SHS by specification provided by IDCOL, there are also low specification SHS of 10 – 20 W being offered. The cost of 20 W system, for example, is only BDT 12,600, which means that a monthly payment of BDT 350 for three years will be enough to acquire the system. From the fact that SHS is now affordable to many, the necessity to install BCS in Bangladesh may not be commercially justified.

(2) Solar-Wind Hybrid

A test plant for the Solar-Wind System was installed in St. Martins Island under the support from the UNDP and Ministry of Environment and Forest (MoEF). The system has seven wind power turbines with each having a rated value of 3.2 kW (when the wind speed is 13.5 m/second). The system contributes to power natural research institutes and facilities for ecotourism (central plaza, accommodation facilities and barracks as well as for the pump for drinking water). Its principal strength is that the system can supplement sunshine by wind and vice-versa, when either of them is not available. Wind power makes it possible to generate electricity during night time. However, as wind condition in Bangladesh, in general, is not suitable for wind power generation, the system's performance may be limited.

LGED constructed solar-wind hybrid system in 2004, supported by UNDP. Its ownership has been transferred to be operated and managed by the local government. A few months after the installation, a wind turbine sail was damaged and still remains unrepaired.

(3) Solar LED Lantern

The base of pyramid population in Bangladesh comprises a huge portion of the country's total population. Population of the BOP 1,000 category amounts to 52.6 percent of the total population while that of BOP 500 category amounts to 24.8 percent of the total population.[49] These add up to 77.4 percent of total population, or 98 million people. These people are using oil lamps for lighting and firewood, tree leaves and cattle manure for cooking fuel. 61 percent of the BOP 1,000 category people, and 73.2 percent of the BOP 500 category people are paying less than BDT 500 for their electricity fees.[50] Their ability to pay for energy is less than around BDT 500 per month. There is a need to develop a lamp which could be supplied at BDT 500 or less per month.

People belonging to low BOP categories are particularly having difficulty in obtaining even a rudimentary SHS. The Solar LED lantern, which is more affordable than SHS, would therefore be suitable for their lighting. A solar LED lantern is currently being sold for BDT 1,500 to 2,500. However, solar LED lanterns do have disadvantages such as a short lifespan due to running on lead batteries as well as a long charging time. GIZ has jointly developed an affordable but sufficient in performance (brightness of at least 200 lumen), and durable (product lifetime of at least two years) model of solar LED lantern with a Chinese manufacturer, and has ordered 3,000 sets for test marketing in Bangladesh. These will be marketed (cash sales) within the SHS Program, to be offered at BDT 3,000-5,000 per set. If the result of this pilot marketing is found to be favorable, GIZ intends to order further 100,000 sets to have them offered to low-income customers who could not afford SHS.

IDCOL will be cooperating with the GIZ on pilot introduction of the solar LED lanterns. IDCOL will look into the reaction from their existing SHS customers on the popularity of the lanterns. The solar LED Lanterns being a small product, IDCOL sees that it will not be suitable for a loan scheme, where payback money collection will not be commercially viable.

[49] WRI/IFC (2007)
[50] JETRO (2011)

BOX 1: Solar LED Lantern available in the market

Few types of solar LED lanterns are currently available in markets in Dhaka. A type shown in the photograph is 60, 180 Lumen switchable model, making it possible to choose either strong light or long life modes. It guarantees 16 times stronger light compared with a 11 Lumen "Hurricane Lamp", which is a comparable oil lamp.

Solar LED lanterns, such as the one shown, can become an optimal alternative to oil lamps to improve safety and air quality. However, the lifespan of lead-acid battery may be the issue that might inhibit the popularization of these products.

2.2.8.Comparison between the Solar PV Technologies

Six solar PV technologies: SHS, solar pump, mini-grid, BCS, solar wind hybrid, and LED lantern were compared and evaluated as component candidates. Grid connected solar PV was excluded from comparison as its relevance and viability are questionable.

SHS, with still abundant needs and with high feasibility is the technology with top versatility. The track record of 1.2 million or more sets being installed, with further 16 million potential users makes SHS a well proven and dependable means of solar PV deployment.

The solar irrigation pump, although yet to be proven, is another technology that has a vast possibility for deployment. The fact that there are already various pilot projects being implemented shows that there is a high expectation toward its utilization.

An only example of an existing mini-grid is the one that was installed in Sandwip Island. It is currently being utilized in sustainable manner, with the electricity utilization charges being fully collected. Despite its experimental character, the mini-grid is offering benefits to the users, enabling O&M costs to be well covered by the charge collected from the users.

Solar irrigation and mini-grids share a common concern on their investment cost. Although their O&M costs can be recovered from usage, the investment cost remains an issue for these technologies to be commercially viable.

BCS and Solar wind hybrid system are the projects which have been abandoned. BCS may be substituted by SHS, and therefore its advantage can hardly be justified. On the other hand, solar wind hybrid may still require technological considerations. Wind mapping activities may identify some of the potential sites. Therefore, solar wind hybrid may still be a premature option to be taken.

Solar LED lanterns also require further technological research. Products with high performance, long durability and less cost will have to be introduced in order to meet its requirement in the context of development.

Table 2.2-21 Summary of Existing Solar PV Technologies

Technologies	SHS	Solar pump	Mini-Grid
Size	Average 50W	3.5 / 5.5 kW	100 kW
Units deployed	1,233,886 sets	15 pumps	1 market
Future deployment plan and estimated cost	IDCOL: 4 million by 2016 Further USD 296 million	IDCOL: 1,550 pumps by 2016 Further USD 62 million	IDCOL: 50 markets by 2016 Further USD 30 million
Ownership	Users	4 SL Co. (private) NUSRA (private)	PGEL (private)
Involvement of international development partners	[Loan]: IDA, ADB, IDB [Grant]: GEF, KfW, GIZ, GPOBA	[Loan]: IDA [Grant]: GPOBA	[Loan]: IDA [Grant]: KfW
Implementing entity	IDCOL and POs	4 SL Co. (private) NUSRA (private)	PGEL (private)
Project scheme and form of income	Sales of equipment and installation Loan for purchasers	Income from water sales	Income from electricity sales
Lessons from the project	There is still a significant demand Device recycling system will have to be introduced	Significant cost saving can be expected by substituting fuel oil. Initial cost should be cut down to become financially viable	Significant cost saving can be expected by substituting fuel oil. Initial cost should be cut down to become financially viable
Start of construction	2003	2011	2009
Cost (USD)	367 / 50W	49.5 million	55.37 million
Financial arrangement	Grant (14.3%)	GPOBA (40%) through IDCOL	KfW (50%) through IDCOL
	Loan (85.7%)	IDA (30%) through IDCOL	IDA (30%) through IDCOL
Financial viability	Commercially viable when supported by buy-down grant and concessional loan	O&M cost can be recovered from revenue while initial cost require support	O&M cost can be recovered from revenue while initial cost require support
Public incentives (subsidy, tax exemption, preferential loans, etc)	Grant and preferential loan through IDCOL	Grant and preferential loan through IDCOL Income tax waived	Grant and preferential loan through IDCOL Income tax waived Tax holiday: 15 years
Preferential terms for imported goods	Exempt from 15% VAT	Exempt from 15% VAT	Exempt from 15% VAT
Foreign investors	None	None	None
Promotional measures for investment	Tax holiday of 5 years for corporate tax	Tax holiday of 5 years for corporate tax	Tax holiday of 5 years for corporate tax
Bottleneck for deployment	None	High cost of investment	High cost of investment
Size	1.6 kW for 16 batteries	10 kW, 3.2kW/13.5m/s wind	5 to 10 W
Units deployed	1 village	1 island (St. Martin's island)	Commercially sold in mass
Future deployment plan and estimated cost	No plan	BPDB: (MoEF)	No plan
Ownership	Transferred from LGED to NGO (Energy system)	Transferred from LGED to local government	Users
Involvement of international development partners	UNDP	UNDP	GIZ (Technical Assistance for pilot projects)
Implementing entity	LGED	LGED	POs
Project scheme and form of income	Income from charging fee	None	Sales of equipment

Technologies	SHS	Solar pump	Mini-Grid
Lessons from the project	No further demand	There is a need for further technical development (wind turbine failed 3 month after the completion).	There is a need to introduce products with longer durability. Unit price may be too small for sales under loan.
Start of construction	2004	2004	
Cost (USD)	0.42 million (estimate)	20 million (estimate)	70/lantern
Financial arrangement	UNDP (100%)	UNDP (100%)	Pilot project funded by grant from GIZ
	-	-	-
Financial viability	Not viable (lack of demand)	Not viable (experimental stage)	Commercially viable
Public incentives (subsidy, tax exemption, preferential loans, etc)	None	None	None
Preferential terms for imported goods			Exempt from 15% VAT (PV modules)
Foreign investors	None	None	None
Promotional measures for investment			
Bottleneck for deployment	No demand	Absence of wind map	Quality will have to be improved. Unit price is too small for loan.

Source: Compiled by the Survey Team

2.2.9.Selection of Solar PV RE Components

The components were selected based on criteria explained in Chapter 4 Section 2 of this report:

- Applicability of technology
- Feasibility of introduction and promotion
- Market size
- Relevance of the support scheme
- Avoidance of the distortion of the market

Adequateness of prospective six solar PV technologies is summarized in the below table. With regards to the selection criteria, three technologies, namely the SHS, the solar pump and the mini-grid were found to be adequate for Component to Renewable Energy Project in Bangladesh.

Table 2.2-22 Adequateness as Components

Evaluation Category	Component Candidates					
Evaluation Criteria	SHS	Solar pump	Mini-Grid	BCS	Solar wind hybrid	Solar LED lantern
Feasibility of introduction and promotion						
Technical Applicability	Technically applicable	Technically applicable	Technically applicable	Technically applicable	Uncertain	Further R&D required
Existence of Implementing Organizations	IDCOL	4SL RSF (IDCOL)*	PGEL BCTCL (IDCOL) *		REB LGED BPDB	(IDCOL) *
Expected Effect						
Alternative energy-saving potential	1.233 million SHS save 22,210kl/year kerosene & 1.4mill. m3 CNG	10 solar pumps save 19.3 kill /year diesel oil	A mini-grid saves 34 kL/year diesel oil	16 batteries save 288L/year kerosene & 36m3 CNG	10 kW solar PV saves 3.4 kL/year kerosene & 227 m3 CNG	5W lantern saves 1.8 L/year kerosene

Development effects	Significant effect on educational development	Promotes agricultural activities	Stimulates rural economic activities	Promotes BOP business	Rural Electrification	Pro-poor approach. Significant effect on educational development
Means to secure proper operation / maintenance	End users' ownership and after service by POs Average O&M cost: BDT 2.280 /yr (8% of investment)	O&M by Sponsors Average O&M cost: BDT 56,700 /yr (1.9% of investment)	O&M by Sponsors Average O&M cost: BDT 981,000 (1.7% of investment)	Uncertain	O&M by Sponsors O&M cost unknown	End users' ownership Short product lifetime
Economic viability						
Market Size	16 million non-electrified households	1.2 million diesel pumps to be replaced	5,000 Non electrified local markets	16 million non-electrified households	16 million non-electrified households	16 million non-electrified households
Financial viability	IRR: 38 %	IRR: 12 %	IRR: 12 %	Less competitive against SHS or solar LED lantern.	Uncertain	Uncertain
Applicability of the Supporting Scheme						
Conflict with existing interventions	YES, if conducted separately	YES, if conducted separately	YES, if conducted separately	No	YES, if conducted separately	No
Conformity between borrowers category and Supporting Scheme	User is a middle class and adequate for IDCOL supports.	Users are farmers. Adequate for IDCOL support	User is a middle class and IDCOL supports	None	None	None
Market distortion	YES, if low interest rate loan is provided in parallel with existing activities	NO	NO	NO	YES, if electricity is sold at low rate.	NO
Social and Environmental Considerations						
Means to avoid negative effects	Batteries should be properly collected and recycled	None	Batteries should be properly collected and recycled	Service can be provided only to proximity habitants	Noise from wind turbine will have to be reduced	Lanterns should be properly disposed
Adequateness as Components	YES	YES	YES	NO	NO	NO
Primary reason	Strong demand and firm commitment of the executing agency (IDCOL)	Expected transition from project to program and firm commitment of the sponsors (4 SL, RSF, NUSRA)	Success of a pilot project and firm commitment of the sponsors (PGEL, BCTCL, Grameen Shakti)	Lack of demand	Uncertainty with the technology and financial viability	Uncertainty with the technology, lack of willingness of the sponsors

Source: Compiled by the Survey Team
Note *: IDCOL will become the executing agency once the projects are formulates as programs.

BOX 2: Are these Proven Technologies?

Examples of Solar Irrigation Pumps other than in Bangladesh

Country	Sites
Pakistan	Pak Agro, Bella Orki, Sanghar Bakkar, Uttal Balochistani, Multan, Lakki Marwat, Chakri, Kashmore Sindh, and more than 200 locations.
India	Bhavnagar - Gujarat, Kalyan - Bihar, Soneb hadra, and more than 100 locations.
China	Guangxi – Nanning, Xining – Qinghai, Hainan, plus more locations.
USA	Phoenix Arizona, Locke Ranch Calfornia, Dufur Oregon
- Other Examples Australia (Riverina), Benin (Kalale), Egypt (Wadi EL Natrun), Kenya (Nyamindi), Mozambique (Maghreb), Sudan (Akobo), Syria (Abed village)	

Examples of Solar Mini-Grids in Countries other than Bangladesh (includes wind power hybrids)

Country	Sites
India	Akamalpur, Murityunjoynagar, Gayeibazar, Khasmahal, Mahendranagar, Natendrapur, Dakshin, Uttar Haradhanpur, Mandirt, Kaylapara, Bagdanga Moushuni, Baliara Moushuni., and other locations.
China	Xinjiang - Uygur, Gansu
Canada	Northern community, Nemiah Valley
- Installations under NEDO program: Thailand, Mongolia, Myanmar, Cambodia, Lao PDR.	
- Other Examples: South Africa, Namibia, Zambia, Palestinian Authority, Morocco, Ecuador	

Solar irrigation pumps and Mini-Grids are not commonly seen facilities throughout the world. Nevertheless, the technology is well proven, and there are already various preceding examples of the similar facilities in selected countries.

Many of the examples are found in the South Asia, notably in India and Pakistan. There are also cased in developed countries such as in the USA, Canada, and Australia where there are remote areas not covered by the electricity grid.

Japan’s NEDO (New Energy and Industrial Technology Development Organization) has been actively deploying various types of RE mini-grids in Asia, in more than five countries. The experiences from these examples are expected to provide valuable implications for further installation in Bangladesh.

2.3. Biomass Derived RE

2.3.1. Overview of Biomass Derived Renewable Energy in Bangladesh

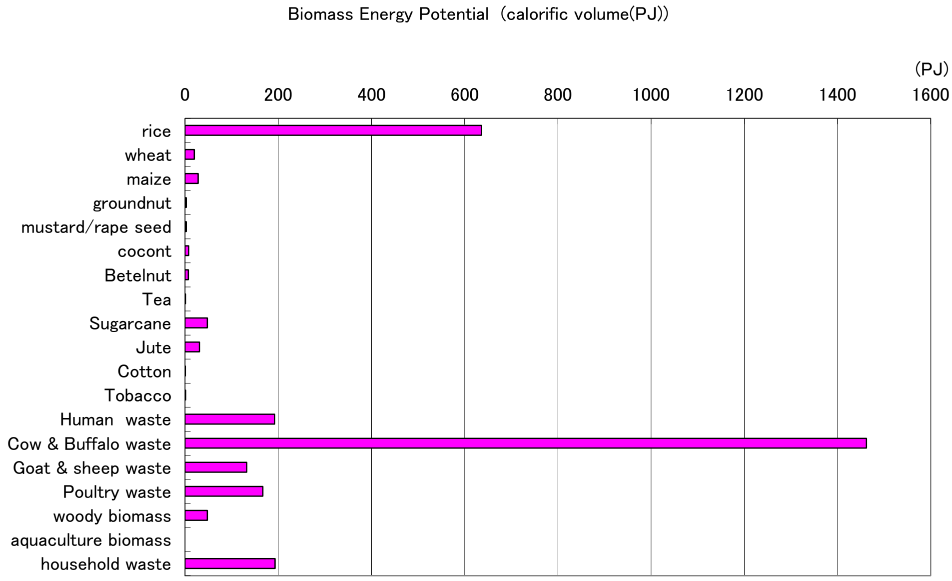
(1) Biomass Potential in Bangladesh

Bangladesh has a unique structure of biomass production such that agriculturally derived biomass is abundantly available, while naturally existent biomass is limited. Biomass resources in Bangladesh are: agriculture residues, such crop/tree residue, rice husk, and jute stick; animal waste, such as cow dung, human excreta; wood/tree leaves; municipal waste; vegetation; sugarcane bagasse; poultry droppings; and garbage, among others.. With these, the most dominant biomasses, in quantity as well as in terms of ease of use, are rice husk and rice straw.

For example, as for rice husk, Bangladesh produces 40 to 45 million metric tons of paddy annually. Rice husk comprises 20 percent of the total weight amount, which means that eight to nine million metric tons of rice husk is generated annually. On the other hand, as for forest resources, the total forest area covers only 14 percent of the total land area, and therefore fuel wood is not what is available to everyone throughout the country.

The overall status of biomass resources in Bangladesh can be found from documents prepared by Dr. Md Golam Rabbani of Bangladesh Agricultural University. His study shows that 70 percent of the total energy consumption comes from biomass. This comes with the fact that around 65 percent of the country’s economic activities are based on agriculture. It is estimated that about 40 million tons of biomass (timber, crop residues, cow dung) are used per year for cooking only.

Considerable amounts of crop residues are generated, which can be distinguished into field residue and process residue. Field residues are generally left in the field after harvesting and are used as manure to maintain the soil fertility and health. Process residues are those utilized for fuel or in material form as they are. Among the biomass residues, the highest contribution is from rice residues in terms of total calorific value (635.86 PJ).



Source: Dr Md Golam Rabbani, Bangladesh Agricultural University
Note: The original metric volume data of biomass are as of following time; 1) rice in 2009,2) cow and buffalo in 2005,3) human census in 2001, 4) forests and wood processing in 2003, 5) aquaculture in 2008 ,and 6) municipal and solid waste in 2008.

Figure 2.3-1 Biomass Energy Potential

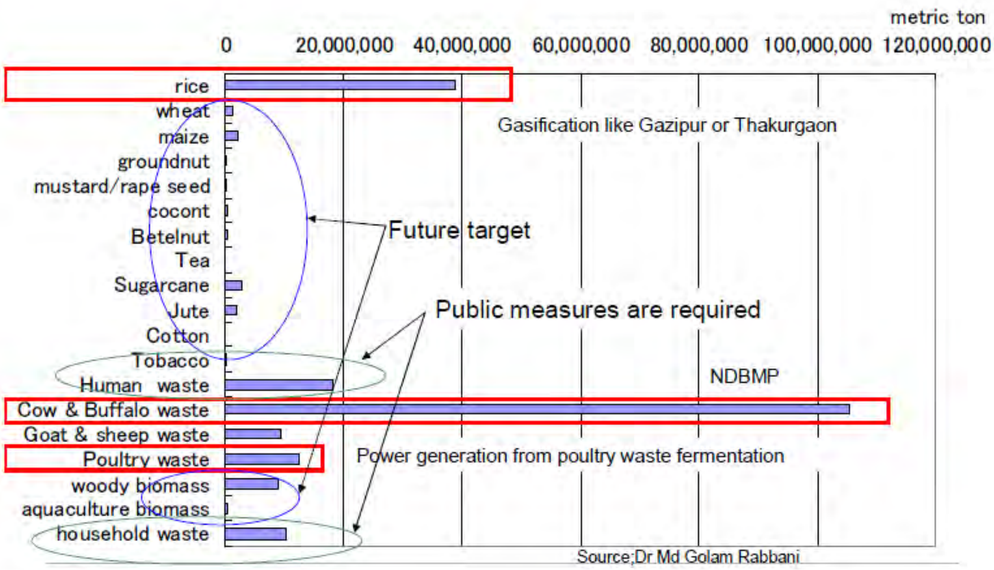
(2) Significance of Biomass Utilization

Biomass utilization in rural area might bring 1) local energy production, 2) formulation of waste management and recycle society, 3) organic farming and chances to product more agricultural product, and 4) new employment through raw material collection or facility maintenance.

For example, biodigester brings about opportunities for: cow excrement management, user-friendly cooking gas, and liquid fertilizer production for paddy fields. Moreover, with cooking gas production, this easy-to use gas will improve cooking environment for the sake of women's health. It will also liberate women from excessive labor burden of collecting fire wood, and lighting a fire. Above all, the electricity production through biomass gasification and gas engine technology will bring about electricity to rural areas, where there grid electricity is not yet provided. Electricity produced can also be brought toward not only to individual households but also to public facilities such as schools, clinics, and offices. This will provide more opportunities for children to study even after dark, and possibly an opportunity for clinics to store preserved vaccines in refrigerators.

(3) Existing programs and future targets of Biomass Derived Renewable Energy

Biomass from rice, cow & buffalo waste, and poultry waste are targeted at IDCOL's program and projects (rice husk gasification, NDBMP, and poultry waste biodigester). Biomass derived from wheat, maize, sugarcane and jute are thought to be future target. As for human waste and household waste, public measures like separation and collection which has already been conducted by the Japanese municipal governments are required to be utilized. Since these public measures are not implemented in Bangladesh, it will take more time for human waste and household waste biomass utilization to be conducted, compared to that of wheat, maize, sugarcane and jute.
According to the figure below, the metric volumes of biomass from wheat, maize, sugarcane, and jute are smaller than that of cow and buffalo. However, even the former volumes are in large scale as 1,299,435 metric tons are produced from sugarcanes in 15 sugarcane mills, which demonstrate that unused biomass potential is massive. Biomass utilizations at the generating spot as gasification or direct incineration can be potential biomass projects.



Source: Dr Md Golam Rabbani, Bangladesh Agricultural University

Note: The original metric volume data of biomass are as of following time; 1) rice in 2009,2) cow and buffalo in 2005,3) human census in 2001, 4) forests and wood processing in 2003, 5) aquaculture in 2008 ,and 6) municipal and solid waste in 2008.

Figure 2.3-2 Whole Biomass Potential in Bangladesh and IDCOL's Program & Projects

(4) Biomass Utilization

Regarding biomass utilization, in general, it can be categorized into two forms: energy utilization and material utilization. Both forms of utilizations are essential to promote sustainable society in rural areas.
Major utilization methods for commonly available biomass in Bangladesh, are the followings:

Table 2.3-1 Major Utilization Methods of Biomass Commonly Available in Bangladesh

No	Biomass resource	Energy utilization	Material utilization
1	Rice husk	Biomass gasification or biomass power generation by direct incineration like parboiling	Cattle feed
2	Rice straw	Cooking fuel material (solid fuel)	Cattle feed
3	Cow excrement	Biodigester for cooking gas , lightning for household, or power generation	Biodigester for liquid fertilizer
4	Poultry excrement	Biodigester for cooking gas , lightning for household, or power generation	Biodigester for liquid fertilizer Compost
5	Fuel wood (Traditional biomass)	Cooking usage in household	-
6	Sugarcane	Steam and electricity generation	Manure

Source: Survey Team

(5) Natural Conditions as the Potential for Deployment of Biomass Derived RE

The Bangladesh climate enables multiple cropping such as three seasons of rice production. This brings not only sufficient food supply to the habitants but also abundant biomass resources for energy and material usages. The bounty of nature that enables high annual yield is due to the preferable matching of fertile soil, solar irradiation, and water supply, as well as temperature and humidity suitable for agricultural production.

As for temperature, Bangladesh has a constant and steady high temperature from March to October. The temperature in most parts of the country is steadily around 25-30 degrees centigrade, which is not only suitable for agriculture but also biomass usage for energy. This is because the temperature in Bangladesh is mostly within an appropriate band for methane fermentation. The most suitable fermentation temperature is around 37, which will promote what is called the mid-fermentation process. Air temperature during the most of the period is almost equal to most appropriate temperature for mid-fermentation. Therefore a good performance of methane fermentation can be expected in most of the areas in Bangladesh, almost throughout the year. Biodigester is the equipment which is suitable to be deployed in Bangladesh, taking advantage of this preferable climate for methane mid-fermentation.

As for precipitation, Bangladesh clearly has a monsoon rain season (Barsha), which usually starts from June and lasts till August. Abundant precipitation can be expected during such period while rainfall becomes scarce especially from November till February (Sheet, Bashonto). It should also be noted that monthly precipitation will even become zero during these dry seasons.

The rice husk, which is the most abundant of biomasses for energy utilization, should be dry, especially if gasification technology were to be applied. Although constant precipitation is essential for agricultural production, it can also be a factor that will impede the easy use of biomass for gasification. Drying procedure will be required especially in rainy seasons.

(6) Policies and Trends to Promote Biomass Derived RE

According to the World Bank data (WDI 2011), only 41 percent of the total population in Bangladesh has access to electricity (as of 2009).[51] The GoB is committed to ensure access to affordable and reliable electricity for all by 2020.

As a supreme national energy policy, the National Energy Policy of 1996 (updated in 2005) urges the need of sustainable development with minimal environmental effect. Biomass fuel is placed as one of the core source of energy for rural economy. At the time, agricultural and rural institution headed by Ministry of Agriculture, Ministry of Environment and Forest, and Ministry of Fisheries and Livestocks were designated as responsible authorities for development and promotion of biomass fuels.

The most recent government policy to promote the use of RE is as stipulated in the Renewable Energy Policy of Bangladesh. Among six kinds of RE sources identified (solar, wind, biomass, biogas, hydro, and others), two, namely biomass and biogas are both biomass-derived RE in a broad sense. Hence, these RE sources are officially declared as the energy resources to be promoted in Bangladesh. The Power Division on MoPEMR is the current authority responsible for promotion of biomass derived RE.

Apart from the promotion of the use of biomass in traditional forms, there have been broadly two major streams of interventions to further promote the use of biomass derived RE in Bangladesh. One is to promote biodigester use, and the other is to develop biomass power generation facilities.

Numerous biodigesters have been constructed in various part of the country, at least since the 1970s. The Local Government Engineering Department (LGED) which has been one of the most active organizations for promotion of biodigesters has started installing the equipment since the 1980s. The current major intervention for promotion of biodigesters is the National Domestic Biogas and Manure Program (NDBMP) conducted by IDCOL, under support from SNV, an international development organization based in Netherlands. The program installed more than 22,000 biodigesters. Their activities have significantly contributed in supplying safe and clean energy to the rural households, which also liberates women from excessive housework, and at the same time, prevents further environmental and agricultural deterioration.

Another stream of promotion of biomass electricity generation is the series of projects to construct biomass gasification plants for power generation. This relatively new intervention is conducted by few private companies and regional NGOs. Most of the installation projects are financed through concessional loans from IDCOL.

(7) Obstacles

Energy production costs from biomass resource tend to be higher than the cost of renewable energy from other sources. This is because biomass utilization requires raw material to be collected and also have to find local energy demand. Furthermore, certain economies of scale

[51] World Bank (2011)

become necessary to make biomass energy production commercially viable. The difficulty in creating a viable biomass utilization RE project lies in this complexity. Finding a location and where all of the above conditions are met, will be possible, only in extremely limited occasions.

In order to promote the use of biomass energy in rural area, there is a need for incentives and/or promotional policy. For example, feed-in tariff (FIT) or subsidy against the construction of biomass energy facilities are common tools which may also be applied in Bangladesh. FIT is a practical solution to fill the gap between RE-derived electricity prices and grid electricity price. The subsidy for initial cost and/or operational and maintenance cost is another tool for mitigating project organization's financial burden. Such kinds of subsidies, for operational and maintenance costs, are already existent in US, Germany, and elsewhere. However, in case these incentives and subsidies were to be introduced, financial resource to support the cost should be allocated.

2.3.2. Domestic Biodigesters

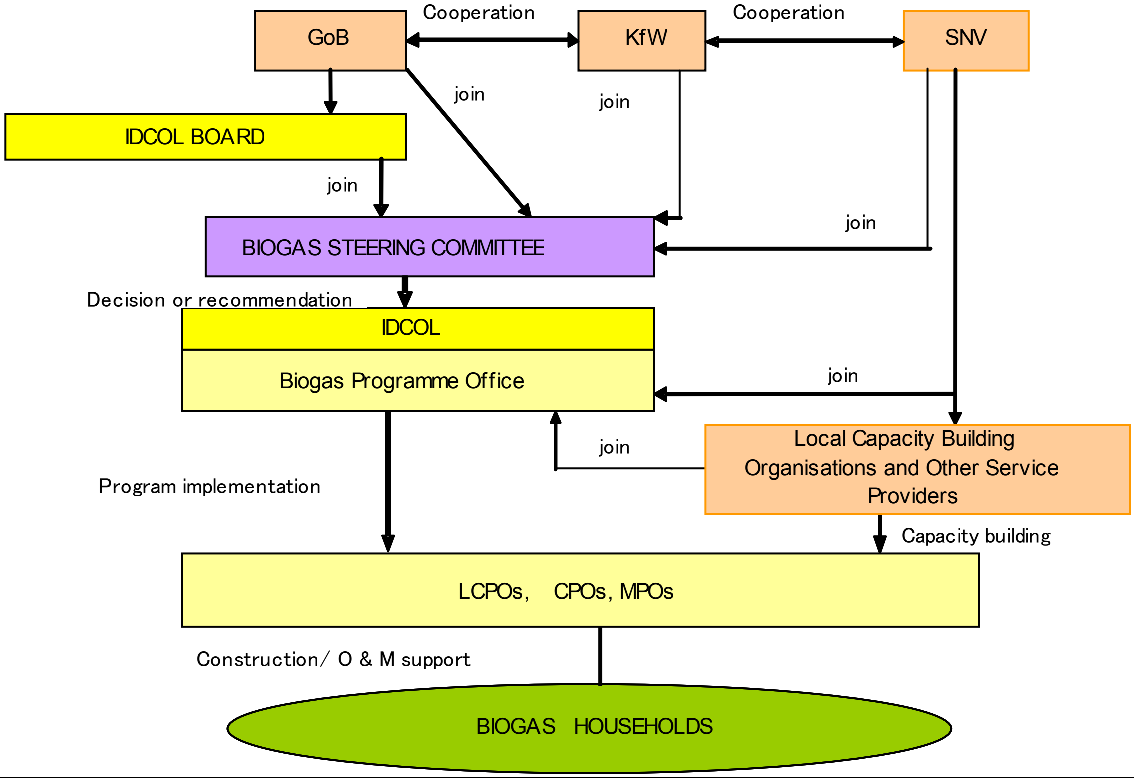
(1) IDCOL's National Domestic Biogas and Manure Program (NDBMP)

1) Overview of NDBMP

NDBMP has been carried out since 2006, implemented by IDCOL and financially supported by SNV and KfW. The overall objective of the NDBMP is to further develop and disseminate domestic biogas in rural areas with the ultimate goal of establishing a sustainable and commercial biogas sector in Bangladesh. Major expected results from implementing the program are as follows:

- Reduction of workload especially of women;
- Improvement in health and sanitation condition;
- Increase in agriculture production with proper utilization of slurry;
- Employment generation;
- Saving of conventional fuel sources such as firewood, agriculture residues and dried dung cakes; and
- Reduction in green house gas emission especially of CO2 and CH4.

NDBMP is run by a cooperation of various organizations. The principal implementing organizations are the POs, which is composed of leading, constructing, and manufacturing partner organizations. The steering committee, technical committee, and operations committee are in charge of the overall management of the program.



Participating organizations
- Construction Partner Organization (CPO)
- Lending and construction Partner Organization (LCPO)
- Manufacturing partner Organization (MPO)

Committees
- National Biogas Steering Committee (SC)
- Technical Committee (TC)
- Operations Committee (OC)

Source: IDCOL

Figure 2.3-3 Structure of NDBMP

As for Biogas steering committee, the members are as following:
1. A member of the Board of Directors of IDCOL - Chairperson
2. Representative from ERD - Member
3. Representative from Ministry of Agriculture - Member
4. Director General/Representative from NGOAB - Member
5. Representative from Ministry of Power, Energy & Mineral Resources - Member
6. Representative from Ministry of Science and Information & Communication Technology - Member
7. Energy Professor from reputed University - Member
8. Representative from PKSF (Palli Karma Shahayak Foundation) - Member
9. Representative from SNV - Member
10. Representative from KfW - Member
11. Programme Manager, Biogas Programme Office - Member Secretary

This committee will mainly be responsible for:
- Recommendation for approval of the new POs;
- Approval of the Annual Plan of Biogas Programme;
- Endorsement of designs and quality standards of biogas and appliances;

- Decision making on any policy and programme related matter, which is deviating from the approved plan; and
- Giving directives to implementing and participating organizations.

Besides the BSC, the Operation Committee (OC) will continue to assist BPO in relation to providing field level feedbacks, promotion, training, and slurry extension activities. This OC will gather every month and give its specific opinions and advices to the program. The representatives from participating organizations, including concerned staff of BPO will be the members of this committee.

As for the CPO (construction partner organization), since plant construction and maintenance needs highly trained technical human resources, it will take some time for the CPO to build their capacity and be fully prepared to take the challenge of quality construction. It is therefore envisaged that gradual inclusion of a new CPO in the sector would be beneficial rather than including quite a large numbers of CPOs without building their capacity. Some criteria are set to identify and pre-qualify these CPOs. These criteria are the following:

- Experience in biogas or similar technology promotion;
- Satisfactory management and financial position;
- Grassroots involvement in plant construction areas with a well established office;
- Good business plan and long-term planning;
- Technically trained human resources, preferably from local areas; and
- Registered as company or NGO with clear mandate to be involved in biogas plant construction.

CPOs will have the following responsibilities:

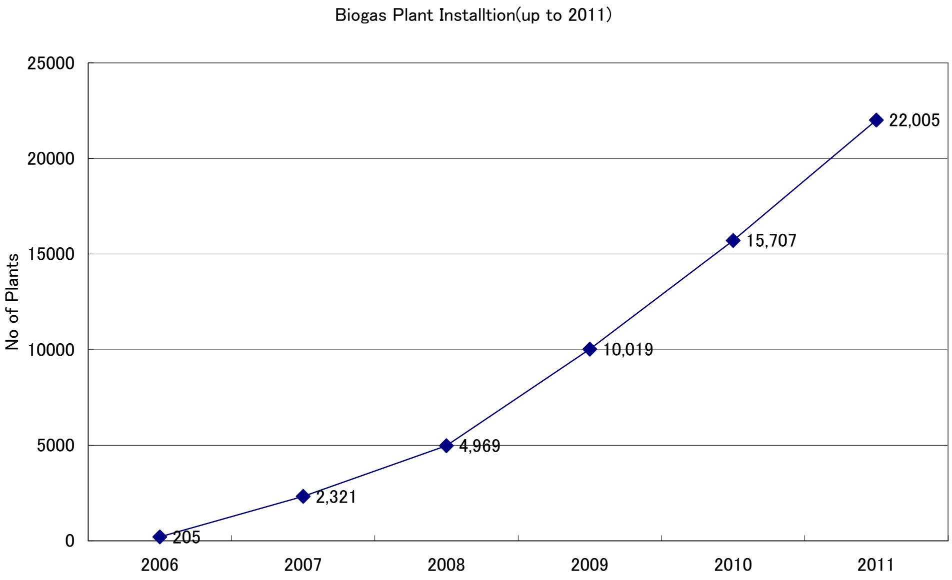
- Construct good quality biogas plants;
- Provide guarantee and proper after-sales-service to the plant users;
- Provide operation and maintenance training to the users especially to female members at the household level;
- Handover subsidy to the farmers; and
- Carry out effective promotion and marketing of the technology in own working areas.

As for the MPO (manufacturing partner organization), the appliances used in biogas plant will be: mixer, water drain, gas stoves, gas lamp, gas tap, main gas valve, and gas pipe. Appliances manufacturers will be pre-qualified by the BPO based on their technical capability, human resources, workshop facilities and equipments, quality management system and short and long-term business plans. For the sustainability of these manufacturers and production of quality appliances, they will be monitored closely and their products will be checked regularly for quality control.

As for LCPO, in most cases the same PO can do both construction and lending as per the recommendation of Biogas Steering Committee, therefore called as Lending and Construction Partner Organization (LCPO).

2) Achievements of IDCOL's NDBMP

Under IDCOL's NDBMP, more than 22,000 biodigesters have been installed throughout Bangladesh. A total of 37,269 small scale domestic use biodigesters are planned to be installed by 2012.



Source: IDCOL

Figure 2.3-4 Number of Installed Biodigesters

IDCOL published the achievement by activities on their NDBMP during the calendar year 2011. The data shows that the target number of construction is not being met, which consequently resulted in less beneficiaries and persons trained. On the other hand, the average size of plants being constructed is increasing. This shows that the demand for domestic biodigesters is gradually shifting to larger sized models.

Table 2.3-2 Achievement of NDBMP during 2011

Activities	Target	Achievements
Number of plants construction	9,000	5,049 (56%)
Number of direct beneficiaries from biogas[52]	54,000 45,000	30,294 (67%)
Number of persons capacitated through training	2,200	1,434 (65%)
Number of Partner Organizations (POs)		38
Number of appliances manufacturers	2	1
Average construction defaults points[53]	8.0	9.89
Biogas plants with compost pits	All plants should have two compost pits	% of plants with no(zero) pit: 49% % of plants with one pit: 34% % of plants with two pits: 17%
Average plant size	2.4	2.99
Average investment costs per plant	34,000	36,453 (107%)
User's training (at least 70% female)	5,688	641 (11%)
Plant functioning	100%	97%
Plant maintenance reports	5,688	1,175 (21%)

Source: IDCOL

52 Average family size is seven according to Bangladesh Bureau of Statistics (BBS, 2010)

53 Each quality standard is allocated with some marking depending upon its importance for the optimum usages of the plants. The non-compliance by the POs on any quality standard will be scored with the respective quality score. The quality default point of an installation is the summation of quality standard scores. If the quality default points is lower, the better is the quality of the installation.

3) Expected effects of NDBMP

The expected benefits from installing a typical biogas plant employed in NDBMP is as shown in the table below.

Table 2.3-3 Expected Benefits from the biogas plant

Benefits	Per HH/ per year /per plant
Reducing workload	49 days (395 hours)
Fuel wood saving	1,500 kg
Agriculture residues saving	508 kg
Dung cakes saving	409 kg
GHG emissions reduction	1-5 tones
Organic fertilizer available	917 kg
Better sanitation (toilets)	(10-15% HH)
Reduction indoor air pollution	All HH

Source: IDCOL

4) Technologies and equipment Employed

The customers who acquire biodigesters through NDBMP are mostly middle class farmers. Biodigesters offer good cooking gas and good liquid fertilizer to be utilized for paddy fields. A notable merit of having a biodigester is that biogas for cooking is available throughout the year, including during rainy seasons when fuel wood collecting becomes difficult. Furthermore, the availability of gas relieves the farmers and their families from the workload of firewood collection, especially during the busy seasons for planting or harvesting.

There is also an issue that with small scale farmers, managing and maintaining biodigesters to sustain their performance often becomes difficult due to lack of manpower. Furthermore, small scale farmers may not always possess enough livestock to maintain the performance of the biodigesters (at least five or six cows are required). If a biodigester should be provided to a small class farmer, it will require the farmers to form an organization so as to concentrate each small scale supply of manure. Such collective installation and utilization examples are common in China.

There are some small but well-developed technologies applied to the biodigesters under the NDBMP. For example, a gas switch is set on the gas pipe. When the switch is turned on, biogas is brought into the burner. On the other hand, when the switch is turned off, biogas is stored into chamber and the pressure of biogas push out slurry towards out of the digester.


Daily maintenance of input entrance


Biogas pipe and digester tank


Biogas at burner

Figure 2.3-5 A Typical Biodigester Being Operated near Thakurgaon

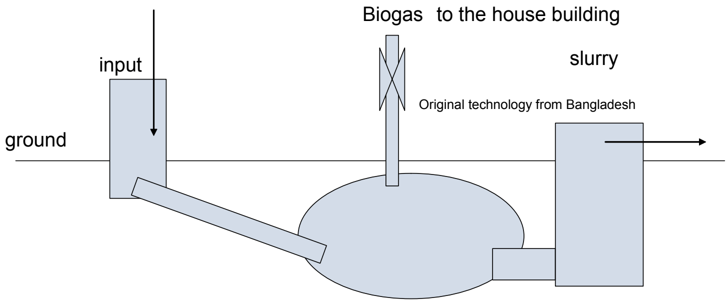


Figure 2.3-6 Images of Biodigester

The characteristics of biodigester are as follows:

- Lifetime of biodigester: 30 years under full maintenance;
- Target usage of biogas is cooking ovens;
- Cooking oven is efficient than firewood and kerosene. Boiling water in winter, cooking in rainy season becomes more efficient (temperature in winter declines to 7 ~ 8 degrees);
- Retention time for fermentation is from 45 to 60 days;
- Benefits are treatment for animal excrement and providing cooking gas;
- Farmer size is middle size (with farmland of two acres or more);
- Fermentation temperature: 35 degrees;
- There is seasonal change between winter and summer. Biogas production is higher in summer;
- Maintenance: every morning's input and cleaning;
- Guarantee after initial construction : Five years;
- Supplier's maintenance: Three years for burner and whole digester; and
- Initial cost of BDT 35,000 ~ 37,000, among which BDT 7,000 is subsidized from IDCOL, in the form of refinancing of 80 percent the loan payable from the households (c.f. following table).

Table 2.3-4 Financing Structure of a 3.2m3 size Biodigester

(a)Construction cost of 3.2m3 plant	USD 500
(b)IDCOL subsidy	USD 113
(c)Plant Cost for household [(b)-(a)]	USD 387
(d)Down Payment from Household to PO[15% of (c)]	USD 58
(e) Loan Payable from Household to PD[(c)-(d)] Loan Tenure 2years, Interest Rate 12% p.a., Monthly Installment Amount USD18.2	USD 329
(f)IDCOL Refinance [80% of (e)]	USD 263
(g)PO Contribution [20% of (e)]	USD 66

Note: Down payment = Initial amount to be paid by end-users.
Source: IDCOL

5) Future directions of IDCOL's NDBMP

IDCOL has set a target for the program period of 2010 – 2012 (calendar year). The targets cover not only installation numbers but also various development effects due to the program interventions. NDBMP has significant roles in capacity building and biodigester installment.

Table 2.3-5 Target for NDBMP 2010 - 2012

Indicator Target	2010	2011	2012	Total
Number of biogas plants installed	7,000	9,000	11,000	27,000
Number of direct beneficiaries from the plants	42,000	54,000	66,000	162,000
Number of jobs created	1,000	1,500	800	3,300
Number of households directly benefited with slurry demonstration Support	700	900	1100	2,700
Number of households with increased in income due to utilizations of slurry	4,900	6,300	7,700	18,900
Number of persons provided access to sanitation	700	1,350	1,650	3,700
Number of beneficiaries through capacity development activities	6,770	8,400	9,790	24,960
Number of POs	28	28	28	28
Number of appliance manufacturers	4	4	4	4
Biogas plants with compost pits	Minimum 70% of constructed plants	Minimum 70% of constructed plants	Minimum 75% of constructed plants	
Plant functioning	Minimum 95% installed plants	Minimum 95% installed plants	Minimum 95% installed plants	
Plant maintenance	100% of 2009 plants	100% of 2010 plants	100% of 2011 plants	
Number of journalists oriented on Biogas technology	180	—	200	380
Number of female motivators	200	120	80	400
Cluster Construction Approach	30 Biogas Villages and 5 Biogas Unions	40 Biogas Villages, 5 Biogas Unions and 2 Biogas Uppazilla	30 Biogas Villages, 5 Biogas Unions, 5 Biogas Uppazilla and 5 Biogas District	100 Biogas Villages, 15 Biogas Unions, 7 Biogas Uppazilla and 5 Biogas District

Source: IDCOL

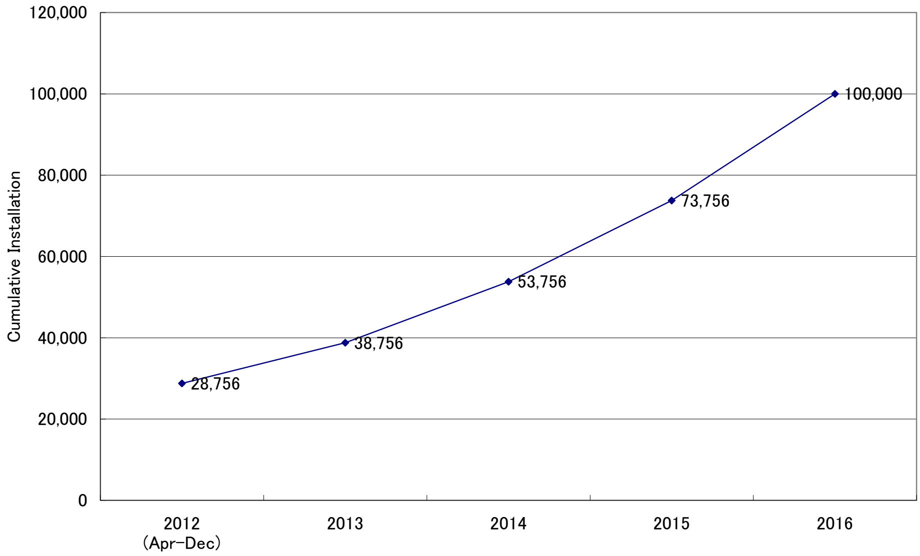
The budget source for NDBMP is shown in next table. In response to the increase in number of biodigester installation, budget source from DGIS/ABP, GoB, and KfW have been increasing. Budget from SNV core fund has changed to that of SNV TA that is funded from KfW. The amount of SNV budget is constant throughout 2010 to 2012.

Table 2.3-6 Budget Source for NDBMP

Proposed financing	2010	2011	2012	Total
Households (cash/credit)	1.611.842	2.072.368	2.532.895	6.217.105
KfW support for credit	*823.200*	*1.058.400*	*1.293.600*	*3.175.200*
DGIS/ABP	443.704	444.825	458.290	1.346.819
GOB (15% of subsidy)	96.429	123.980	151.531	371.940
KfW (85% of subsidy)	546.429	702.551	858.673	2.107.653
SNV TA (likely to be supported by KfW)	0	0	240.000	240.000
SNV core fund	240.000	240.000	0	480.000
Total	**2.938.404**	**3.583.724**	**4.241.389**	**10.763.517**

Source: IDCOL

IDCOL has a tentative installation plan for biodigesters from 2013 to 2016. The cumulative installation target number is 100,000.



Source: IDCOL

Figure 2.3-7 Tentative Plan Target Number of Biodigesters (from 2013 to 2016)

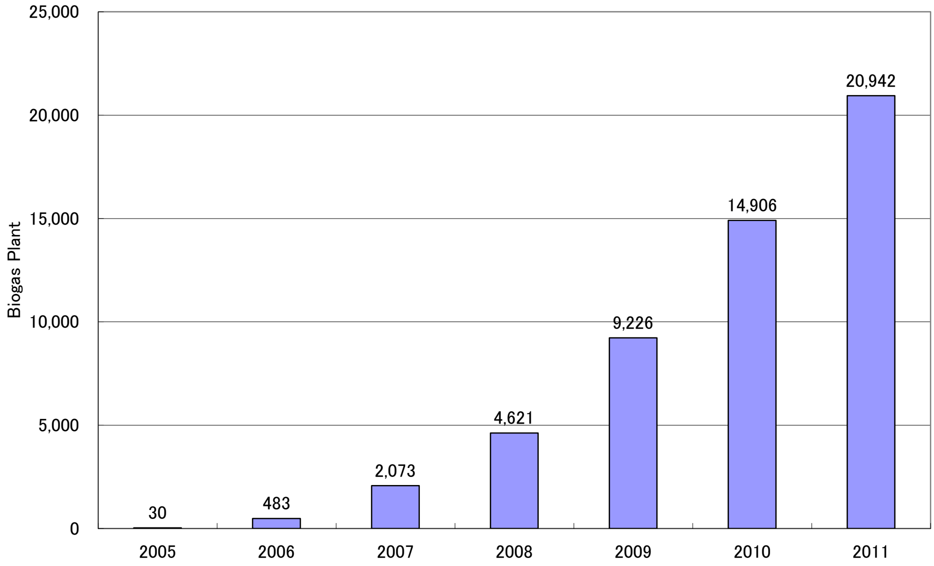
(2) Other Programs

In addition to the IDCOL's program, Grameen Shakti and Local Government Engineering Department (LGED) have implemented projects to install biodigesters.

1) Grameen Shakti

Grameen Shakti has implemented biodigesters since 2005 and cooperated with IDCOL. The design provided by IDCOL is intended for small scale (from 1.6m3 to 8.0m3) cooking gas production. On the other hand, Grameen Shakti has implemented larger scale biodigesters from 50m3 to 500m3 to produce electricity. The initial cost for 50m3 is BDT 60 million. The following chart shows the number of installed biodigesters by Grameen Shakti.

Grameen Shakti also has technical centers across the country. If there are technical problems in a biodigester, civil engineering specialists are sent from their technical center to take care of the problem.



Source: Grameen Shakti

Figure 2.3-8 Number of Installed Biodigesters by Grameen Shakti

2) LGED

LGED has implemented 3.5kW cow dung biodigester at Netrokona district targeting small-scale farmers. This activity was conducted under the Sustainable Rural Energy (SRE) Program funded by the UNDP.

2.3.3. Gasification of Biomass

(1) Existing Facilities

IDCOL, so far, has financed two biomass gasification sub-projects. One is in Chilarong (Thakurgaon Plant), and the other is in Kapasia (Gazipur Plant).

1) Chilarong - Thakurgaon Plant

The 400kW class gasification facility is located in Chilarong, Thakurgaon. The sub-project sponsor is Sustainable Energy & Agro-resource Limited (SEAL). The total cost of this project is BDT 91.94 million. The facility provider is Orbit (Indian company), who supplied the plant on turnkey basis.

This facility uses rice husk as raw material for biomass gasification. Generated electricity is supplied to rice mills and irrigation facilities. The striking feature of this facility is that precipitated silica collected from the gasified residue is sold as a by-product. Revenue from selling of silica as a by-product is expected to improve the profitability of the project. This is due to the fact that Bangladesh relies most of its silica supply in imported products. Precipitated silica is used in rubber, toothpaste, and other chemical industries. Once completed, the annual silica production capacity of the plant is expected to be 918 tons.


Whole view of the plant


Down draft gasifier


Tar output


Cyclone


Cooling tower


Scrubber


CO2 recovery facility


Digester tank


Silica precipitation facility


Silica drying facility


Rotary silica conveyer


Purified silica conveyer

Figure 2.3-9 Gasification and Silica production line at Chilarong-Thakurgaon Plant

The chrematistics of biomass gasification and silica production factory are as follows:

Gasification

- Gasification line is operated by four staffs.
- There are three cyclones to remove ash and tar.
- Tar will be sold or combusted into a small boiler in the facility.
- Three scrubbers are installed to remove moisture and small particle in syngas.
- Gasifier has CO_2 recovery facility to provide CO_2 to silica and $CaCO_3$ production line.
- Operation depends on silica production demand.
- Life time of the gasifier is ten years.
- For maintenance, scrubber needs once a month to exchange filters.

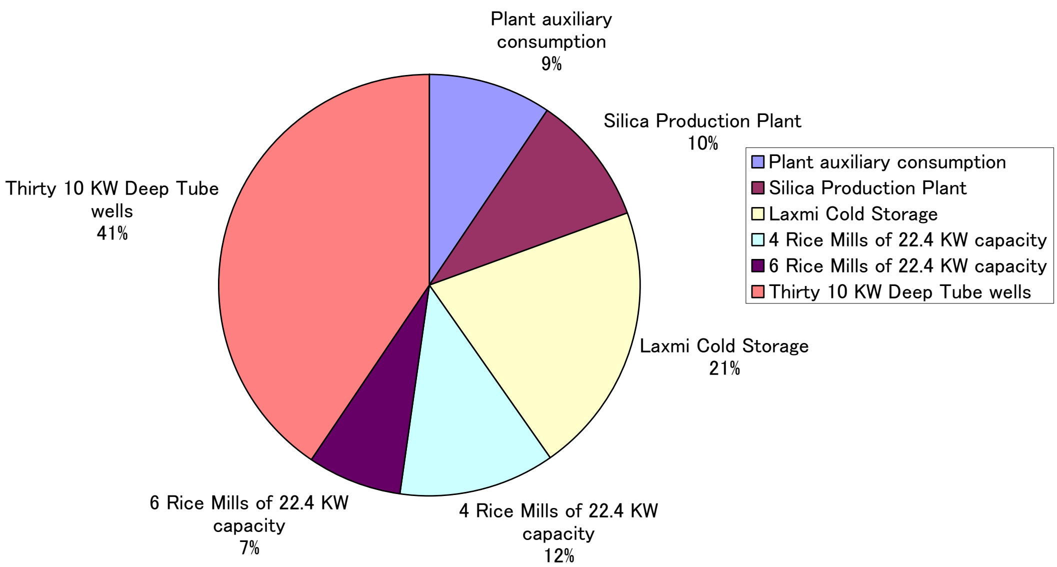
Silica and $CaCO_3$ production

- Capacity: raw material ash after rice husk gasification ash 11t/day (5 t/day at initial stage)
- Output: 2.5silica t/day 3 CaCo3t /day
- Wet silica will be brought precipitation process, and waste water will be also reused in the plant through filtration system.
- 98 percent of Caustic (NaOH) is recycled.
- Silica production line is operated by three shift groups. Each group has seven staff.

Other information
- Human resource needs to be five technical staff & four semi-technical staff and some manual labor for handling rice husks in operation and maintenance. (Japanese system might be at least two or five people.)
- Electricity demand for irrigation pump is not stable under the seasonal variation.
- Electricity demand for cold storage and rice mill are stable.
- Rice mill's motor is not efficient one.
- The plant technology is IIT Mumbai. An Indian company.
- Warranty for the system as a whole period is 5 years.
- Silica demand in Bangladesh is large and this system can be a replicable one.
- Electricity cost is 7BDT/kWh. Production cost is 4 ~ 5BDT/kWh.
- Rice husk prices from 4 to 5 BDT/kg.
- Silica price is BDT 100/kg.

Source: Compiled by the Survey Team based on information obtained from IDCOL and through field surveys

Electricity generated at Thakurgaon plant is supplied to irrigation by thirty 10kw deep tube wells, Laxmi cold storage, two rice mill companies each owning four and six milling machines, and also to silica production line.



Source: IDCOL

Figure 2.3-10 Electricity Consumption plan at Thakurgaon

The breakdown of total cost estimation is shown in the appraisal report by IDCOL. Among them, the facility purchase amounts, mostly of the total cost, which are the purchased from India accounts for 63.68 percent and the local purchase for 10.22 percent. The proportion of land and land development cost is lower than that of biogas power generation projects, such as 50kW RKKL project and the 400kW Phoenix project. The project cost also includes consultancy, pre-operating expenses, contingency, and initial working capital, which indicates biomass gasification project should be implemented carefully based on the proper technical view point.

Table 2.3-7 Breakdown of Total Cost Estimation of 400KW Plant and Silica Plant

Particulars	Amount (in million BDT)	% of Project costs
Land	2.5	2.72%
Land Development	0.5	0.54%
Building and Civil Construction	3.95	4.30%
Plant, Machinery and Equipment –Foreign	58.55	63.68%
Plant, Machinery and Equipment –Local	9.40	10.22%
Duty, Charges & Insurance	3.65	3.98%
Internal Freight	0.5	0.54%
Installation & Erection	1.0	1.09%
Office Equipment, Furniture & Fixture	0.5	0.54%
Consultancy	3.0	3.26%
Pre-operating Expenses	0.3	0.33%
Contingency	3.04	3.31%
Initial Working Capital	0.74	0.80%
Debt Service Reserve	4.31	4.69%
TOTAL PROJECT COST	91.94	100.00%

Source: IDCOL

As for the financing plan, the Thakurgaon project is not supported by any other subsidy. The total project cost will be BDT 91.94 million which consists of debt (70 percent), which is funded by IDCOL and backed by the World Bank (IDA) loan; and equity (30 percent) from the sponsor's own source. The composition is the same as that of the 400 kW Phoenix project.

Table 2.3-8 Financing Structure of the Thakurgaon Project

	Amount (BDT)	Composition
Debt	64.36	70%
Equity	27.58	30%
Total Project Cost	91.94	100%

Source: IDCOL

The debt plan of the Thakurgaon project is shown in the next table. The tenure period is seven years long, which is the same duration as 400kW Phoenix project. The grace period is 12 months. The debt is due for 24 quarterly repayments in six years, which will be due in the second year of the project (c.f. Table 2.3-10).

Table 2.3-9 Project Debt Facilities

Facility	Amount (BDT million)	Interest Rate	Tenure	Grace	Repayment
Term loan	64.36	10% p.a.	7 years	12 months	Level principal; 24 (twenty four) Quarterly repayment

Source: IDCOL

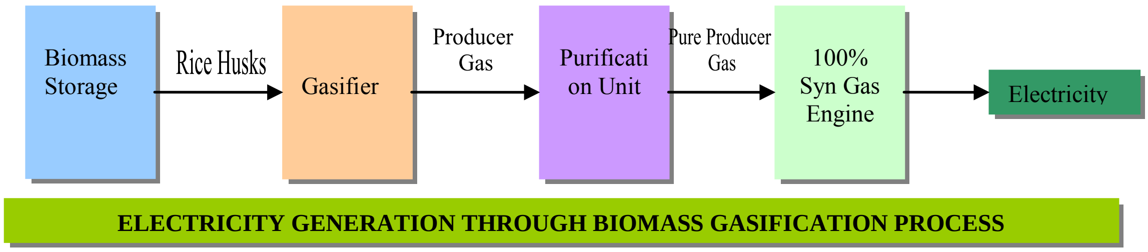
As for the debt repayment schedule, in the first year, the total facility needs trial and check operation towards the full commercial operation during the first half year. The debt will be due for repayment in the second year after steady operation starts and will be finished by the end of the seventh year.

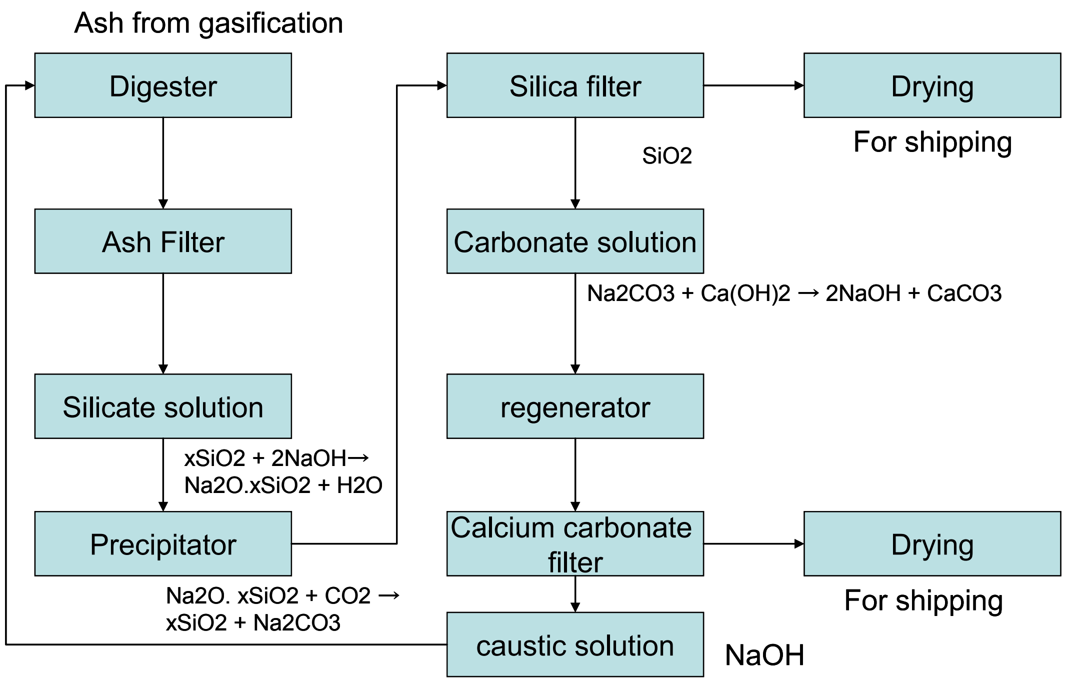
Table 2.3-10 Debt Repayment Schedule

Facility	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Term loan	-	16.67%	16.67%	16.67%	16.67%	16.67%	16.67%

Source: IDCOL

The material flow of gasification and silica production are shown in the following chart.





Source: IDCOL and Survey Team

Figure 2.3-11 Basic Flow of Biomass Gasification and Silica Production

The rice husk generated from rice mill factory is brought to the plant. At first, rice husk is placed into the gasifier, in which biomass is cracked into CO_2, CO, H_2O, and CH_4. The ratio of each molecule differs by gasification method. The gas is called syngas, which is abundant for high calorie and used for power generation and making liquid fuel with catalyst. Since syngas contains H_2S, syngas is needed to be purified so as not to hurt the gas engine. After purification, syngas is brought to the gas engine.

Usually rice husk gasification generates ash residue. In Thakurgaon project, ash is utilized for the precipitation of silica and the regeneration of calcium carbonate to meet facility income.

Financial analysis result of the Thakurgaon plant is presented in the following table.
The project IRR is over 30 percent and minimum DSCR is 1.32 (over IDCOL's criteria of 1.2).[54]

Table 2.3-11 Financial Analysis Result of the Thakurgaon Plant

Ratio	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
DSCR	1.71	1.32	2.06	3.01	3.42	3.91	4.49
Average	2.30						
Minimum	1.32						
ROE	0%	30%	37%	37%	29%	23%	21%
Average	23%						
Minimum	0%						
IRR	30.76%						
NPV	121,167,290						

Source; IDCOL

2) Kapasia- Gazipur Plant

The 250kW class gasification is located in Kapasia, Gazipur. This facility also uses rice husk as raw material and electricity is only provided for three villages, which has 500 households. IDCOL provided concessionary loans and grants to the sponsor, Dreams Power Private Limited (DPPL) for setting up the plant. The total cost of this project is BDT 25.0 million. The provider of equipment is Ankur Scientific Energy Technologies Pvt. Ltd, a company based in India. The technical characteristics of the gasifier are as follows: (Gazipur project is suspended as of June 2012.)

Table 2.3-12 Characteristics of Gasifier

Parameter	Description
Gasifier Type	Downdraft
Capacity	Total 250 kW
Moisture Content	Up to 10%
Rated Gas Flow	625 Nm3 /hr (up to total 250 kW capacity)
Average Gas Calorific Value	> 1,050 (Kcal/Nm3)
Rated Biomass Consumption	Up to 300 kg/hr (for total 250 kW capacity)
Gasification Temperature	1050oC-1100oC
Gasification Efficiency	Up to 75%
Temperature of Gas at Gasifier Outlet	250 to 400oC
Biomass Feeding	Manual
Turndown Ratio	1: 0.5
Desired Operation	Continuous (minimum 300 days/yr)
Typical Auxiliary Power Consumption	Up to 11 kW
Typical Gas Composition	CO-20.62%, H2-10.62%, CO2-13.61%, CH4-
Availability of the Gasifier	Minimum 80% in a year

Source: IDCOL

[54] IDCOL applies its customary rule of minimum DSCR of 1.2 for RE Projects.

The cost estimation of 250kW gasification plant is calculated on the basis of premise of a 50 percent grant. The highest cost of 250kW gasification plant is derived from local and imported equipment cost.

Table 2.3-13 Cost Estimation of a 250kW Gasification Plant

Total Project Cost	BDT (50% grant)	% of Project Cost
Land and land Development	1,350,000	5.35%
Building and Other Civil Construction	3,000,000	11.89%
Equipment (both imported and local)	15,698,586	62.22%
Other Assets	1,775,000	7.04%
Pre-operating Expenses	537,378	2.13%
Initial Working Capital	1,353,713	5.37%
Contingency	934,929	3.71%
Fees and Charges	25,000	0.10%
Interest During Construction Period	56,630	0.22%
Pre-funded Debt Service Reserve	499,141	1.98%
TOTAL PROJECT COST	25,230,378	100.00%

Source: IDCOL

Gazipur project is suspended as of June 2012. This project originally aimed at obtaining income by selling electricity to farmer households as project income. However, the actual demand for electricity by farmer households turned out to be far less than estimated at the planning stage.

Projects to generate and sell electricity from biomass need to be backed by firm commitment to purchase electricity. In case where electricity selling price is low (as with Bangladesh), additional income from selling by-products would also be necessary. Gazipur project can be said to have failed to arrange for either of these project incomes.

(2) Candidate Areas for Future Deployment

Although, currently there is no plan that has been developed to further deploy biomass gasification technologies in Bangladesh, there are some candidate areas for future deployment. One of the candidate areas is Naogaon in the Rajshahi division, where rice husk is abundant and large scale rice mills are located. In order to set up a rice husk gasification and silica production factory, arrangements among rice mill owners are required.

According to the Dr Md Golam Rabbani of the Bangladesh Agricultural University, there are six rice mills cluster in Bangladesh and each cluster can be a candidate area for deployment of rice husk gasification technology.

Table 2.3-14 Rice Mill Cluster Area

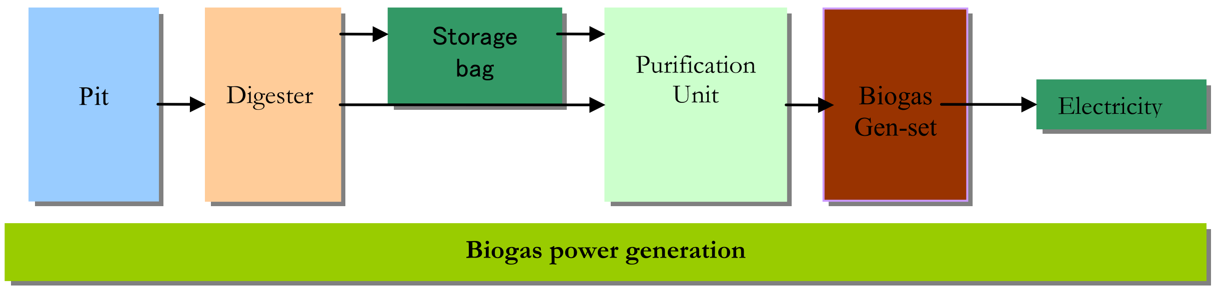
No	Name of the rice mill cluster area
1	Dinajpur (including Thakurgaon) in northern part of the country
2	Sherpur near Bogra
3	Ishwardi near Pabna
4	Kaliakoir near Dhaka
5	Kushtia
6	Chapai Nawabganj

Source: Dr Md Golam Rabbani, Bangladesh Agricultural University
Note: Naogaon lies between No2 and No3.

2.3.4. Biogas Power Generation Component

(1) Poultry Waste Biodigester for Power Generation

IDCOL has carried out a demonstration experiment for power generation through poultry waste biomass as 50kW and IDCOL is now implementing two power generation projects through poultry waste biodigester as 350kW and 400kW. The process of power generation through poultry is shown in the following figure.



Source: IDCOL

Figure 2.3-12 Diagram of power generation through poultry waste biodigester

The poultry waste is brought to the pit and conveyed to the digester, then the anaerobic fermentation process starts. In case of steady biogas production for power generation, a gas holder or storage bag is needed to be settled. After anaerobic fermentation, biogas generates but it contains sulfur in form of H2S. Thus they need to remove H2S for gas purification. If H2S remains in biogas, the machinery of the power generator is damaged.

1) 50kW Mymensingh project

Rashid Krishi Khamar Limited (RKKL) has been operating since 2005 and is mainly involved in agro-businesses i.e. poultry and fish hatcheries, poultry farming, fish farming, agricultural farming, and horticulture. RKKL conducts the 50kW Mymensingh project in its poultry farm located between Gazipur and Mymensingh, where it takes about three hours' drive from Dhaka. This farm has 30,000 poultry heads, two 70 m3 digesters, 50kW (25kW × 2) power generators (warranty: 3 years), and two purification units. The initial cost of the project is approximately BDT five million. This facility aims to provide electricity toward poultry house for six to eight hours per a day and provides slurry for fields and aquaculture. According to IDCOL, they could install a 50kW generator with 40,000 poultry heads and 4t slurry.

The farmer is enlarging the number of poultry. They are preparing two poultry houses. Each poultry house is three-floored and one of the two poultry house has two 70m3 size digesters.


Poultry house and digester(1)


Agitator(2)


Biogas output(3)


Slurry(4)


Digester made from Bricks(5)


Power generator 25kW×2(6)

Figure 2.3-13 50kW Poultry Waste Biodigester Plant

Explanations on above images are as shown in next table:

Table 2.3-15 Notes to the Images of 50 kW Poultry Waste Biodigester Plant

Picture No	Picture explanation
(1)	Poultry house is three-floored. Digester is installed at the foot of the poultry house. Gas tube conveying biogas is stretched to the power generation facility.
(2)	Poultry dung, waste water, and urine from poultry house is collected and then brought to the digester entrance. At the digester entrance, daily maintenance is needed with the agitator so as not to become solid.
(3)	Biogas is stored at a digester settled underground. When they use biogas for power generation, biogas output and green gas tube is connected.
(4)	At the digester, slurry is made and pushed outside by biogas pressure.
(5)	Digester is settled underground and is made of bricks. The size of digester is 70m3.
(6)	This poultry house uses 50kW power generator with biogas. These generators are made in China.

The breakdown of the cost is shown as the following table. The total cost of the project is BDT 4,063,660. From this figure, civil construction of biogas plant accounts for the largest portion. The digester tank settled under the ground is made of brick and cement. The generation unit, which is made in China amounts to about 40 percent of the total cost. On the Purification and Chemical Test, removal of the H2S from biogas is required for the operating power generation unit.

Table 2.3-16 Breakdown of Project Cost

Item	Amount (BDT)
Land Development	171,599
Civil Construction of Biogas Plant	1,889,062
Generation Unit	1,570,000
Purification and Chemical Test	163,000
Staff Cost and Professional Services	270,000
Total	4,063,661

Source: IDCOL

Warranty for the power generating biogas engine is three years. That of the civil works varies by cases. The plant, with periodical renewal of the engines, is designed to be operational for twenty years.

As for the financial plan, this project consists of equity (40 percent), grant (40 percent), and loan (20 percent). Although grant amounts to 40 percent of the total, it might be severe for small scale poultry farmers to pay for equity and loan.

Table 2.3-17 Financial Plan

	Percentage	Amount (in BDT)
Equity	40%	1,625,464
Grant	40%	1,625,464
Loan	20%	812,732
Total	100%	4,063,660

Source: IDCOL

The loan is from the World Bank (IDA) and the grant from GEF, both through IDCOL. As for financial plan, they estimate FIRR and DSCR by different combinations of equity, grant, and loan. The minimum DSCR is 1.85 (over IDCOL's minimum criteria of 1.2), and IRR is 17.14 percent (higher than 12 percent).

Table 2.3-18 Project's Key Results

Ratio	Year 1	Year 2	Year 3	Year 4	Year 5
DSCR	2.04	1.85	3.25	4.81	6.54
Average	3.70				
Minimum	1.85				
ROE	0.00%	18.61%	22.81%	20.11%	18.13%
Average	9.8%				
Minimum	0%				
IRR	17.14%				
NPV	BDT 1,391,925				

Source: IDCOL

2) 400kW Phoenix RE Project

The 400kW size of power generation through poultry waste digester will be installed in Memberbari, Gazipur. The facility is now under construction and will be completed by the end of this year. The purpose of this project is to provide electricity for poultry house. The key information of this project is as follows;

Table 2.3-19 Key Information of Phoenix RE Project

Particulars	Description
Location	Memberbari, Gazipur
Project Company	Phoenix Agro Ltd.
Certificate of Incorporation	12 March 2009
Capacity of Biogas Generator	400 KW
Capacity of Fertilizer Plant	15 MT
Bangladesh Fertilizer Association Membership Certificate	10 July2011
Biogas generator supplier	CAMDA Generator Work Co. Ltd
Turnkey solution provider	Seed Bangla Foundation

Source: IDCOL

The project company, Phoenix Agro limited belongs to the Phoenix group. The phoenix group has more than 800,000 heads at its poultry firms located in the greater Gazipur and Jatrabari areas.

As for the initial cost of the facility, the ratio of building & civil construction is higher than that of the rice husk gasification project. Building and civil construction cost contains construction of biogas digester. The biogas generator cost is the second largest among the initial cost.

Table 2.3-20 Breakdown of Initial Cost of Phoenix RE Project

Costs in BDT million	**Amount**	**Percentage**
Building & Civil Construction	60.55	53.3%
Machineries & Equipment	9.40	8.3%
Biogas Generator	32.80	28.9%
Office Equipment, Motor Vehicles etc.	2.50	2.2%
Pre-operating Expenses	1.20	1.1%
Contingency	1.00	0.9%
Service Charge, Consultancy and User Training	6.20	5.5%
Total	113.66	100.00%

Source :IDCOL

The project is expected to be financed with a debt-equity ratio of 70:30. The financing structure of the project is shown below: The ratio debt to equity is the same as Thakurgaon project.

Table 2.3-21 Financing Plan for Phoenix RE Project

Sources of Funds	Amount (BDT million)	%
Debt	79.56	70%
Equity	34.10	30%
Total	113.66	100%

Source: IDCOL

The key components of the debt plan are shown in table below. The tenure period is the same as the Thakurgaon gasification project. Twenty-six quarterly repayments need seven years. The original source for debt is funded by IDCOL's own fund source.

Table 2.3-22 Debt facilities for Phoenix RE Project

Facility	Amount (BDT million)	Interest Rate	Tenure	Grace	Repayment
Term loan	79.56	9% p.a.	7 years	6 months	Annuity; 26 (Twenty Six) Quarterly repayments

Source: IDCOL

Debt repayment schedule is in a seven years plan. In the beginning of tenure period, the facility's output is low because adjustment or trial operation is needed in the facility. Debt repayment amount increases every year, which indicates steady operation that will be carried out in larger scale every year.

Table 2.3-23 Debt repayment schedule for Phoenix RE Project

Facility	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Total
Term loan	2.20%	5.71%	8.07%	11.39%	16.07%	22.69%	33.88%	100%

Source: IDCOL

The PAL will sell the electricity produced from the project to PPL at the rate of BDT 12/kWh. In addition, a portion of the produced fertilizer will be sold to Lal-Sobuj Seed Ltd. ("**LSSL**"), another sister concern of PAL, at the rate of BDT eight per kilogram.

In terms of technical topics, removing Hydrogen Sulfide (H_2S) is the main goal of the purification unit. The total removal rate of sulfur is expected to be 99.1 percent. Based on 20 operation hours per day and 7,000 hours per year, a comparison between the before treatment scenario and after treatment requirement as shown below:

Table 2.3-24 Feature of Purification System in Phoenix RE Project

Parameter	Before treatment	After treatment
Biogas flow	30 Nm3/hr	
H2S component	3,000 ppm (0.3%).	200-250 ppm(0.02%-0.025%).
Pressure	5-10kpa	≥3kpa
Temperature	ambient temperature	ambient temperature
Impurity component		≤30mg/Nm3

Source: IDCOL

According to the table above, the removal ratio of H2S is 91.6 percent, while in Japanese PSA[55] technology, the average ratio of removal H2S is more than 95 percent. The pressure is 5~10kPa before the purification process and 3kPa after the purification system. This system utilizes low pressure circumstance to purify biogas. The temperature is ambient. This means that it doesn't need to warm up the biogas. The operation of this system does not require higher cost. 200ppm of H2S might be higher to operate in a Japanese biogas engine or micro gas turbine.

The key indicators of the project are presented in the following table. The minimum DSCR is 2.00 (over IDCOL's minimum criteria of 1.2). Although IRR from project perspective is 24 percent (less than 30 percent), IRR from sponsor perspective is 47.24 percent, and more than 30 percent.

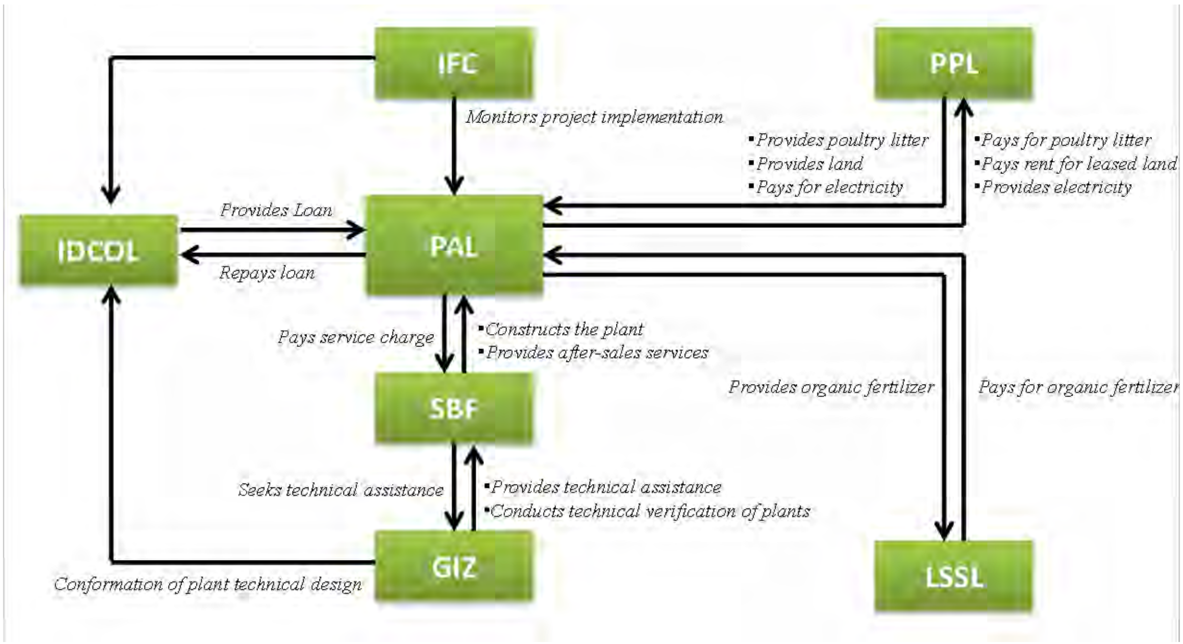
Table 2.3-25 Project's Key Results of Phoenix RE Project

Ratio	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
DSCR	3.82	2.77	2.79	2.73	2.59	2.36	2.00
Average	2.72						
Minimum	2.00						
ROE	20.56%	19.43%	19.94%	19.94%	19.65%	19.06%	18.73%
Average	16.19%						
Minimum	11.70%						
IRR (Project perspective)	24.00%						
IRR (Sponsor perspective)	47.24 %						

Source: IDCOL

Note: IRR (Project perspective) means IRR assessment from the perspective of the project organization "PAL". IRR (Sponsor perspective) means at the point of PPL. PPL provides poultry waste and necessary land.

[55] PSA: "Pressure Sing Adsorption" that enables the separation of methane gas from biogas to obtain higher contents of methane gas.



Source: IDCOL

Figure 2.3-14 Project Implement Scheme of Phoenix RE Project

3) 350kW Paragon RE Project

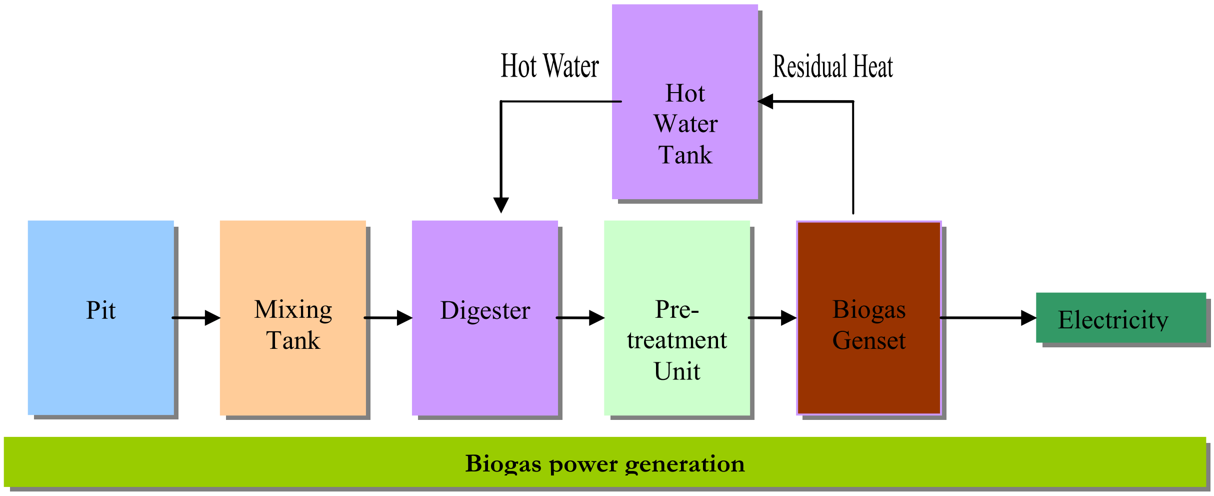
The 350kW size of power generation, through poultry waste biodigester, was planned to be installed in Gazipur. However, the project is now suspended. The key information of this project is as follows;

Table 2.3-26 Key Information of Paragon Project

Particulars	
Project locations	Biogas based electricity plants: Chamiadi, Valuka, Mymensingh and Baniarchala, Bhavanipur, Gazipur
	Organic fertilizer plant: Bauni, Sripur, Gazipur
Capacity	350 KW electricity generation plant and 15 MT organic fertilizer plant
Certificate of Incorporation	26 December 2002
Bangladesh Fertilizer Association Membership Certificate	25 May 2008
Expected COD	March 2010
Biogas genset supplier	CAMDA Generator Work Co. Ltd
Turnkey solution provider	Hangzhou Energy and Environmental Engineering Company Limited

Source: IDCOL

The process of power generation is shown below. In this process, hot water is provided to warm up the biodigester, which is the feature of this facility. This technical method differs from the Phoenix project. Warming up the biogas digester tank brings higher yield of biogas in order not to hinder methane fermentation by NH3.



Source: IDCOL

Figure 2.3-15 Diagram of Power Generation Utilizing Hot Water

Poultry waste is brought to the pit and is conveyed to the digester through the mixing tank. Then anaerobic fermentation process starts. After anaerobic fermentation, biogas generates but biogas contains sulfur in the form of H2S. For biogas power generation, they need to remove H2S for gas purification at the pre-treatment unit. If H2S remains in biogas, the machinery of the power generator is damaged. This facility aims waste heat utilization towards warming-up the digester by hot water. This method of fermentation is called as "higher temperature fermentation" against normal fermentation as "middle temperature fermentation".

The Paragon project has three electricity plants and a fertilizer plant aiming to provide the industry. The ratio of imported machineries is about 50 percent.

Table 2.3-27 The Breakdown of Initial Cost at Paragon Project

(Amounts in BDT million)

Particulars	Bio-Electricity Plant I	Bio-Electricity Plant II	Bio-Electricity Plant III	Fertilizer Plant	Total
Land	-	-	-	20.00	20.00
Building & Civil Construction	9.35	14.25	7.12	16.05	46.77
Imported Machineries	24.50	39.73	1.06	9.20	74.49
Local Machineries	2.87	4.29	0.97	-	8.14
TOTAL	36.72	58.27	9.15	45.25	149.40

Source: IDCOL

Electricity generated from the project will be supplied to the adjacent poultry farms of Paragon Poultry Ltd. (PPL) at BDT 4 / kWh, while the organic fertilizer will be sold in the market at BDT 15 per 1 Kg packet and BDT 400 per 40 Kg packet.

The two projects are similar for power generation. However, the technical methods are different. This is especially true with the Paragon project, which will provide hot water for high temperature fermentation. Note that hot water is needed to be provided for whole duration. The Paragon project might have a higher technical barrier.

4) Other power generation through poultry waste digester

IDCOL, International Finance Corporation (IFC), and GIZ entered into a Cooperation Agreement on April 22, 2010. Such agreement was reached to promote electricity generation using poultry litter across the poultry farms of Bangladesh. Under the project, several contractors with adequate experience have been identified to provide technical solutions to the poultry farms. Some of the existing biogas solution providers under IDCOL and GIZ biogas programs were identified as potential Technical Service Providers (TSPs). Necessary financing supports to the farm owners under the Agreement would be channeled through the TSPs. The list of TSPs identified is provided below:

- Rahman Renewable Energy Company (RREC);
- Kamrul Biogas and Compost Fertilizer Research Development Co. Ltd. (KBL);
- Hossain Biogas and Compost Fertilizer Company Ltd. (HBL);
- Seed Bangla Foundation (SBF);
- Felix Energy Services (FES); and
- Rural Services Foundation (RSF).

The project involves setting up five biogas-based electricity generation plants located in Gazipur. Electricity generated from the project will be supplied to the adjacent poultry farms of Bandhu Poultry (BP), Dewan Poultry (DP), Lipon Poultry (LP), MS SA Poultry (SP), and Rajib Agro Complex (RAC).

Table 2.3-28 Key information of 5 projects

	Bandhu Poultry	Dewan Poultry	Lipon Poultry	MS SA Poultry	Rajib Agro Complex
Project locations	Gazipur	Gazipur	Gazipur	Gazipur	Gazipur
Capacity (kW)	10	10	10	10	10
Number of birds	6,000	6,000	6,000	6,000	6,000
Type of bird	Hens	Hens	Hens	Hens	Hens
Date of Incorporation	2004	2005	2006	1997	2004
Technical Service provider	Seed Bangla Foundation				

Source: IDCOL

The total cost of the proposed project has been estimated to be at BDT 3.11 million. The breakdown of total cost is shown below.

Table 2.3-29 Cost Breakdown of the 5 Projects

Project Cost Components	Al Shishir Poultry Farm (BDT million)	Bondhu Poultry Farm (BDT million)	Dewan Poultry Farm (BDT million)	Rajib Agro Complex (BDT million)	S A Poultry Farm (BDT million)	Total (BDT million)
Building & Civil Construction	0.29	0.29	0.29	0.29	0.29	1.46
Generator	0.25	0.25	0.25	0.25	0.25	1.25
Service charges	0.08	0.08	0.08	0.08	0.08	0.39
TOTAL	0.62	0.62	0.62	0.62	0.62	3.11

Source: IDCOL

As approved by the IDCOL Board, the bio-electricity plants under the Cooperation Agreement might be financed with a combination of debt, equity, and grant at a ratio of 60:30:10 or 70:30 depending on their location, in off-grid or grid area, respectively. Debt is equivalent with the IDCOL Loan and TSP Contribution (0.44 is divided into 0.35 and 0.09). The IDCOL loan is from IDA and the grant is not yet prepared.

Table 2.3-30 Financing Plan of the 5 Projects

	Percentage	Al Shishir Poultry Farm	Bondhu Poultry Farm	Dewan Poultry Farm	Rajib Agro Complex	S A Poultry Farm	Total
Equity:	30.0%	0.19	0.19	0.19	0.19	0.19	0.93
Grant	0.0%	-	-	-	-	-	-
Debt	70.0%	0.44	0.44	0.44	0.44	0.44	2.18
IDCOL Loan	56.0%	0.35	0.35	0.35	0.35	0.35	1.74
TSP Contribution	14.0%	0.09	0.09	0.09	0.09	0.09	0.44

Note: Unit: BDT million
Source: IDCOL

The key financial indicators of the project are presented in the following table from the perspectives of the poultry farms.

The minimum DSCR in each project is higher than IDCOL's minimum criteria of 1.2. IRR in each project is in a higher ratio than that of the other biomass projects, such as the Thakurgaon project, the 50kW Mymensingh project, and the 400kW Phoenix project.

Table 2.3-31 Financing Indicators of the 5 projects

Financial Indicators	Al Shishir Poultry Farm	Bondhu Poultry Farm	Dewan Poultry Farm	Rajib Agro Complex	S A Poultry Farm
NPV (BDT million)	4	4	4	3	4
IRR	101%	104%	96%	81%	107%
Average DSCR	2.97	3.06	2.83	2.37	3.15
Minimum DSCR	2.92	3.01	2.77	2.31	3.09

Source: IDCOL

(2) LGED's Project

The LGED has implemented biodigester demonstration projects. According to LGED, there are five demonstration projects aiming for cooking gas production. The following table shows the comparison between LGED and IDCOL.

Table 2.3-32 Comparison between LGED and IDCOL Practices

	LGED	IDCOL
Number of installed biodigester	5	More than 22,005
Power generation capacity	10kW+3.5kW=13.5kW	400kW+350kW+50kW+50kW =850kW
Purpose for practice	Technical demonstration on biodigester	NDBMP Biodigester implementation
Organization	Research and development	Private company

Source: IDCOL and LGED

2.3.5. Other Biomass Derived RE Potential Projects

Other than rice husk gasification technology and biodigesters, biomass utilization technologies, such as biomass direct incineration technology may be introduced to Bangladesh. Possible biomass feed are sugarcane, and jute, among others. However, as the availability of biomass is dependent on local condition and distribution possibility, the survey will have to be conducted to verify whether such application of technology can be viable.

(1) Biodigester at Central Market

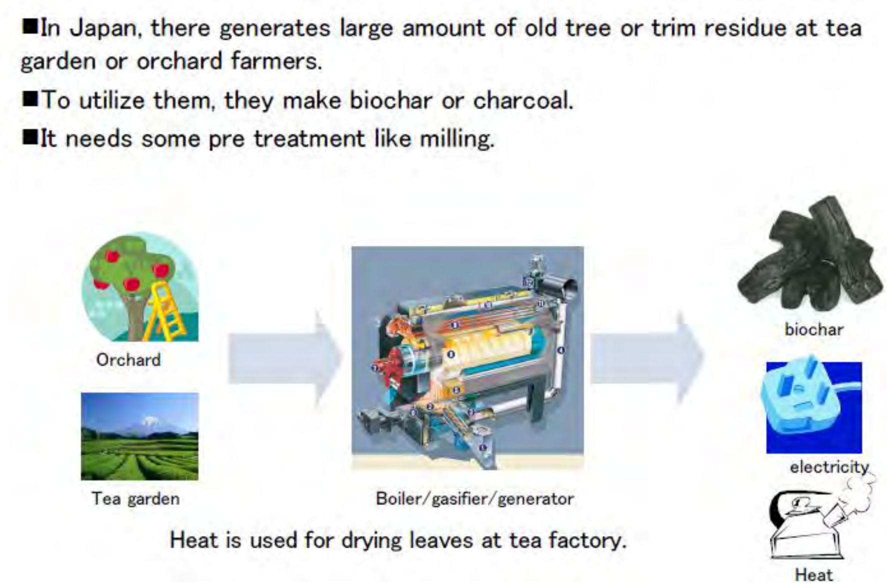
This chart shows the idea of methane fermentation at central market or fish market with garbage selection and collection. The difficulty of this project is steady collection and separation of garbage.

Source: Survey Team

Figure 2.3-16 Idea of Biodigester at Central Market

(2) Biomass Utilization for Trim Residue at Orchard or Tea Garden

This project aims for the utilization of trim residue at orchard or tea gardens and factories. The Biochar is not permitted from biosafety now, but there might be some possibility that it be admitted to use.

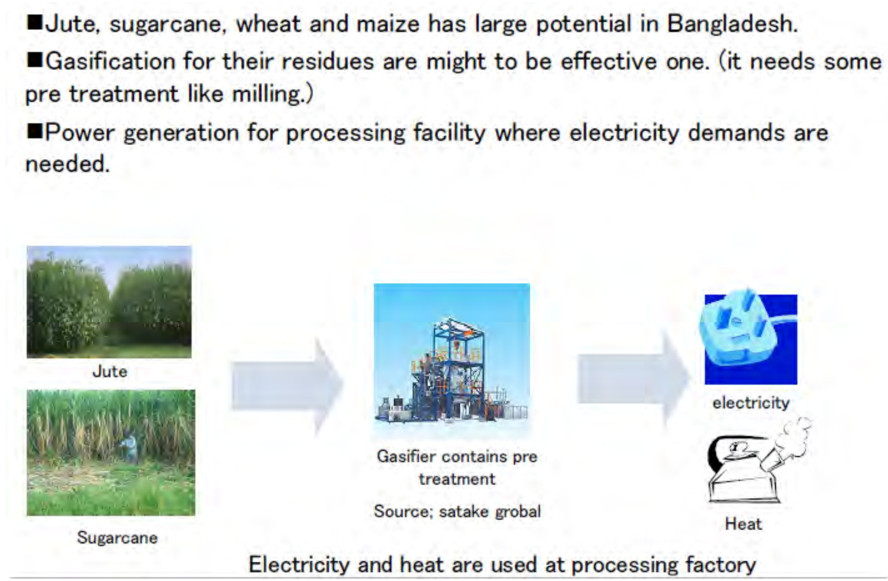


Source: Survey Team

Figure 2.3-17 Idea of Biomass Utilization for Trim Residue at Orchard or Tea Garden

(3) Gasification or Direct Incineration at Other Agricultural Residue

This chart shows local energy production and consumption at processing factory. The target biomasses are jute, sugarcane, wheat, and maize.



Source: Survey Team

Figure 2.3-18 Idea of Gasification or Direct Incineration at Other Agricultural Residue

2.3.6. Comparison between the Biomass derived RE Technologies

As a summary, the existing biomass projects are sorted into three projects. NDBMP has already installed 22,005 biodigesters in Bangladesh. Although rice husk gasification and poultry waste biodigesters are very few at the moment, in the near future, the expectation of both projects implementation is high.

The facility size and cost of each technology differs widely between biodigester and power generation facilities (biomass gasification and biogas power generation), since the former targets household and the latter targets, either rice mill companies or poultry farmer companies. Biodigester is in practical use. On the other hand, biomass gasification and biogas power generation technologies will be in practical use from now.

Table 2.3-33 Summary of Existing Biomass derived RE Technologies

Technologies	Domestic Biodigesters (NDBMP)	Biomass (Rice Husk) Gasification	Biogas Power Generation
Size	3.2m3	400kW,250kW	50kW, 400kW, 350kW, 10kW×5 Average 100kW
Units deployed	22,005	2(1) *1	3(2) *2
Future deployment plan and estimated cost	IDCOL, SNV	IDCOL	IDCOL
Ownership	Users	Users	Users
Involvement of international development partners	Loan SNV, grant KfW	GIZ (technical advice)	GIZ (technical advice)
Implementing entity	IDCOL and POs	IDCOL and rice mill owners	IDCOL and Poultry farmer
Project scheme and form of income	Substitute fuel wood collection and usage	Income from Silica ,CaCO3 and electricity sales	Income from slurry and electricity sales
Lessons from the project	• More than 6 cattle farmer have eager to keep their biodigesters. • Cow farmers less than 4 heads have little incentive to their biodigesters. • Reduction of energy cost by biomass derived energy production	• Sales of electricity to the surrounding rural area do not bring enough income. • Any other profitable project such as silica production should be combined. • Reduction of energy cost by biomass derived energy production	• Slurry sales are higher income then electricity sale to their electric company. • Daily operation and sulfur removal are important to keep their digester as long as possible. • Reduction of energy cost by biomass derived energy production
Start of construction	• 2006~2012 • Tentative plan continues till 2016.	• 2011(400kW),2009(250kW)	• 2009(50kW)
Cost (USD)	• USD500 (3.2m3)	• USD 1.14 million (400kW)	• USD 0.52million (100kW)
Financial arrangement	• Refer Table 2.3-4	• Grant, loan and equity	• Grant, loan and equity
Financial viability	• Viable	• Viable under silica production	• Viable
Public incentives (subsidy, tax exemption, preferential loans, etc)	• Grant and preferential loan through IDCOL	• Grant and preferential loan through IDCOL	• Grant and preferential loan through IDCOL
Foreign investors	• None	• None	• None

Technologies	Domestic Biodigesters (NDBMP)	Biomass (Rice Husk) Gasification	Biogas Power Generation
Promotional measures for investment	• Regular seminar for capacity building targeting POs and farmers	• None	• None
Bottleneck for deployment	• None	• Secure rice husk as raw material • Project sustainability • Technical reliability for continuous operation	• Project sustainability • Technical reliability for continuous operation

*1: 400kW Thakurgaon project is now under construction and 250kW Gazipur project is suspended.

*2: 50kW Mymensingh project is now O & M stage and 400kW Phoenix project is now under construction. 350kW Paragon project is suspended now. Also 10kW × 5 project is now under implementation.

Source: Survey Team

2.3.7. Issues for Further Deployment of Biomass Derived RE

As for the biomass program and project ever supported by IDCOL, remarks or effects are sorted according to the category (market, environment, technical aspects and project sustainability) in the table below:

Table 2.3-34 Issues for Further Deployment of Biomass Derived RE

Program /project	Category	Remarks/Effects
NDBMP	Market	Implementation stage or development stage. IDCOL have supported 20,000 biodigesters and IDCOL will support 100,000 biodigesters till 2016.
	Environment	Efficient for household to get cooking fuel instead of gathering firewood and prevent diseases for women and children from its usage in the household.
	Technical aspect	Proven technology targeting more than five to six cattle farmers. Daily O&M are needed in order to prevent leakage of biogas from pipe, bulb, and near the stove.
	Project sustainability	Slurry and biogas utilization brings farmers income.
Biomass (Rice husk) Gasification	Market	Initial stage or introduction stage. There are two practices at IDCOL so far. Thakurgaon project will be a base model.
	Environment	Leads to utilization of 50 percent of unused rice husk biomass. Treatment for ash and tar is required.
	Technical aspect	Proven technology and needs silica treatment for machinery at O&M stage. Consideration for syngas as combustible gas is required at design stage in order to avoid leakage of H2 and CO toward outside of the gasifier and explosion of the plant. Tar and waste water treatment should also be considered in order to avoid direct emission toward outside of the plant. Syngas purification is required for running the gas engine.
	Project sustainability	Electricity production + silica production or any other profitable project should be combined.

Program /project	Category	Remarks/Effects
Biogas Power Generation	Market	Initial stage or introduction stage. There are three practices at IDCOL so far. Phoenix project will be a base model for large scale and 50kW Mymensingh project will be a base model for middle class.
	Environment	Substitute normal electricity for biomass derived electricity for six to eight hours per day. Consideration for biogas treatment is required in order to avoid H_2S emission towards outside of the plant.
	Technical aspect	Proven technology targeting more than 20,000 heads of poultry. Daily O&M are needed. Consideration for biogas purification is required for power generation in order to prevent machinery damage by H_2S and H_2O.
	Project sustainability	Electricity and slurry utilization are the keys to widen income or to reduce energy cost.

Source: Survey Team

In general terms, in order to implement biomass projects, raw material collection, arrangements among stakeholders on raw material supply and product utilization (electricity, fuel, slurry etc), and sustainable project management are needed. Since biomass projects hardly generate profit, subsidies for initial cost or operational and maintenance cost are vital for its promotion.
In Bangladesh, electricity price is generally lower than that of other countries. In addition, electricity generated from biomass resources costs higher than that of general electricity, which could be a bottleneck. In the future, FIT might also become an influential method to promote biomass power generation.

In biomass gasification, the leakage of H_2 and CO should not be permitted, since they are combustible gas. Also, waste management for tar and waste water is required to design the plant. In biogas power generation, H_2S and H_2O should be captured in a biogas purification unit in order to prevent gas engine damage.

2.3.8.Selection of Biomass Derived RE Components

The significance and possibility of Japanese ODA support to IDCOL's ongoing projects and program are shown in the following table. Various supports can be proposed to further enhance the activity in promoting biomass-derived RE in Bangladesh.

Table 2.3-35 Proposed Support Elements for IDCOL's Biomass RE Activities

Category	IDCOL project/program	Proposal project /program
Biodigester	NDBMP program	IDCOL's NDBMP is effective program, which was shown by 22,005 implementations of biodigesters. Since IDCOL has a tentative plan to implement 100,000 biodigesters, the extension of NDBMP can be a target of 2step-loan.
		(Additional project) IDCOL and project organizations recognize effectiveness of larger scale biodigester (more than 20m3 size) at community level. The aim is centralizing small biodigesters that doesn't work effectively.

Category	IDCOL project/program	Proposal project /program
Biomass Gasification	400kW rice husk gasification and silica production	The technology can be effectively replicated by means of low interest loan (10 percent). A candidate for application of a two step-loan.
	250kW rice husk gasification	Difficult to be supported due to its low financial viability.
Poultry Waste Biodigester	50kW project, 350kW of Paragon project and 400kW of Phoenix project	The technology can be effectively replicated by means of low interest loan (9 percent). A candidate for application of two-step loan.

Source: Survey Team

Based on the above table, the three components can be identified to be financially supported by Japan's ODA loan. The IDCOL will be the funding organization for each of these components. Furthermore, the components were selected based on criteria explained in Chapter 4 Section 2 of this report.

The adequateness of prospective three RE technologies is summarized in the table below. NDBMP, as a program is well-established, effective, and vibrant, being a favorable candidate for the component. However, the program is currently not in need for loan. It is rather a grant that is required to support the program. As such, the conformity with the Japanese ODA loan assistance is not fulfilled.

The biomass gasification and biogas power generation technologies are suitable for components that require capital procured at low cost for these to be financially viable. These technologies are also expected to contribute to the activation of agriculture, poultry husbandry, and dairy industries by providing an extra opportunity to obtain cash. These components will also lead to providing electric power that can be efficiently utilized to save the consumption of fuel oils.

Table 2.3-36 Adequateness of Biomass RE Activities as Components

Evaluation Category	Component Candidate		
Evaluation Criteria	Domestic Biodigester (NDBMP)	Biomass (Rice husk) Gasification	Biogas Power Generation
Feasibility of introduction and promotion			
Technical Applicability	YES Technologies and materials are already well proven	YES Proven in one pilot case. Technology is already proven in other countries.	YES. Proven in few pilot cases. Technology is already proven in other countries.
Willingness of Implementing Agency	Limited IDCOL's program is already in full swing with KfW and SNV	YES IDCOL has identified cooperatives that are willing to implement	YES IDCOL has identified cooperatives that are willing to implement
Expected Effect			
Energy-saving Potential	Biogas substitute firewood and kerosene at each farmer household.	Provides electricity to offset fuel power generation. Electricity demand at rice mill factory and cold storage are large and will be substituted by rice husk derived electricity.	Provides electricity to offset fuel power generation. Electricity demand for poultry house is large. The usage for electricity is for air conditioner and lightning at poultry house.
Development effects	Significant effect to relieve the burden of housewives. Provides cleaner environment for cooking.	Supports rural economy by providing extra income for those involved in rice production.	Promotes poultry, husbandry, and dairy industry in rural areas.
Means to secure proper operation /	Every morning's input and cleaning	Five technical staff & four semi-technical staff and some	O&M by sponsors

Evaluation Category		Component Candidate		
	Evaluation Criteria	Domestic Biodigester (NDBMP)	Biomass (Rice husk) Gasification	Biogas Power Generation
	maintenance		manual labors are needed for O&M (Thakurgaon Plant)	O&M cost unknown
Economic viability				
	Market size and demand Expenditure	Biodigester installation number by participating organizations is 1,233,886. Average unit initial cost is USD500. Then market size of biodigester is BDT 50,000 million.	Actual introduction number of rice husk gasification is still few. But large scale of rice mill factory is target. Large scale of rice mills (50t/day) can be targeted.	Actual introduction number of poultry biodigester with power generation is still few. More than 10,000 heads of poultry farms can be targeted.
	Financial viability	Socially viable but financially marginal. 500 × 83 BDT/1500kg-fuelwood [56]=5,685BDT/kW (1500kg-fuelwood: 1500 × 5.35 kWh[57] / 365 days / 3hour = 7.3 kW)	Marginal BDT 91.94 million / 400kW = BDT 0.23 million / kW IRR: 30.76%	Marginal BDT 149 million /400kW = BDT 0.37 million / kW IRR: 24.00%
	Operation & maintenance cost	Each farmer operates biodigester.	Annual cost for general and administrative expense and salary and allowances: BDT3,034,730=36,563USD	Maintenance cost is BDT 389,333. Salary expenses assumption is BDT 35,000 /month=BDT 420,000
Applicability of the Supporting Scheme				
	Conformity between borrowers category and supporting scheme	NO Participating Organizations are seeking for grant rather than loan.	Debt is 70 percent of total initial cost. It will be paid back within seven years. Might be combined with other grants.	Debt is 70 percent of total initial cost. It will be paid back within seven years. Might be combined with other grants.
	Market distortion	KfW sees that additional loan may not support the project	Possibility of applying supply pressure on rice husk that could affect rice parboiling.	No
Social and Environmental Considerations				
	Means to avoid negative effects	Waterproofing at digester and slurry tank Biogas purification for sulfur removal Soil analysis to avoid over injection of slurry	Install scrubber to collect dust generated through gasification Install waste water management system for tar generated through gasification.	Waterproofing at digester and slurry tank Biogas purification for sulfur removal Soil analysis to avoid over injection of slurry
Adequateness as Components		NO	YES	YES
Primary Reason		Loan is not currently required for the project.	Will support agricultural industry. Suitable for two-step loan	Will support agricultural industry. Suitable for two-step loan

Source: Survey Team

NDBMP is operated under a separated organization from the other activities of IDCOL. IDCOL explains that exclusivity of NDBMP is a requirement from the other stakeholders. Due to the necessity to maintain an appropriate balance of loan and grant, NDBMP was not regarded as a candidate for JICA-REDP Component, in which loan will be the major source of funding.

[56] Refer to Table 2.3-3
[57] Calorific value of fuel wood is 5.35 kWh/kg

BOX 3: Are these Proven Technologies?

Examples of Biomass gasification (rice husk) other than in Bangladesh

Country	Sites
India	More than 100 facilities in West Bengal, Uttar Pradesh by Ankur Scientific Energy Technology Pvt. Ltd
Myanmar	Lin Tha Village, Thandwe Township, Rakhine State (awarded by ASEAN in 2006)
Cambodia	Battambang Rice Mill for thermal usage
Japan	JA Niigata for heat source in bioethanol production factory by Satake corp.

Examples of Biogas Power Generation (Poultry wastes fermentation) other than in Bangladesh

Country	Sites
China	The Minhe Animal Husbandry, Penglai City in Shandong Province (GE,3MW)
United Kingdom	Ynergy. Ltd (ENER-G,450kW CHP)and Gloucestershire town, Cirencester (Alfagy,260kW CHP)
Thailand	Saha Farms Co, Ltd (NEDO, 20kW)

Rice husk gasification technologies are already implemented in India, Myanmar, Cambodia, and Japan. Especially Ankur Scientific Energy Technology Pvt. has already installed more than 100 gasifiers around India. Japanese engineering company "Satake" have the same original technology from India and installed in Niigata, Japan.

The largest size of poultry waste fermentation with power generation is China's practice which handles 300t of poultry waste and 50t of waste water per day. Hitachi engineering and service has the experience to install in Thailand with NEDO project in Japan. There are two practices in United Kingdom for CHP by poultry waste fermentation.

2.4. Energy Efficiency and Conservation (EE&C)

2.4.1.Overview of EE&C Measures in Bangladesh

(1) Structure

The Structure of EE&C measures in Bangladesh with regards to EE&C is outlined below. The power outages are frequent in Bangladesh, and the government's main focuses are on expansion of generation capacity and the electrification of non-electrified areas. In the areas of EE&C, there are movements toward establishment of Sustainable and Renewable Energy Development Authority (SREDA: a body for promotion of renewable energy and EE&C measures), and the introduction of labeling of electrical appliances. However, these policies have not yet been introduced as the SREDA proposal is currently awaiting parliamentary approval, which is currently being delayed as parliament has been going through budgetary session. However, it is expected to go through parliament before the end of the year.

Table 2.4-1 Structure of EE&C Measures in Bangladesh

Category	Item	Details
Regulatory authority	SREDA establishment plan	There is a plan to establish SREDA, but not yet founded. As of now, the Ministry of Power, Energy and Mineral Resources (MoPEMR) is responsible for various energy saving measures.
Industry sector	Energy management scheme	There are currently no established energy management schemes.
	CO2 regulation	There are no regulations regarding the reduction of CO2.
	Energy savings criteria of equipment	Currently none; UNDP is acting to formulate labeling scheme.
Commercial and residential sector	Mandatory photovoltaic panel installation for new houses	Photovoltaic panel installation is mandatory for new houses by the executed decision of Ministry of Power, Energy and Mineral Resources (MoPEMR).
	CFL adoption	CFL is now widespread. However, as of today no regulations to mandate CFL adoption.
	Labeling of electric appliances	Energy Star Labeling for electric appliances through BSTI is considered by MoPEMR, However, as of today there is no progress.
	Building code	There are criteria regarding energy savings for buildings (Building Code 2006).
Consumer electric / gas savings regulation*1	Demand side management	Early shop closure at 8pm, and prohibition of irrigation at daytime are encouraged.
	Metering	Electricity pre-payment meters are in part introduced. Fixed amount without metering for residential gas.
	Pricing	No energy saving incentive for gas with fixed amounts.

*1: The study focuses on energy savings on the demand side; generation and distribution in beyond the scope
Source: Compiled by the Survey Team

The most comprehensive information available on Bangladesh's current situation for EE&C potential is a roadmap prepared by GTZ (now GIZ) and the WB in 2009.[58] The Roadmap identifies 19 projects as the practical and effective measures that should be carried out to promote EE&C. Among these, four measures are based on RE while fifteen other measures described in the following figure are identified as priority EE&C measures. Although these priority projects have been identified so far, all of them are yet to be implemented.

Technology Name	Description		
Generation	Utilizing pressure reduction in natural gas supply for power production	Supply side is out of scope in this study	
	Combined Cycle Gas Turbine (CCGT) for baseload		
	Aero derivative Gas Turbine for peaking		
Transmission / Distribution	Metering household and commercial gas water heating usage		
Residential Commercial	Improved natural gas cooking stove	Cooking	
	Commercial and industrial FL re-lamping program	Lighting	
	Fluorescent lamp reflectors		
	Passive cooling of commercial building	Air conditioning	
	Ceiling fan replacement program		
Industrial	Retrofitting urea fertilizer plants to improve EE&C	Specific industrial sub-sector	Industry is generally out of IDCOL's activity
	Bagasse cogeneration at sugar mills		
	Steel mill furnace rehabilitation		
	Industrial boiler retrofit	Applicable industry wide	
	Variable speed drive for industrial motors		
	Cogeneration with captive generator		

Source: Compiled by the Survey Team based on GIZ study results

Figure 2.4-1 Priority Measures for EE&C Identified in the Roadmap

These identified 15 measures can be categorized as generation side, transmission/distribution side, residential/commercial sector, and industrial sector. Among these sectors, generation and transmission/distribution are out of scope in this study. Industrial sector is basically out of IDCOL's activity unless industry is related with infrastructure or the industry is not accessible to commercial bank loan. Hence, the primary focus of this study will be in the residential and commercial sectors. In this sector, GIZ identified energy savings potential in lighting, air conditioning, and cocking areas.

(2) Regulatory Authorities

The current regulatory authority in the energy sector is Ministry of Power, Energy, and Mineral Resources (MoPEMR). The ministry has a technical advisory organization called Power Cell. As a regulatory and execution body in the electricity sector, Bangladesh Energy Regulatory Commission (BERC) was established as an independent organization outside MoPEMR. BERC's main responsibilities include determining efficiency standards, electricity tariffs, and issuing licenses.

In the areas of renewable energy and EE&C, the establishment of SREDA has been envisaged. SREDA is supposed to become a promoter and technical advisor for renewable energy and EE&C measures. However, while there have been discussions over the last few years regarding the establishment of SREDA, the organization is yet to be established. It is understood that SREDA will not have any regulatory powers, and will not issue funds to support EE&C

[58] GTZ (2009)

implementation. However, it will assist in determining tariffs for renewable energy but it will need to be approved by BERC.

BERC was established through an Act entitled "Bangladesh Energy Regulatory Commission Act, 2003". In order to encourage private investment in the generation of electricity, transmission, transportation, marketing of electricity, gas resources, and petroleum products; BREC ensures transparency within the utility industry, issuing, cancellation, amending, license conditions determination, and tariff determination. BERC is not active in the EE&C regulation at this moment. However, BERC may introduce regulations in regard to EE&C with assistance from SREDA.

The draft for SREDA was revised several times including the changes made on cabinet advice, which meant that there was a delay before it could be presented to the cabinet again. The bill to establish SREDA has now been approved by the cabinet, and now waiting to be approved by the parliament. It is expected to go before parliament during the next session, which is expected to begin in the latter part of 2012.

2.4.2. EE&C Measures for the Industry Sector

There is a survey on the energy usage in the industry sector in Bangladesh conducted by GTZ in 2006. Several sectors with EE&C potential for EE&C were identified in the survey. These include scrap steel industry, and cement clinker grinding mills. Furthermore, the survey GTZ has not implemented any specific projects in the industrial sector. There are currently no regulations requiring businesses to reduce CO2 emissions, or systems for energy management applicable to the industry sector activities in terms of policies and regulations, The Ministry of Environment and Forests (MOEF) issued a directive which requires fade out of inefficient brick making kilns, but the main objective of this directive is the mitigation of air pollution rather than energy conservation.

(1) Energy Management Scheme

There are currently no established energy management schemes in Bangladesh and immediate plans to establish it.

(2) CO2 Regulation

The CO2 abatement or trading schemes are not in place in Bangladesh. There are no immediate plans to establish them.

(3) Energy Savings Criteria of Equipment

Currently, there are no energy savings criteria of equipment. However, UNDP is acting to formulate labeling scheme for some industrial equipment.

(4) Brick Kiln Efficiency Improvement

Brick making industry is a major polluting industry sub-sector in Bangladesh. There are six basic types of brick kilns in Bangladesh: (i) bulls trench kiln (BTK), (ii) fixed chimney kiln (FCK), (iii) improved zigzag kiln, (iv) vertical shaft brick kiln (VSBK), (v) Hybrid Hoffman kiln (HHK), and (vi) tunnel kiln. From (i) to (vi), BTK is the least energy efficient and most polluting. The tunnel kiln is among the most energy efficient and least polluting. According to ADB[59], 92 percent of the 4,880 brickfields in Bangladesh are using the highly polluting FCK design.

To mitigate air pollution, Ministry of Environment and Forests (MOEF) issued a directive on 15 July 2010, requiring that (i) no annual FCK licenses will be renewed after September 2012; (ii)

[59] http://pid.adb.org/pid/LoanView.htm?projNo=45273&seqNo=01&typeCd=3

environmental clearance favor more energy efficient improving zigzag kilns, VSBKs, and HHKs; and (iii) all FCKs cease to exist from September 2013. However, given the tightening liquidity and credit condition in the financial system, there is a lack of targeted finance to complement the government effort to help construct more energy efficient brick kilns.

In this context, The World Bank and ADB have been provided credit facility and technical assistance. ADB provided USD 20 million for the credit facility as a catalyst for domestic capital, to help upgrade cost of FCKs, to improved zigzag kilns, and construction of more advanced VSBKs, HHKs, and tunnel kilns.

(a) FCK facility (b) Manual casting

Source: Survey Team

Figure 2.4-2 FCK Brick Making Facility

2.4.3. EE&C Measures in Commercial and Residential Sectors

The office buildings, shopping malls, hospitals, schools, and residential buildings are categorized in these sectors. The measures for energy savings in the commercial and residential sectors are as follows:

(1) Mandatory Photovoltaic Panel Installation for New Houses

An executive order of MoPEMR "New electricity connection and inclusion of solar panels" (No. 27.052.031.00.00.001.2010-847) stipulates mandatory solar photovoltaic (PV) panel installation.

On the first 50 percent of the applicants who have received sanction of more than 2 kilowatts and have paid the compulsory demand note amount will be requested to install solar panels at different rates as stated below. Those who will install solar panels will be given priority in providing connection.

- Consumers who have received sanction up to 2 kW will not be requested to set up solar panels;
- For domestic consumers who have received sanction of more than 2 kW (2,000 watts) will be requested to install solar panel with capacity of 3 percent of total demand;
- Commercial and industrial consumers who have received sanction up to 50 kW will be requested to install solar panel with capacity of 7 percent of only light & fan load. Those who have received sanction of more than 50 kW will be requested to install solar panel with capacity of 10 percent of only light & fan load, and the garment industries will be requested to install solar panel with capacity of 5 percent of only light & fan load.

Source: Survey Team

Figure 2.4-3 PV Panels Installed on the Building Roof

(2) Replacement of Incandescent Bulbs with CFLs

The Compact Fluorescent Light (CFL) is a moderate new technology in Bangladesh. Till now, the product has never won with consumer confidence due to several factors: unawareness and high upfront cost. Recently, Bangladesh Power Development Board (BPDB) has taken a decision to conduct a four-month long feasibility study on promotion of CFLs in different areas of the country and to identify its local market. It is desired that after completion of the study, BPDB will be in a better position to initiate actions to have this energy efficient product further penetrated.

In early 2009, when the MoPEMR, and Rural Electrification Board (REB), with support from the World Bank, came up with the “Efficient Lighting Initiatives of Bangladesh (ELIB)” program to help bridge the supply-demand imbalance in the Bangladesh’s power sector. The key to the program was the promotion of high quality CFLs that are 4-5 times more energy efficient than incandescent bulbs and last much longer. As demonstrated in many countries by the World Bank, large-scale deployment of CFLs can contribute to reducing peak electricity demands. In the first phase of ELIB, 10.5 million CFLs were decided to be distributed by REB and four other participating utilities to their residential consumers free of charge, which according to conservative estimates was expected to reduce electricity demand by 300MW.

On 19th of June 2010, almost 5 million energy efficient CFLs were distributed in exchange of incandescent lamps among residential consumers in selected areas of 27 districts of Bangladesh.

This operation was nationally coordinated over 1,400 urban and rural distribution centers. Building on this positive experience, another 5 million CFLs were also planned for distribution in September 2010 within the same phase. In addition, the GoB requested the World Bank for additional support for deployment of another 17.5 million CFLs under the second phase of ELIB.

(3) Labeling of appliance

For the cost effective implementation of energy efficiency and for resourceful demand side management of electricity, the GoB is actively participating in initiatives such as “Barrier Removal to the Cost-Effective Development and Implementation of Energy Efficiency Standards and Labeling” (BRESL), which is sponsored by the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF). The BRESL initiative aimed at rapidly accelerating the adoption and implementation of energy standards and labels (ES&L) program in Bangladesh, which will facilitate the transformation of the manufacture and sale of energy-efficient appliances and equipment. The project activity started from 2010 and is expected to accomplish its expected outcomes by 2014.

Table 2.4-2 BRESL Project Overview

Official title	Barrier Removal for Energy Standards and Labeling (BRESL)
Timeframe	July 2010 – June 2014
Implementing partner	Bangladesh Standards and Testing Institute
Development partner	UNDP (GEF; Global Environment Facility)
Budget	USD 230,000
Participating countries	Bangladesh, China, Indonesia, Pakistan, Thailand and Vietnam

Source: Compiled by the Survey Team based on BRESL website information

Some of the achievements of this project to date are as follows:

- Energy Efficiency Standards & Labels of CFL & Electronic Ballast for Mandatory Policy have been completed (For CFL as BDS-IEC #, 1734, 1735 & 1761, and for Electronic Ballast as BDS-IEC# 60921)
- The Voluntary Policy for Standards of Electric Fan & Electric Motor has been formed and waiting for BRESL’s final approval.
- The process of Voluntary Policy for EE Standards of Room Air-Conditioners and Refrigerator have been formed and waiting for BRESL’s final approval

(4) Improved Cooking Stove (ICS)

The Improved Cooking Stove (ICS) is a replacement for brick made cooking stove with aim to curb smoke emissions from open fires inside households and reduce fuels (mainly biomass fuel). GIZ provided technical assistance to assist manufacturing of ICS and its promotion. GIZ believe that ICS can be commercially diffused without financial assistance, because ICS requires less biomass and price difference between ICS and conventional cooking stove is marginal.

(a) Conventional cooking stove

(b) Improved cooking stove

Source: GIZ, "Promotion of Improved Cock Stove in Bangladesh"

Figure 2.4-4 Improved Cooking Stove

2.4.4. Consumer Electricity / Gas Savings

With regard to the importance of saving electricity and gas consumption in residential sector, the measures are treated as an independent category of EE&C measures. Following measures are taken for consumer electricity and gas usage savings.

(1) Electricity Peak Reduction

BPDB, by means of its executive order (Memo: 181-BUB/SB/circular/12), request the followings to reduce electricity peak demand. However, in the event that these rules are not followed, as there is no penalty system in place and enforcement is not guaranteed.

- Markets and shops close at 8 o'clock
- Irrigation can only be done at night and at non-peak hours
- The staggering of holidays of markets
- The usage of 2 time meters, i.e. using meters to record peak hour and off peak hour consumption (where different rates for peak hours and off peak hours are applicable)
- The setting of Air Cooler temperature control at 25°C in government offices

(2) Electricity Pre-Payment Meter

As a countermeasure for the nonpayment of charges, the distribution company BPDB, has started to introduce pre-payment meters in some part of the urban areas. After installation, it is envisaged that revenue would increases from the reduction of non-payment, and feeder system loss decreases.

Table 2.4-3 Introduction of Pre-payment Meters and Results

Project site	No. of meter	Per meter collection before pre-payment meter [BDT million/yr]	Per meter collection after pre-payment meter [BDT million/yr]	Bill collection increase [%]	Feeder system loss before pre-payment meter	Feeder system loss after pre-payment meter	Benefit	Payback period
Shajalal Upshahar feeder, Sylhet	2400-1P 20-3P	Avg. 1.19	Avg. 1.54	38.00%	19.64%	7.41%	Per month revenue increases BDT 0.35 million	5 yrs 6 mon
Town-01 Feeder, Sirajgonj	3039-1P 76-3P	NA	Avg. 0.76	30.00%	20.26%	18.00%	Per month revenue increases BDT 0.76 million	6 yrs
Hospital Feeder, Bogra	3400-1P 104-3P	NA	Avg. 1.00	NA	19.11%	7.75%	Per month revenue increases BDT 0.76 million	7 yrs 6 mon
Agrabad H-17 Feeder, Chittagong	5789-1P 204-3P	NA	Avg. 0.30	NA	23.97%	NA	NA	Assessment ongoing

Source: Power Cell

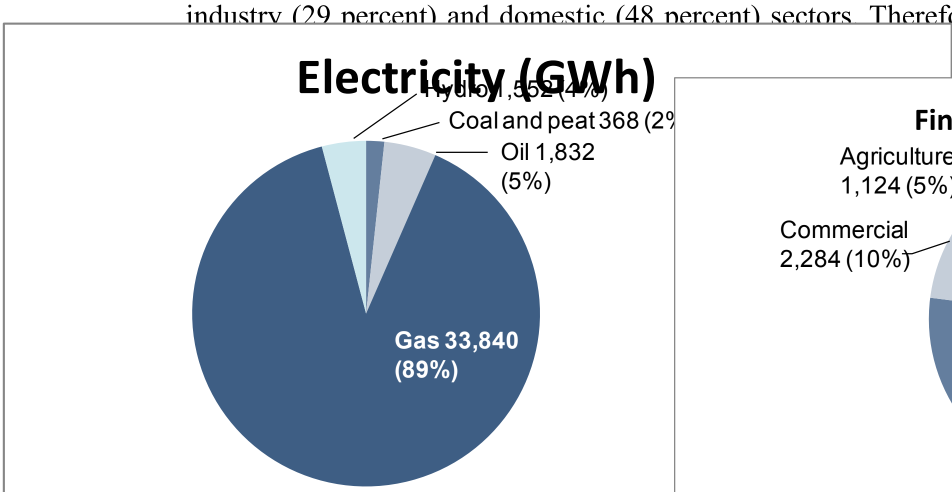
(3) Gas metering

For domestic customers, gas bills are charged based on the number of burners in the household but not the metering. Industrial customers are billed based on m3 usage and by metered.

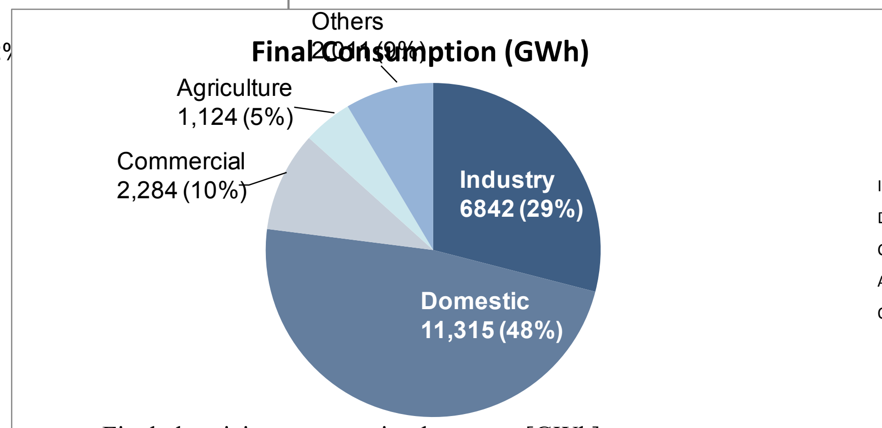
2.4.5. Issues and Future Directions for Promotion of EE&C Measures

(1) Sectors with Intensive use of Electricity

The following figure shows electricity generation by fuel source and final consumption by sector. According to the Power Cell statistics in 2011, most of electricity is consumed by industry (29 percent) and domestic (48 percent) sectors. Therefore, EE&C sub-projects should



Electricity generation [GWh]



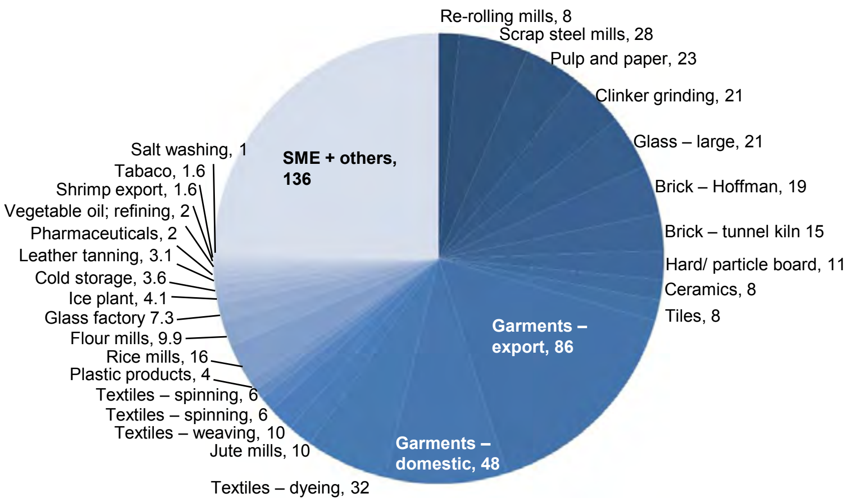
Final electricity consumption by sector [GWh]

Source: Generation data compiled from IEA website: Electricity/ Heat in Bangladesh in 2009. Final consumption by sector data compiled from Power Cell 2011 statistics.

Figure 2.4-5 Electricity generation by Source and Final Consumption by Sector

Among these sectors, industrial sector is consisted from many different sub-sectors, such as garment manufacturing and steel rerolling. Exact energy usage breakdown by industrial sub-sectors are not available. However, as part of a study conducted by GIZ Sustainable Energy for Development (SED) initiative, estimated energy usage breakdown by industrial sector could be compiled as shown in the next figure.

Garment, textile, and jute sectors are seen to be the biggest energy consuming sub-sectors. As for energy intensive industries, steel mill (scrap steel mills and steel rerolling mills), brick making factories, glass factories, clinker gridding factories are the major energy consumers.



Source: Compiled by the Survey Team based on GIZ study results

Figure 2.4-6 Electricity Generation by Source and Final Consumption by Sector

(2) Summary of Existing EE&C Projects

Details of six major EE&C projects conducted with the support of the government and international development partners are outlined in the following table. All of the interventions are done on public support basis; none of them on business basis. With the support to the brick kiln industries the users of installed facilities are expected to pay back, based on their ability to pay the initial cost incurred. The ELIB project to disseminate CFLs is conducted on a giveaway basis. The measures to promote EE&C through business are yet to be introduced.

Table 2.4-4 Summary of Existing EE&C Projects

Technologies	CFL replacement (Efficient Lighting Initiatives of Bangladesh (ELIB))(World Bank)	Financing Brick Kiln Efficiency Improvement Project (ADB)	Brick Kiln Efficiency Project (World bank)
Units deployed / Project overview	10.5 million CFLs distributed to household through REB	5 hybrid kilns; 20 vertical shaft kilns; 200 kiln upgrades	Financial support for greener kilns including Vertical Shaft Brick Kiln
Deployment period	2010	June 2012 – June 2015	August 2009 – June 2016
Ownership	• Users	• Brick kiln owner	• Brick kiln owner
Involvement of international development partners	[Grant]: World Bank	[Loan]: ADB	[Loan]: World Bank
Implementing Entity	Rural Electrification Board: REB	Bank and Financial Institutions Division	Industrial and Infrastructure Development Finance Co.
Project scheme and form of income	• Distribution of equipment	• Loan for procurement	• Loan for procurement
Lessons from the project	• Poor quality of procured CFLs. Quality control in procurement is important.		• Proved effective to reduce air pollution
Start of construction	2010	2012	2009
Cost (USD)	15 million	50 million	14.3 million
Financial arrangement	World Bank (100%)	ADB 20 million (40%)	Local sources of Borrowing Country (35%)
		Ordinary Capital Resources 30 million (60%)	Borrowing Country's Financial Intermediary (65%)
Financial viability	Public intervention not financially viable	Payback of borrowed loan designed with regard to the users' ability to pay.	Payback of borrowed loan designed with regard to the users' ability to pay.
Public incentives (subsidy, tax exemption, preferential loans, etc)	CFLs distributed are Exempted from Import Tariff	N/A	N/A
Preferential terms for imported goods	N/A	N/A	N/A
Foreign investors	N/A	N/A	N/A
Promotional measures for investment	N/A	N/A	N/A
Bottleneck for deployment	• Quality of CFLs will need to be confirmed. • Concern on mercury pollution.		

Source: Compiled by the Survey Team

Continued from previous page

Technologies	Promotion of Improved Cook Stove in Bangladesh (GIZ)	Improving Kiln Efficiency in the Brick Making Industry (UNDP)	Barrier Removal for Energy Standards & Labeling (UNDP)
Units deployed / Project overview	Technical assistance to help manufacture Improved Cook Stove (ICS) and its promotion	Investment in 16 demonstration kilns	ES&L for Motors, Transformers, Air Conditioners
Deployment period	2008	January 2010 – December 2014	June 2009 – December 2013
Ownership	NA	• Brick kiln owner	NA
Involvement of international development partners	Technical assistance	[Loan]: UNDP	Technical assistance
Implementing Entity		UNDP, CEA, Xian Institute of Wall Building Materials	In cooperation with Bangladesh Standards and Testing Institute
Project scheme and form of income	N/A	• Loan for procurement	NA
Lessons from the project	• Significant effect to improve the living condition of women.	• Bick making practice needs to change from making solid brick to hollow bricks.	
Start of construction	NA		NA
Cost (USD)	NA	3 million	650,000
Financial arrangement	GIZ (100%)	GEF (100%)	GEF (100%)
Financial viability	Public intervention not financially viable	Payback of borrowed loan designed with regard to the users' ability to pay.	Public intervention not financially viable
Public incentives (subsidy, tax exemption, preferential loans, etc)	N/A	N/A	N/A
Preferential terms for imported goods	N/A	N/A	N/A
Foreign investors	N/A	N/A	N/A
Promotional measures for investment	N/A	N/A	N/A
Bottleneck for deployment			• Foreign and local manufacturers' participation is essential

Source: Compiled by the Survey Team

2.4.6. Selection of EE&C Sub-Projects

The EE&C sub-projects candidates are shortlisted based on the magnitude of energy consumption of sub-projects. For shortlisted candidates, applicability of the supporting scheme was considered.

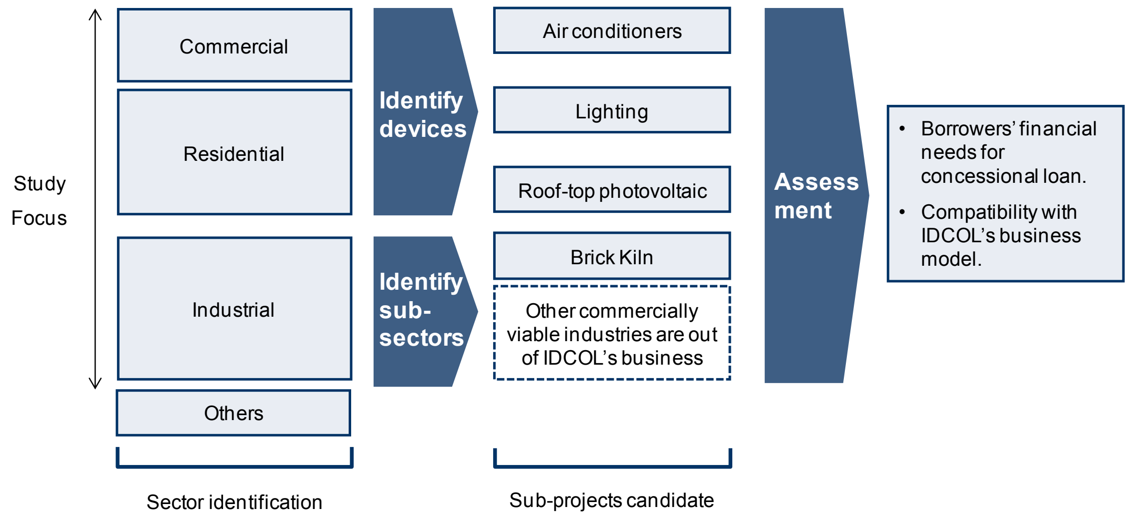
(1) Shortlisting by Magnitude of Energy Consumption

The Sub-project candidates should be selected from major energy consuming sectors which are identified in the previous sub section. By sector bases, the residential and commercial sectors accounted for 58 percent of electricity consumption according to the 2011 Power Cell statistics, and these sectors are selected. Although statistical breakdown of devices among commercial and residential sectors in Bangladesh is not available, air conditioners (AC)/chillers and lighting are deemed to comprise a significant portion of the energy consumption within residential and commercial sectors.

Another option for energy saving is to offset the use by means of other energy sources. Installing roof-top solar PV panels can effectively reduce energy demand in buildings. As a result, air conditioner/chillers, lightings, and roof-top solar PV are selected as sub-projects for the residential and commercial sectors.

As for the industrial sector which is the second biggest energy consuming sector, steel scrap mills, garment, textile, jute, and brick making sectors are large energy consumers. According to IDCOL due to its charter, it is not able to finance industrial sectors unless the industry is related with infrastructure (which include the power generation sector), or the industry is not accessible to commercial bank loan. Practically, in the industrial sector, brick industry is the only candidate sub-sector.

From the viewpoint of EE&C, brick kiln improvement has limited impact on energy conservation as brick kiln does not consume electricity or gas but low rank coal. Such low rank coal is not traded in the seaborne market. Thereby, mitigation of low rank coal usage in the brick making sector would have little impact in the context of conservation of internationally tradable energy source. In addition, other development partners are active in assistance in the brick making industry with aim of mitigation of air pollution. Therefore, brick making industry should be less prioritized in terms of EE&C sub-project candidates.



Source: Survey Team

Figure 2.4-7 Identification of Sub-Projects candidate

(2) Shortlisting by Applicability of the Supporting Scheme

1) Air Conditioner and Lighting for Household

There are no existing concession loan provision mechanisms for household appliances. Therefore, such loan program should be demonstrated first and thus not dispersible at this stage.

2) Chillers and Lighting for Commercial Building

According to interviews with IDCOL and building developers, it is unlikely for developers to apply for a different loan only for building equipment such as chillers when they can access ordinary bank loan for construction of entire building including necessary equipment.

3) Roof-top PV

The buildings are mandated to install roof-top PV are large, so the comparison with capital requirement of building construction cost, and additional cost burden for PV is marginal for building developers. Therefore, mandatory roof-top PV installation is bankable through commercial banks.

(3) Adequateness of EE&C Technologies as Sub-Projects

Table 2.4-5 Adequateness of EE&C Technologies as Sub-Projects

Evaluation Category / Evaluation Criteria	Sub-project candidate: Air Conditioner	Lighting (LED)	Rooftop PV	Brick Kiln
Feasibility of introduction and promotion				
Technical Applicability	Yes	Yes	Yes	Yes
Willingness of Implementing Agency	Not willing	Willing for LED in grant scheme	Not willing	Limited willingness
Expected Effect				
Energy-saving Potential	Very large (approximately 50% reduction*1)	Limited (CFL – LED conversion has limited saving potential)	Depends on the size of panel	Limited (No electricity or gas saving. Only coal saving)
Development effects	N/A	N/A	N/A	Supports the local industry on which rural population is resorting
Means to secure proper operation/ maintenance	N/A	N/A	O&M cost unknown	O&M cost unknown
Economic viability				
Market size and demand Expenditure	Large	Large (Any buildings typically use bulb lamps, thereby market is large)	Small (only newly built large buildings)	Large
Financial viability	Mid (Initial price difference can be as high as 20%-30%)	Low (CFL is as low as USD 1.5. LED costs more than USD 10. Too expensive compared to CFL)	Low (System cost is around USD 2000/kW. Generation cost higher than the grid)	Low (Limited incentives for kiln owners for upgrading)
Applicability of the Supporting Scheme				
Conformity between borrowers category and supporting scheme	No (Borrowers unlikely apply for different loan only for air conditioner)	No (Borrowers do not typically use loan to buy lamps. Rural Electrification Board is better suited to implementation agency)	No (Utilities are better suited implementation agency)	Yes
Market distortion	No Provided that the sub-project will be integrated with the existing interventions	Yes The project cause conflict with the existing ELIB project	Yes Fund for PV installation are usually included in the building development cost	No Provided that the sub-project will be integrated with the existing interventions
Social and Environmental Considerations				
Means to avoid negative effects	N/A	LED should be properly collected.	Batteries should be properly collected and recycled	To use more energy efficient to improved kilns.

Adequateness as Sub-Projects	Not suitable	Not suitable	Not suitable	Not suitable
Primary Reason	Borrowers is unlikely to apply for different loan only for air conditioner	Borrowers do not typically use loan to buy lamps	Without financial assistance, building owners are financially capable of installing PVs	No impact on electricity or gas conservation

Source: Survey Team

The candidate technologies for sub-projects in EE&C are identified as: air conditioners, LED lighting, rooftop PVs, and Brick kiln. Interventions to industry other than brick industry were omitted from the list of potential sub-projects because these are out of IDCOL's scope for concessional loan extension.

The measure on air conditioners and rooftop PVs were found to be inadequate because the implementing organization could not be identified. LED lighting promotion was found to be incompatible with the scheme of two step loan via IDCOL. Furthermore, although the support for brick kiln industry is feasible and has huge significance to development effect, it has little relevance to energy conservation for improving the power supply condition. This is due to the fact that the intervention will not directly lead to saving natural gas, oil or coal that is traded in international market.

3. Institutional Arrangements for Project Implementation

3.1. Project Executing Agency

3.1.1. Status of IDCOL

Infrastructure Development Company Limited (IDCOL) is a Government-Owned Non-Banking Financial Institution (NBFI). It was established in 1997 pursuant to two agreements: (i) the Development Credit Agreement executed between the GoB and IDA, and (ii) the Project Agreement executed between IDA and IDCOL. It is registered as a public company limited by shares under the Companies Act 1994. IDCOL's status as a Non-Banking Financial Institution was selectively decided for the reason that IDCOL should not be regulated under capital adequacy requirements as with the banks.[60]

IDCOL is playing a major role in bridging the financing gap for developing medium and large-scale infrastructure and renewable energy projects in Bangladesh. The company now stands as the market leader in private sector energy and infrastructure financing in Bangladesh.[61] [62]

IDCOL is the largest local financier in private sector infrastructure and renewable energy financing. IDCOL is funded by the Government and international development partners, i.e. the World Bank (WB), Asian Development Bank (ADB), KfW, Gesellschaft für Internationale Zusammenarbeit (GIZ), Islamic Development Bank (IDB), SNV and others. IDCOL and its activities are under the supervision of the Ministry of Finance (MOF), and Economic Relations Department (ERD).[63]

IDCOL's mission is to promote economic development in Bangladesh by encouraging private sector investment in energy and infrastructure projects. IDCOL's primary objectives, as stipulated in its constitutional document "Memorandum of Association", are:

- to receive and accept from the Government of Bangladesh and /of any other source whether foreign of local including official or semi official development sources, funds and moneys by way of loans, aid, donations, contributions and the like and to lend or advance same or any part or portion thereof to any person, company, firm or corporation or other legal entity as may be thought fit and on such terms and conditions and with or without interest or security or otherwise as may be determined by the Company for the development of private sector infrastructure projects in Bangladesh and under arrangements/concessions which facilitate or enable persons to Build, Operate and Transfer (BOT) and or Build, Operate and Own (BOO) same and generally to finance the construction, development and use of infrastructure facilities in Bangladesh;

[60] NBFIs are financial institutions which are regulated under the Financial Institution Act, 1993 and controlled by Bangladesh Bank. Major sources of funds of NBFIs are: term deposit (at least six months tenure), credit facility from banks and other NBFIs, call money as well as bond and securitization.

[61] IDCOL website information

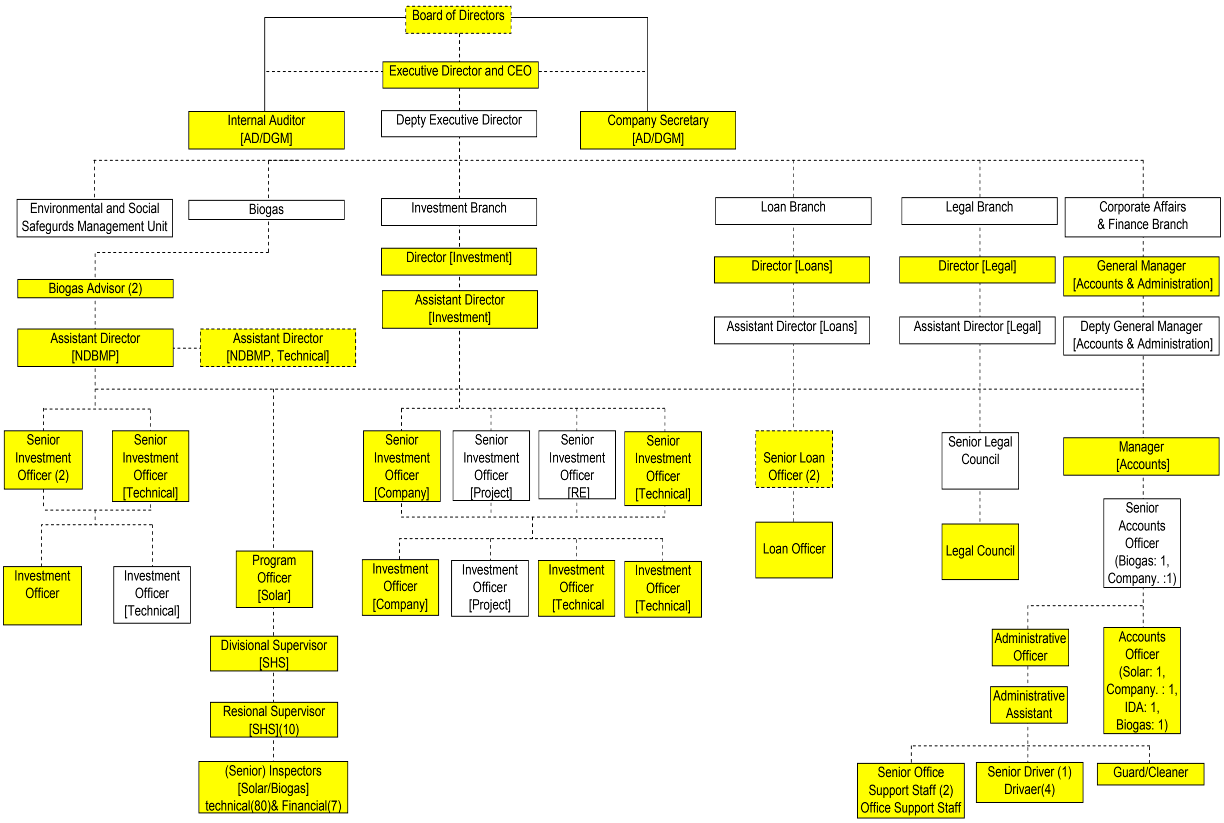
[62] Bangladesh Private Sector Infrastructure Guidelines (2004) defines "Large Projects" as those requiring the cost in excess of USD 25 million.

[63] IDCOL reports to MOF-ERD as the supervising organization. IDCOL, as regulated by the Bangladesh Bank as a Non-Bank Financial Institution reports to the Bangladesh Bank on its status and transactions. IDCOL does not bear other reporting responsibilities to any other governmental bodies (including MOF Bank and Financial Institutions Division) except for financial status report to its funding organizations which are the MOF Financial Division (for funds extended from the international development partners) and the Ministry of Power, Energy and Mineral Resources (MoPEMR) through which the World Bank RAPSS fund is being chanelled.

- to promote, encourage and finance private Sector investment in all major infrastructure sectors including power, telecommunications, water and waste water, transport, solid waste management and all related areas, sectors and facilities and for such purposes to identify, appraise, evaluate, recommend, develop, finance, negotiate, implement and supervise suitable infrastructure projects in Bangladesh in conjunction with foreign and/or local private sector investors, commercial banks, investment banks, merchant banks and other financiers and promoters whether in or outside Bangladesh.;
- to engage fund managers, investment advisers, management consultants or any such other advisers or staff to manage the business of the Company, to advise the Board of Directors of the Company and to do all such things as the Company may require to be done in order to comply with its objects.

3.1.2. Organization

IDCOL, as of July 2012, has 170 staffs, of which 37 are posted at it Headquarters. The management structure of IDCOL takes form in executive director governance, which is commonly introduced in corporations. Its top management body is the Board of Directors under Executive Director and Chief Executive Officer (CEO) who executes the decision of the Board. The Board is represented by members from both public and private sectors. There are 5 branches under the management of Deputy Executive Director, namely Corporate Affairs & Finance Branch, Legal Branch, Loan Branch, Investment Branch, Biogas and Environment & social Safeguards Management Unit.



Note 1): Yellow-colored box means a position which has been already occupied by a nominated person while white box means that a position of the person in charge is yet to be nominated as of April 2012.
Note 2): Number within a parenthesis stands for a number of staffs
Source: IDCOL

Figure 3.1-1 Organization of IDCOL

3.1.3.Governance Structure of IDCOL

(1) IDCOL Board

The IDCOL's Administrative Manual stipulates the structure, functions, and procedures of the corporate management. The IDCOL Board is the supreme managerial body. All decisions at the Board meetings are made under a unanimous accord. Committees, in principle, are also adopting unanimity rule for decision making. Following descriptions are extracted from the manual:

The IDCOL Board consists of special Committees comprising Board members or any other members from outside of the Company for special purposes. The following are the existing administrative committees of the IDCOL Board. Credit Committee Audit Committee Recruitment and Promotion Committee (RPC)
1) Credit Committee: Credit Committee of IDCOL is primarily responsible for reviewing all final term sheets and project appraisal reports before it can be submitted to the Board for approval. The approval of this Committee is mandatory before it can be submitted to the Board for final approval. The Credit Committee also makes recommendations for pricing of all IDCOL loans. The five-member committee is currently headed by the Secretary, and Prime Minister's Office. The other three members are former Secretary, Power division, two members from the private sector, Directors of the IDCOL Board, and the CEO of IDCOL. The Committee reviews loan proposals and make recommendations to the Board. The Credit Committee also provides guidance to the IDCOL Board with regard to IDCOL's role as lender of last resort in private sector infrastructure projects implemented in Bangladesh. While discharging this duty, the committee considers the following: 1. the need for IDCOL's participation in the project as a lender of last resort and; 2. if this participation is required in such project(s), making recommendations to the full Board regarding the extent and nature of such participation.
2) Audit Committee: IDCOL has a two-member Audit Committee comprising two private sector and Directors of the Company. The Audit Committee is to ensure the independence of IDCOL's internal control functions and audit activities in compliance with the requirements established in Development Credit Agreement, Agency and Administration Agreement, various Project Agreements and Boards' decisions. This Committee is responsible for the following: 1. overseeing activities of IDCOL's internal auditor; 2. defining scope of the IDCOL audit and; 3. taking appropriate actions to address any violations of independence that are brought to its attention by IDCOL internal and external auditors.
3) Recruitment and Promotion Committee The Recruitment and Promotion Committee of IDCOL is a six-member committee represented by Chairman, IDCOL, former Secretary, Power Division (Director), Secretary, Prime Minister's Office (Director), two directors nominated from private sector, and CEO of IDCOL. The Committee deals with the recruitment and promotion related activities. The Committee is responsible for reviewing and making recommendations to the Board regarding all new

recruitments and promotions of personnel within IDCOL, including the following:
1. selection of new officials and making recommendations to the board;
2. making recommendations to the board regarding promotions of staff and officials within IDCOL and;
3. making recommendations to the board regarding revisions in organizational structure and pay scale of IDCOL staff and officials.

Source: IDCOL, Administrative Manual

Further to the descriptions in the Administrative Manual, the Credit Risk Management Guidelines stipulates the function of the Credit Risk Management Committee as follows:

The "Credit Risk Management Committee" will be headed by the CEO and comprise heads of investment, loans, accounts and legal affairs. The functions of the Credit Risk Management Committee will:

- be responsible for the implementation of the credit risk policy/ strategy approved by the Board;
- monitor credit risk and ensure compliance with limits approved by the Board;
- recommend to the Board, for its approval, clear policies on standards for presentation of credit proposals, financial covenants, rating standards and benchmarks;
- taking decisions in terms of capital allocation and defining limits in line with the risk strategy;
- decide delegation of credit approving powers, prudential limits on large credit exposures, standards for facility collateral, portfolio management, facility review mechanism, risk concentrations, risk monitoring and evaluation, pricing of facilities, provisioning, regulatory/legal compliance, etc.;
- lay down risk assessment systems, develop MIS, monitor quality of facility/investment portfolio, identify problems, correct deficiencies and undertake facility review/audit; and
- undertake portfolio evaluations and conduct comprehensive studies on the environment to test the resilience of the facility portfolio.

Source: IDCOL, Credit Risk Management Guidelines

In addition to the above committees, an approved panel of lawyers and law firms assists the Board by providing legal advice and support in respect with different agreements and other valuable documents of the Company. Legal advice is provided by the panel on case to case basis.

(2) Internal Control

IDCOL possesses its Internal Control and Compliance Manual, which is in line with the requirement from the Bangladesh Bank. The Manual sets out the standards, components, and principles of control among others. Therefore, it includes the functions or environmental control, risk assessment, institutional control, accounting, management information system, and monitoring.

(A) Components of Internal Controls

- Management oversight and environment for control
- Risk Assessment & Management
- Instituting Controls
- Accounting, Information & Communication Systems
- Self-Assessment & Monitoring

(B) Principles
RESPONSIBILITIES of:

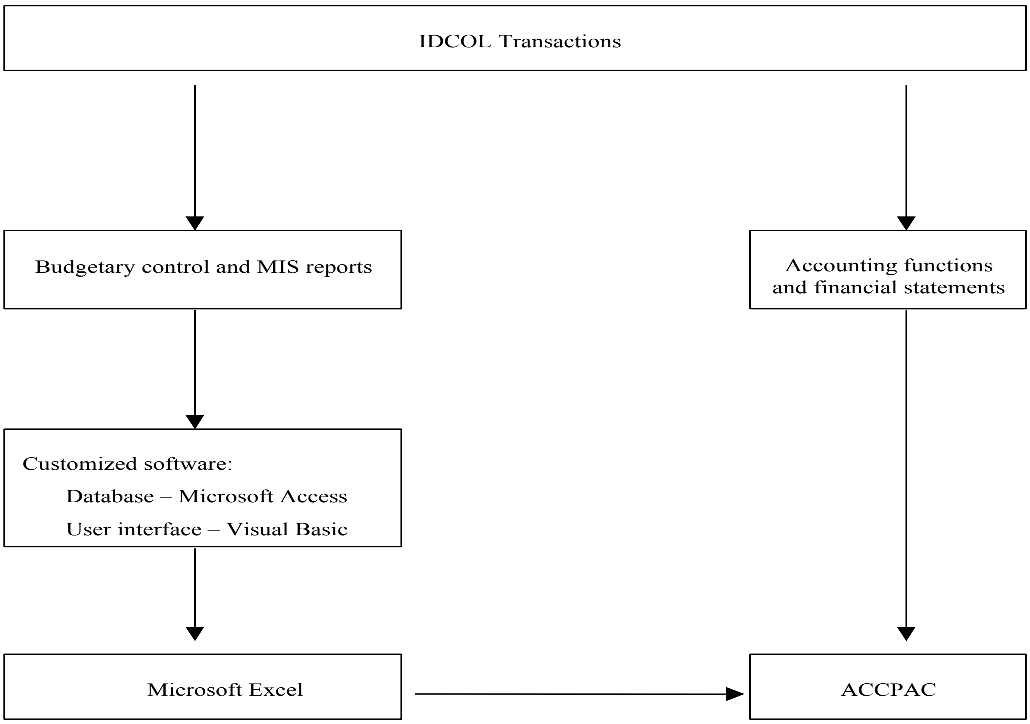
- Board of Directors
- Management
- Auditor Committee
- External Auditor
- Regulator

Source: IDCOL, Internal Control and Compliance Manual

(3) Management Information System

Primarily, the objective of the management information system (MIS) is to capture the transactions of IDCOL. Likewise, to ensure that the expenditure is within budget, maintain proper accounts, produce financial statements, and MIS reports. For the accounting and financial statements, the system is using ACCPAC,[64] a multi-currency off-the-shelf accounting software. For the MIS reports a customized software program is developed using Microsoft Access as its database and Visual Basic as the user interface. Transactions are basically entered into the MIS system where they are subjected to various validations and control, and subsequently the accounting data is thrown from the MIS to Microsoft Excel from where it is read into ACCPAC.[65]

IDCOL has a user's manual for the MIS. Development of MIS user manual is also a requirement by the Bangladesh Bank.



Source: IDCOL, Management Information System Users Manual

Figure 3.1-2 IDCOL Accounting and MIS Flowchart

[64] SAGE ERP ACCPAC
[65] IDCOL Management Information System Users manual

(4) Internal Auditing

IDCOL's requirement and procedure for internal auditing is stipulated in Chapter 5 of IDCOL's Accounting, Audit and Internal Control Manual. One permanent internal auditor is positioned at IDCOL's headquarters and reports to CEO. Internal auditing is conducted in the light of operation and compliance audits.[66] The internal auditor prepares an annual audit plan, obtains approval from the CEO and pursues the audit.

3.1.4. Financial Status of IDCOL

(1) Basic Accounting Policy

The financial statements of IDCOL are prepared under historical cost convention in accordance with generally accepted accounting principles as laid down in the International Financial Reporting Standards (IFRSs) applicable to the company so far as adopted by the Institute of Chartered Accountants of Bangladesh as Bangladesh Financial Reporting Standards (BFRSs). The reported financial statements, i.e. Statement of financial position, statement of comprehensive income, statement of changes in equity, and statement of cash flows are prepared by capturing the transactions of IDCOL. The financial statements of projects accounts are being maintained and prepared separately showing movement of funds, i.e. loans and grants received from various donors, lenders, realization of principal and interest from borrowers, loan and grants disbursed to borrowers, repayment of loans to donors, lenders, etc. These projects accounts are audited and reported separately.

IDCOL's accounting policy as well as its financial statements is consistent with the International Accounting Standards (IAS).

(2) Income Statement

The profit loss account of IDCOL shows that its total revenue during FY 2010/11 was BDT 1,248.5 million out of which BDT 387.7 million was interest from infrastructure projects; BDT 490.6 million interest from renewable energy programs and projects; BDT 15.8 million fees income from infrastructure projects; BDT 86.4 million fees income from renewable energy programs and projects, and BDT 262.7 million income from short-term investments. The total operating income after deducting interest expenses was BDT 1,001 million. During the same period, IDCOL's operating and interest expenses were BDT 312 million. The profit before tax and provision (= EBITDA) was BDT 936.6 million. The provision of BDT 87.4 million has been made for loans and advances and BDT 400 million for tax. Retained Earnings at the end of the reporting period was BDT 456 million.

Evolvement of income and expenses for the recent three years shows that IDCOL's operation has been rapidly growing. Its EBITDA has been growing approximately 1.5 fold every year. Therefore, IDCOL has been successful in increasing the retained surplus every fiscal year, also enabling the constant increase of earning per share.

(3) Assets and Liabilities

IDCOL's paid up capital increased from BDT 660 million in FY 2009/10 to BDT 870 million in FY 2010/11. With a 45 percent increase in asset base, IDCOL achieved after tax income growth

[66] IDCOL's Accounting, Audit and Internal Control Manual

by nearly 52 percent. Shareholders' equity also experienced more than 38.6 percent growth over the previous fiscal year.

(4) Profitability Indicators

Most of the revenues during FY 2010/11 came out of income from renewable energy programs, projects, interests on loans, and advances. The profitability indicators show an upward trend in FY 2010/11, with ROA reaching 2.85 percent and ROE reaching 33.88 percent in the latest fiscal year against 2.72 percent and 30.89 percent, respectively, in FY 2009/10.

(5) Non-Performing Loans

On 30th of June 2011, 98 percent of IDCOL loans were unclassified in terms of recovery, except for eleven loans holding of which the share is only two percent of total loan portfolio. Three of these loans were bad, six sub-standard, and two doubtful. IDCOL filed a lawsuit against one of its loan defaulter i.e. Panama Hilli Port Link Limited[67]. Besides, IDCOL was in the process of taking legal action against another defaulter, Thermex Trade Limited[68].

(6) Credit Rating

IDCOL has obtained credit rating from Credit Rating Agency of Bangladesh Ltd. (CRAB). The first rating was in April 2007, when it received AA2 (long term) rating. The third and current rating was received in June 2012, at AA1 (long term). CRAB's AA rating is explained as "Very Strong Capacity & Very High Quality" rating.

(7) Financial Audit

The external financial audit is conducted annually and disclosed to the stakeholders in the form of disclosure report. Financial auditors are appointed by the shareholders. Therefore, auditors report to the shareholders.

Auditors' responsibility is to express an opinion on financial statements based on the audit. The audit is conducted in accordance with International Standards on Auditing (IAS). Those standards require that the auditors comply with ethical requirements, plan, and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

[67] A Bangladeshi dry port owner/operator company. The company is in the midst of labor disputed with law suit being filed against the management.

[68] A CNG trading company. The company's operation is experiencing a severe restriction due to lack of gas supply.

Table 3.1-1 Profit Loss Account of IDCOL

Operating income	FY 2010/11	FY 2009/10	FY 2008/09
Interest on loans and advances	387,657,610	329,830,265	217,684,916
Interest income from renewable energy projects	490,591,889	154,992,984	16,401,498
Interest income from short term investment	262,681,104	120,979,813	105,744,069
Interest expenses	(247,427,622)	(99,185,994)	(6,065,080)
Net interest income	893,502,982	506,617,068	333,765,403
Fees income from renewable energy projects	86,358,577	165,679,821	71,814,263
Fees income from project finance	15,808,023	40,694,199	29,039,382
Other operating income	5,420,106	4,803,731	4,828,076
Total operating income (A)	1,001,089,687	717,794,819	439,447,124
Operating expenses			
Salary and allowance	5,773,937	5,453,413	3,515,428
Rent, taxes, insurance, electricity etc.	696,273	354,554	328,042
Legal expenses	534,043	-	60,750
Postage, stamp, telecommunication etc.	472,416	322,485	308,452
Stationery, printing, advertisement etc.	797,487	549,156	975,882
Chief Executive's salary and fees	5,528,844	4,687,665	1,958,101
Directors' fees	569,250	483,000	713,000
Auditors' fees	91,960	83,600	68,343
Depreciation and repair of Company's assets	6,188,076	3,722,766	4,112,571
Other operating expenses	43,886,191	28,003,515	9,672,205
Total operating expenses (B)	64,538,477	43,660,154	21,712,774
Profit/(Loss) before amortization, provision & tax (C) = (A - B)	936,551,211	674,134,665	417,734,350
Amortization for Valuation Adjustment (D)	-	-	-
Profit/(Loss) before provision & tax (E) = (C - D)	936,551,211	674,134,665	417,734,350
Provision for loans and advances	87,396,506	90,117,010	26,612,190
Other provision	-	-	-
Total provision (F)	87,396,506	90,117,010	26,612,190
Net profit/(loss) before Tax (G)=(E-F)	849,154,704	584,017,655	391,122,160
Provision for tax	399,861,106	288,268,560	178,218,171
Net profit/(loss) after tax	449,293,599	295,749,095	212,903,989
Appropriation:	-	-	-
Statutory reserve	-	-	-
General reserve	-	-	-
Retained surplus	449,293,599	295,749,095	212,903,989
Earnings Per Share (EPS)	51.64	44.81	42.58

Source: IDCOL Annual Report (2010-2011, 2009-2010)

Table 3.1-2 Balance Sheet of IDCOL

PROPERTY AND ASSETS	FY 2010/11	FY 2009/10	FY 2008/09
Cash	114,622	19,676,812	107,660,653
Cash in Hand (including foreign currencies)	561	25,000	23,288
Balance with Bangladesh Bank and its agent bank (including foreign currencies)	114,061	19,651,812	107,637,365
Balance with other banks and financial institutions	2,897,320,823	2,121,957,280	1,345,256,532
In Bangladesh	2,897,320,823	2,121,957,280	1,345,256,532
Outside Bangladesh	-	-	-
Money at call and short notice	-	-	-
Investments	800,000,000	1,000,000,000	-
Government	-	-	-
Others	800,000,000	1,000,000,000	-
Loans and advances	11,316,088,883	7,057,847,557	3,440,407,406
Loans, Cash Credit & Over Draft etc.	11,316,088,883	7,057,847,557	3,440,407,406
Bills Discounted and Purchased	-	-	-
Fixed assets including land, building, furniture and fixtures	27,649,441	20,230,483	22,384,933
Other assets	702,348,439	640,797,075	292,532,334
Non-banking assets	-	-	-
Total assets	15,743,522,207	10,860,509,207	5,208,241,858

LIABILITIES & CAPITAL	FY 2010/11	FY 2009/10	FY 2008/09
Liabilities			
Borrowings from Government of Bangladesh	13,689,679,038	9,212,333,774	4,239,638,741
Deposit and other accounts	-	-	-
Other liabilities	727,799,415	691,425,278	247,602,057
Total liabilities	14,417,478,453	9,903,759,052	4,487,240,798
Capital/Shareholders' equity	870,000,000	660,000,000	500,000,000
Paid-up Capital			
Statutory and general reserve	-	-	-
Revaluation and amortization reserve in Govt. securities	-	-	-
Retained surplus from profit and loss account	456,043,754	296,750,155	221,001,060
Total shareholders' equity	1,326,043,754	956,750,155	721,001,060
Total liabilities and shareholders' equity	15,743,522,207	10,860,509,207	5,208,241,858

Source: IDCOL Annual Report (2010-2011, 2009-2010)

Table 3.1-3 Cash Flow Statement of IDCOL

		FY 2010/11	FY 2009/10	FY 2008/09
A.	Cash flows from operating activities			
	Interest received	1,140,930,604	605,803,062	339,830,483
	Interest paid	(247,427,622)	(99,185,994)	(6,065,080)
	Dividend received	-	-	-
	Fees income received	102,166,600	206,374,020	100,853,645
	Payment of income tax	(467,525,112)	-	(119,697,689)
	Paid to employees and suppliers	(58,350,401)	(39,937,388)	(17,600,203)
	Receipts from other operating activities	5,981,861	6,261,935	6,728,432
	Operating profit/(loss) before changing in operating assets and liabilities	475,775,929	679,315,635	304,049,588
	(Increase)/decrease in operating assets and liabilities			
	Advances, deposits and prepayments	(5,214,888)	(24,519,651)	(58,980,982)
	Advance income tax	66,780,483	(215,197,191)	-
	Receivables	(125,755,839)	(111,714,681)	(81,004,794)
	Interest suspense account	7,270,932	(403,148)	-
	Payables and accrued expenses	8,375,765	65,870,141	18,313,727
	Deferred liability - gratuity	297,628	795,174	(4,400)
		(48,245,918)	(285,169,356)	(121,676,449)
	Net cash from operating activities (A)	427,530,011	394,146,279	182,373,139
B.	Cash flows from investing activities			
	Acquisition of fixed assets	(10,832,597)	(684,254)	(5,375,289)
	Net cash from investing activities (B)	(10,832,597)	(684,254)	(5,375,289)
C.	Cash flows from financing activities			
	Loan from Government of Bangladesh	4,477,345,264	4,972,695,033	2,828,592,348
	Investment	200,000,000	(1,000,000,000)	-
	Loans and advances	(4,258,241,326)	(3,617,440,151)	(2,218,999,598)
	Dividend paid	(80,000,000)	(60,000,000)	(40,000,000)
	Net cash from financing activities (C)	339,103,938	295,254,882	569,592,750
D.	Net increase in cash and cash equivalents (A+B+C)	755,801,352	688,716,907	746,590,600
E.	Effect of exchange rate change on cash and cash equivalent	-	-	-
F.	Cash and cash equivalents at the beginning of the year	2,141,634,092	1,452,917,185	706,326,585
G.	Cash and cash equivalents at the end of the year	2,897,435,444	2,141,634,092	1,452,917,185
	Cash and cash equivalents at the end of the year			
	Cash in hand (including foreign currencies)	561	25,000	23,288
	Balance with Bangladesh Bank and its agent banks	114,061	19,651,812	107,637,365
	Balance with other banks and financial institutions	2,897,320,823	2,121,957,280	1,345,256,532
		2,897,435,445	2,141,634,092	1,452,917,185

Source: IDCOL Annual Report (2010-2011, 2009-2010)

Table 3.1-4 Classification of loans and advances of IDCOL

	FY 2010/11	FY 2009/10	FY 2008/09
Unclassified	11,183,764,173	6,975,535,163	3,440,407,406
Standard	11,182,630,403	6,944,241,462	3,326,801,310
Special Mention Account	1,133,771	31,293,701	113,606,096
Classified	132,324,710	82,312,394	-
Sub-Standard	15,278,864	-	-
Doubtful	31,045,556	48,508,332	-
Bad or loss	86,000,291	33,804,062	-
Total Loans and Advances	11,316,088,883	7,057,847,557	3,440,407,406

Source: IDCOL Annual Report (2010-2011, 2009-2010)

3.1.5. Products and Services provided by IDCOL

The sectors eligible for financing by IDCOL cover wide areas including power generation sector, telecommunication sector, renewable energy sector, and transport infrastructure sector. These are listed as follows:

Table 3.1-5 Sectors Eligible for Financing by IDCOL

IDCOL's eligible sector for financing
• Power generation • Telecommunications and ICT • Renewable energy • Ports • Effluent Treatment Plants • Toll roads • Water Supply • Gas and gas related infrastructure • Urban Environmental Services • Mass transport systems • Shipyards and shipbuilding

Source: IDCOL

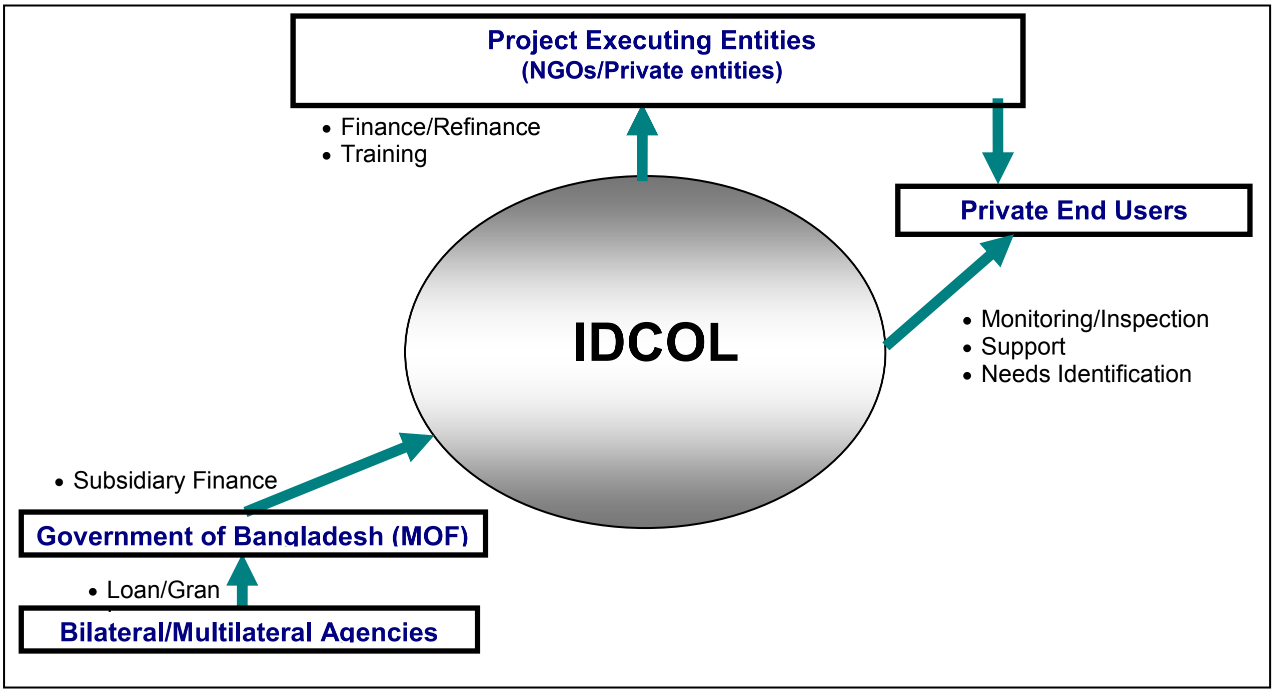
The products and services which IDCOL has been providing can be categorized into three main categories, which are: 1) Support for infrastructure sector in terms of financing, 2) Initiation of renewable energy & energy efficiency sector, and 3) Training programs. An outline of the three products and services provided by IDCOL are shown in the following table 3.1-6. Among these three, RE Projects and RE Programs fall under the second category.

Table 3.1-6 Products and Services Provided by IDCOL

Products/Services	Outline
1) Support for infrastructure sector	• Long-term local and foreign currency loans • Debt and equity arrangement • Financial advisory services
2) Initiation of renewable energy & energy efficiency sector	• Concessionary financing and grant supports • Technical assistance and quality assurance • Capacity development of stakeholders
3) Training programs	• Training programs: Project Finance Financial Modeling Renewable Energy Trainees for the above programs contain not only IDCOL staff but also outside bank staffs. The purpose of the above-listed training program is not only capacity development but also human network development. Trainers are IDCOL directors, financial experts coming from the central bank, university professors, and experts coming from "Mirpur Training Academy of Central Bank" Annual training Participants of this training are only IDCOL staff. This training is done in a form of a brain-storming meeting. Overseas study tour Study tour to other countries, for instance, Malaysia, Singapore, USA, and Japan. Technical training for inspectors Trainees are inspectors of IDCOL. Trainers are representatives of POs. The training curriculum contains visiting sites where the SHS equipment is actually installed. Trained about 1,500 professionals as of May, 2012)

Source: IDCOL

As stated previously, IDCOL is a Government-owned non-banking financial institution. Therefore, the business partners of IDCOL contain various stakeholders including the Government of Bangladesh, international development partners, and local project executing entities which include the Participating organizations (POs) for the SHS program and the Biogas plant installation program, mainly consisting of NGOs, and end-users such as households and individuals, which are shown as follows:



Source: IDCOL

Figure 3.1-3 IDCOL, Partners and Users

3.1.6. IDCOL's Renewable Energy Initiatives

(1) Programs and Projects

IDCOL conducts Renewable Energy (RE) "Programs" and RE "Projects" under its renewable energy initiative. The RE "Program" means overall planning based on the IDCOL medium term strategic planning while the RE "Projects" are the specific RE implementation undertaken by the individual sponsors financially supported by IDCOL. The RE "Program" is an activity in which a replicable small scale transaction (installation of equipment and provision of related supportive services) is conducted by numerous "Participating Organizations" (POs) in the case of the SHS program, whereby IDCOL develops the implementation structure and oversees the total scheme. On the other hand, RE "Projects" are usually one-off or few repetitions of works conducted by implementing organizations other than IDCOL and financially supported by IDCOL. Most of these RE "Projects" are conducted as experimental or pilot projects.

Currently, there are two RE Programs, the Solar Home System (SHS) Program and the National Domestic Biogas and Manure Program (NDBMP). There are altogether six of the RE Projects, for the utilization of either solar photovoltaic (PV) or biomass.

Table 3.1-7 IDCOL's Renewable Energy Programs

SHS Program	National Domestic Biogas and manure Program (NDBMP)
Major Achievements: • Installed 1.2 million SHSs (equivalent to 60 MW) in remote rural areas • Serving 6 million people, 3.70% of the population • Savings of 97,104 tons of kerosene worth USD 80 million per year • Created 50,000 direct and indirect jobs	Major Achievements: • Installed 22,000 biogas plants • Serving 110,000, people • Savings of: 52,800 tons of firewood worth USD 1.5 million per year; 18,700 tons of chemical fertilizers worth of USD 15.76 million per year; 598 tons of kerosene worth of USD 0.5 million per year. • Created 10,000 direct and indirect jobs

Source: Compiled by the Survey Team based on IDCOL information

Table 3.1-8 IDCOL's Renewable Energy Projects

Renewable Energy Projects	Achievements
Biomass Gasification based Power Plant	650 kW biomass gasification based power plants
Biogas based Electricity Plant	80 kW biogas based electricity plants
Solar irrigation pump project	Eight solar irrigation pumps
Solar Powered Solution for Telecom Base Transceiver Station (BTS)s	Solar powered solution for 82 telecom BTSs
Solar PV Assembling Plant	Two solar PV assembling plants
Solar Mini-grid Project	100 kW solar mini-grid project

Source: Compiled by the Survey Team based on IDCOL information

(2) Financial Arrangement of Renewable Energy Sector

As of May 2012, the amount of financing executed by IDCOL for the aforementioned renewable energy sector is as follows:

Table 3.1-9 Financing Executed by IDCOL in the RE Sector

Amount of financing	Sector
BDT 17,475 million	SHS installation program
BDT 223 million	Biogas plant installation program
BDT 374 million	Others
BDT 18,073 million	TOTAL

Source: IDCOL

3.1.7. IDCOL's Component Management Structure (SHS Program)

IDCOL's activity in promoting RE technology can broadly be categorized into two forms: The RE Program and RE Projects. The SHS Program and the NDBMP are the only two RE Programs conducted by IDCOL. Other activities are conducted in the form of RE Projects.

IDCOL's SHS Program and the NDBMP are managed under a different management structure from RE project. One of the major differences is the existence of POs as the sponsors. The management structure of the SHS Program is explained in this sub-section.

(1) Participating Organizations (POs) for RE Programs

1) Outline of the POs' Activity

Participating Organizations (POs) play central roles in IDCOL's RE Programs, especially in the SHS and Biogas plant installation program. IDCOL, being a financial institution does not conduct equipment installation, and service provisions by itself. In the case of RE Programs it will be the POs who will be conducting these actual transactions. Therefore, selection, appointment, and monitoring/inspection of these POs has become crucial for the RE Programs. IDCOL has been working together with a variety of POs which are mainly NGOs including Grameen Shakti, and BRAC. These POs are selected through IDCOL's own process, that is described in the following subsection on project management structure. The POs for IDCOL's SHS Program, selected as entities providing SHS and services for end-users number to 31 as of April 2012. The POs that are engaged in NDBMP for biogas related service provision are also those collaborating with IDCOL in the SHS Program. Therefore, there are 31 of them.

Table 3.1-10 Participating Organizations and Their Progress with SHS Installation

(As of April 2012)

Participating organizations	Number of SHS Installed
Grameen Shakti	795,957
RSF	216,434
BRAC	77,019
Srizony Bangladesh	58,927
Hilful Fuzul Samaj Kallyan Sangstha	37,078
UBOMUS	25,234
BRIDGE	20,449
Integrated Development Foundation	14,238
TMSS	13,059
PDBF	10,672
SEF	21,720
AVA	12,817
DESHA	10,931
BGEF	16,995
RDF	20,027
COAST	6,181
INGEN	9,871
CMES	5,714
NUSRA	9,369
RIMSO	8,196
Shubashati	5,370
REDI	5,711
GHEL	6,138
SFDW	9,458
PMUK	2,166
Patakuri	3,409
ADAMS	2,848
AFAUS	1,161
RISDA	1,552
Xenergeia	320
Others	389
Total	1,429,437

Source: IDCOL

In addition to the SHS program, the POs have played significant roles in the field of Biogas plant installation program. The progress with the Biogas plant installation done by POs as of May 2011 are as follows:

Table 3.1-11 Participating Organizations and Their Progress with the Biogas Plant Installation

(As of May 2011)

Participating organizations	Biogas Plant Completed
Grameen Shakti	713,928
RSF	184,407
BRAC	73,902
Srizony Bangladesh	50,461
Hilful Fuzul Samaj Kallyan Sangstha	29,741
UBOMUS	22,732
BRIDGE	16,805
Integrated Development Foundation	11,756
TMSS	11,041
PDBF	9,120
SEF	12,752
AVA	8,784
DESHA	8,574
BGEF	11,264
RDF	12,003
COAST	6,181
INGEN	7,310
CMES	5,444
NUSRA	6,364
RIMSO	5,563
Shubashati	4,543
REDI	4,331
GHEL	4,246
SFDW	5,774
PMUK	1,962
Patakuri	1,488
ADAMS	1,901
AFAUS	920
Xenergeia	200
Others	389
Total	1,233,886

Source: IDCOL

2) Assessment of the POs' Capacity

The top 3 POs of NGOs in Bangladesh in the field of the SHS installation program in terms of the number of SHS equipment being installed nationwide in Bangladesh are Grameen Shakti, BRAC, and Rural Services Foundation. These 3 NGOs and other 2 NGOs namely TMSS and COAST have been engaged in the solar power energy program since late 1990s. These NGOs have affluent experiences and technical know-how in the field of SHS project implementation. Throughout the study the interview surveys with the top 3 POs in the SHS installation program have been conducted in order to evaluate their capacity of SHS project implementation. Based on the result of the interview survey, their capacity should be evaluated in the context of the following strengths:

- A huge network of branches nationwide;
- Technical know-how covering wide areas of finance, technical, and project management backed by well skilled staff;
- Abundant experiences with long careers in the field of SHS since the middle or late 1990s;
- Familiarity of the regional conditions and financial situation of all the end-users being grasped by their frequent visits;
- Consciousness of severe economic and financial viability for the project;
- Careful selection of the end-users to ensure sufficient level of repayment rate.

As a result, current repayment rate to the top 3 POs from the end users is now more than 90 percent. As for the repayment from the POs to IDCOL, 100% is maintained.

The following table is a summary of the interview survey with the top 3 POs in the field of the SHS installation program.

Table 3.1-12 Assessment of Major POs (Grameen Shakti)

	Grameen Shakti
Starting year of the RE business	1996
Organization	170 branches nationwide in Bangladesh. Grameen Shakti is not only financial specialists, but also mechanical engineers, and civil engineers.
Outline of the activity in RE project	SHS installation (major field), 0.8 million installed SHS in rural areas Biogas plant installation
Lending terms for end-users	3 options are as follows: 1) Down-payment: 5%, Loan Tenure: 3 years, Interest rate: 6% 2) Down-payment: 25%, Loan Tenure: 2 years, Interest rate: 4% 3) Down-payment: 100%, with 4% discount of total repayment cost Financial scheme is totally different from the micro-credit scheme.
Amount of debit loan as of June 2012	7,700 million BDT for SHS, 40,000 BDT for Biogas plants
Repayment rate for end-users	More than 90%
Comments on IDCOL	IDCOL has been focusing on the small SHS installation program. However small projects are not effectively achieved in terms of cost, human resources, and overall project implementation. The NGO has its own plan for more large-scale solar power projects using its own funds.
Criterions for selection of end-users	Target households are: 1) Permanent residents in the target areas; 2) Residents with good financial performance that are medium income households rather than low income households; 3) Residents with good reputation in the region

Source: Compiled by the Survey Team based on Grameen Shakti's information

Table 3.1-13 Assessment of Major POs (RSF)

	Rural Services Foundation (RSF)
Starting year of the RE business	2006
Organization	10 zonal offices, 78 regional offices and 500 Unit offices covering major rural areas
Outline of the activity in RE project	Up to June 2012, RSF has supported installation of 241,000 SHS equipments. Now planning to install another 160,000 SHS under IDCOL financing (July 2012 – June 2013). So far, no solar irrigation pump installation has been achieved.
Lending terms for end-users	Loan Tenure: 3 years, Interest rate: 8% Financial scheme is not based on the micro-credit scheme.
Amount of debit loan as of June, 2012	BDT 2,000 million
Repayment rate for end-users	Approximately 92% in average
Comments on IDCOL	RSF has been suffering from decreasing concessionality of IDCOL's loan. Due to the harsh loan condition, the unit price has to be raised every year and policy of the loan recovery has to be more severe every year. The severe loan repayment policy brings about higher management costs which have been oppressing the RSF's financial condition
Criterions for selection of end-users	RSF has two criterions: the area selection criterion and household selection criterion. As for the area criterion, RSF does not select the area where low income households are located, and RSF selects the medium income households rather than the low income households.

Note: Down payment = Initial amount to be paid by end-users.
Source: Compiled by the Survey Team based on RSF's information

Table 3.1-14 Assessment of Major POs (BRAC)

	BRAC
Starting year of the RE business	1997
Organization	A huge network of branches nationwide
Outline of the activity in RE project	SHS installation project implementation is the major business field. Others are solar irrigation and solar pump-related projects.
Lending terms for end-users	Down-payment rate:20%, Loan Tenure:1-3 years, Interest rate: 12.6%. Financial scheme is not based on the micro-credit scheme.
Amount of debit loan as of June, 2012	BDT 450 million
Repayment rate for end-users	Approximately 95% in average
Comments on IDCOL	IDCOL has been focusing on the small SHS installation program. Due to the small SHS project, the load of the loan recovery has increased every year. Therefore, increasing management costs have been oppressing the BRAC's financial situation now. BRAC is now intending to go forward on more large-scale solar power projects using its own funds.

Criterions for selection of end-users	BRAC has two criterions: the area selection criterion and household selection criterion. As for the area criterion, BRAC does not select the area where the low income households are located, and BRAC selects the medium income households rather than the low income households.

Note: Down payment = Initial amount to be paid by end-users.
Source: Compiled by the Survey Team based on BRAC's information

(2) Selection of POs

The PO selection procedure consists of multiple steps[69]. The selection process starts with the publication of advertisement in the newspaper soliciting an "Expression of Interest" from interested POs, Private Companies, NGOs, MFIs, commercial banks, and cooperatives validly operating under the Government of Bangladesh. The laws and rules are potentially eligible as POs, subject to satisfactory creditworthiness assessment, and meeting eligibility criteria outlined are as follows. The criteria below are the latest version of the criteria from recent publications for Request for EOI.[70]

(1)Eligibility Criteria for Participating Organizations (POs)

1) For All Participating Organizations:
a) General Criteria

- Satisfactory business plan approved by the PO's Board of Directors;
- Particulars of the operational and financial results of the PO for at least two (2) previous years;
- The PO should furnish proof to IDCOL that the financial performance of the PO concerned is in accordance with the applicable financial criteria outlined below;
- After fulfilling the eligibility criteria by PO for program entry, the PO shall continue to meet the aforementioned eligibility criteria to the satisfaction of IDCOL;
- The PO has established and maintained sound and transparent accounting, MIS and internal auditing system;
- Accounts are audited by a reputable external auditor on an annual basis.

b) Financial Criteria

- Minimum Tk. 10,000,000/ of equity;
- Debt to equity ratio of the MFI not in excess of 3.0;
- Minimum total cash collection ratio of principal and interest on current loan portfolio calculated on a rolling 12 month basis of 95 percent;
- In case of an existing SHS loan portfolio, a minimum total cash collection ratio of principal and interest calculated on a rolling 12 month basis of 95 percent;
- Minimum after tax profit equivalent to 4 percent p.a. on a Revolving Loan Fund (RLF);
- In cases where prospective business profitability is considered to be positive, the PO should be at least break-even after meeting operational expenses and debt service. But in these cases, continued eligibility will be conditional on the table to meet the 4 percent p.a. after tax profit criterion on the following year and;
- Minimum debt service cover ratio of 1.25.

[69] Information on PO selection stage is cited from IDCOL SHS Operational Guidelines.
[70] Request for Expression of Interest for Selection of Non-Government Organizations (NGO)/Micro-Finance Institutions (MFIs)/ Private Entities for Implementation of IDCOL SHS Program

2) Specific Eligibility Criteria for NGO/MFI (Supplier and Lender POs)

- Registered with appropriate registration authority to conduct microfinance services; Currently conducting microfinance services with soft loan funds from:
- PKSF (Palli Karma Shahayak Foundation) as a participating organization (POs);
- Bank of Small Industries and Commerce (BASIC) Limited and/or;
- Any other similar national or international funding source.
- Have microfinance operations in project areas identified by the PO for the promotion of solar energy;
- Number of beneficiaries is not less than 10,000 and;
- Capable of managing rural renewable energy program.

3) Selection Criteria for Private Entity (Supplier POs)

- A lawful private business entity organized under the laws of Bangladesh, complying with pertinent laws and regulations regarding capital adequacy, classification of assets, non-accrual of interest and provisioning, exposure limits, etc.;
- A verification that PO meets satisfactory financial criteria, ratio requirements, and exposure limits and;
- Capable of managing rural renewable energy programs.

4) Conversion of Supplier PO into Supplier and Lender PO

- A Supplier PO may be converted into a Supplier and Lender PO following the fulfillment of major criteria;
- The Supplier PO will signed a Participation Agreement with IDCOL;
- The Supplier PO has installed minimum 1,000 SHS under the IDCOL SHS Program;
- The loan recovery rate for those SHS shall not be less than 95 percent;
- Satisfactory report from the Auditors engaged by IDCOL.

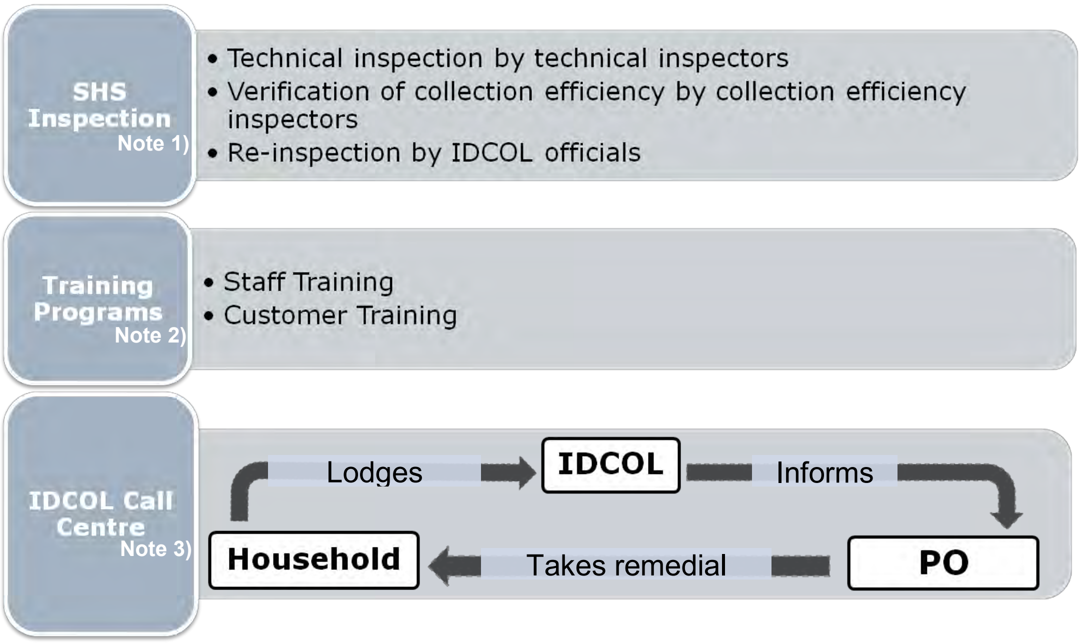
Source: IDCOL, "Request for Expression of Interest for Selection of Non-Government Organizations (NGO)/Micro-Finance Institutions (MFIs)/ Private Entities for Implementation of IDCOL SHS Program", June 2012

After the pre-selection and short listing of qualified applicants, IDCOL will send a team on an inspection visit to the applicants' offices. After that, a detailed evaluation report is submitted before the PO Selection Committee considers the applications as well as the received IDCOL inspection report. The PO Selection Committee recommends suitable applicants for selection by IDCOL Board. By the approval of IDCOL Board, the list of selected POs along with the minutes of the PO Selection Committee and IDCOL Board are sent to the development partners for their information and record.[71]

(3) Operation and Maintenance

For the operation and maintenance structure for RE Programs run by IDCOL, inspections are major task for the SHS and NDBMP. The IDCOL's function is to give trainings. It plays a major role to keep the service quality at a certain level. The three major elements, i.e., inspection, training, and call center supports are the arrangements set under the Program Officer of IDCOL. The quality control mechanisms are shown as follows:

[71] Information on PO selection stage is cited from IDCOL SHS Operational Guidelines.



Source: IDCOL

Figure 3.1-4 Quality Control Mechanisms in Operation / Maintenance Structure

1) Inspectors

A team of inspectors consist of technical inspectors (74 persons), regional inspectors (10 persons), collection efficiency inspectors (7 persons), and training inspectors (2 persons), totaling to 93 inspectors/supervisors that are engaged in the SHS inspection. All inspectors are outsourced and most of them are technical consultants. A qualification required for the inspectors is to have either of the following degrees: Electrical engineering, Civil engineering or Computer engineering.

Now, the inspection has covered 45 percent of total 1.4 million SHS equipments installed. Inspectors inspect SHS equipments once after the initial installment. Furthermore, IDCOL officials conduct re-inspection. Any of the IDCOL mandates itself to have any of its staff conducting a re-inspection at minimum of 100 sites per month.

2) Trainings

Training of Trainers (TOT) is emphasized in the IDCOL's staff training program. A 4 to 5 days intensive training is conducted. After completion of the training program, IDCOL issues certificates of the completion of the training. If the trainees do not reach the appropriate level of the training program, the said trainees can be given a chance to take part in another training program.

For the customer training, short time instruction is given e.g., 15 minutes of orientation before installation of the SHS equipment, an instruction on how to install the solar panel on the roof-top or how to operate the RE related equipment and so forth.

3) Call Center

IDCOL established their call center 2 years ago. Currently there is only one full time operator responding to the call. Approximately 600 calls are logged per month. IDCOL has recognized that the system is not sufficient and is planning to expand the Call Center.

(4) Committees for Overseeing IDCOL's SHS Program

In the SHS Program there are three designated committees managing the operation. These are: the technical Standards Committee, the PO Selection Committee the Operations Committee. Among these three, the Technical standard Committee and the PO Selection Committee are independent committees, while the Operations Committee functions under IDCOL's management.

Composition, functions and authority of the committees for SHS Programs are stipulated in IDCOL's SHS Operational Guidelines. Followings are the major points mentioned in the guidelines:

Table 3.1-15 Features of the Committees for IDCOL's SHS Program

	Technical Standards	PO Selection	Operations
Function	TSC is responsible for the selection of equipment and the suppliers under IDCOL's Renewable Energy Programs. The role of TSC is to (i) Establish and update equipment and service standards, (ii) Design a quality assurance program, (iii) Determine technical standards for equipment to be financed, (iv) Review the product credentials submitted by dealers/suppliers, and approve the eligible equipment, and (v) Evaluate the feedback from dealers/suppliers and POs to develop the industry standards for the PV equipment.	(i) Evaluates the applications received, (ii) Recommends suitable applicants for selection by the IDCOL Board. To ensure the transparency and justice, the PO selection is conducted based on the thorough investigation of the POs' financial, social and technical capability.	Looks after the operational aspects of the solar program which include issues like installation of the SHS by the POs in the preceding month, implementation status of the decisions taken in the previous meeting, collection efficiency and Portfolio at Risk (PAR) report submitted by the POs and IDCOL inspectors, technical report submitted by POs and IDCOL technical inspectors, periodic submission of financial and other reports by the POs, and any other issues related to the implementation of the program.
Composition	Vice Chancellor of a technical university (presently UIU), Rural Electrification Board (REB), Local Government Engineering Division (LGED) and IDCOL. IDCOL management may consider co-opting other relevant persons as members to the committee.	Representatives from (i) Economic Relations Division (ERD), (ii) Bangladesh Institute of Development Studies (BIDS), (iii) NGO Affairs Bureau, (iv) Palli Karma Shahayak Foundation (PKSF), and (v) IDCOL. IDCOL management may consider co-opting other relevant persons as members to the committee.	Chaired by the CEO of IDCOL and consisting of program-in-charges from all POs and representatives from IDCOL. PO representatives are authorized by their respective management.

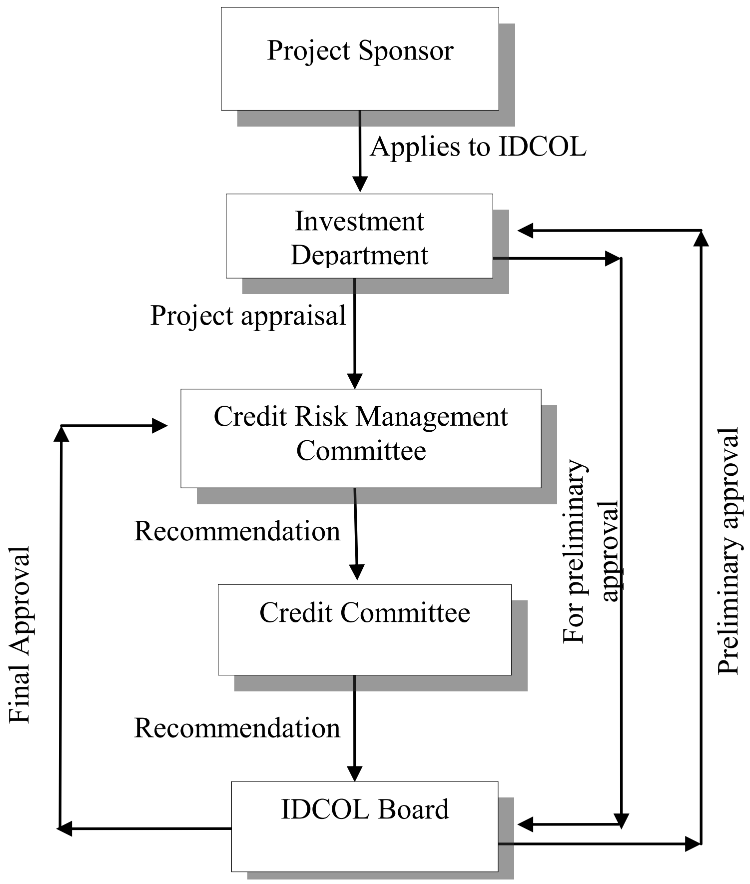
	Technical Standards	PO Selection	Operations
Decision making process and authority	1) Application from potential suppliers; 2) Review and recommendation of eligible equipment based on set specifications; 3) Approval by the IDCOL management	1) Applications from potential organizations; 2) Review of application based on set eligibility criteria; 3) Recommendation for selection as POs; 4) Approval by the IDCOL Board	1) Discussion of issues identified by IDCOL and POs; 2) Approval by the Committee
Meeting frequency	The meeting is held once every month.	The meeting is held when and as required.	The meeting is held once every month.
Notes	Only TSC approved equipment is eligible for financing under the RERED Project. IDCOL may appoint independent engineers for the selection/verification of suppliers under other RE projects or may seek advice from the TSC, if necessary.	In most cases, the PO selection procedure takes more than 6 months. For instance, in case of the PO selection in the previous SHS installation, 84 NGOs and private entities submitted the proposals. 15 entities were shortlisted, and finally only 8 NGOs were selected as additional POs.	

Source: Compiled by the Survey Team based on information provided from IDCOL

3.1.8. IDCOL's Component Management Structure (RE Projects)

(1) RE Project Appraisal Procedure

After the project sponsors apply to IDCOL for project proposal, the Investment Department of IDCOL will conduct the first appraisal of the proposed RE project. Based on the results of the project appraisal, Credit Risk Management Committee will review it and send the recommendations to the Credit Committee that will conduct further review of both project appraisal and recommendations submitted by the Investment Department and will send further recommendations to the IDCOL Board. Simultaneously, the Investment Department will requests the IDCOL Board for preliminary approval for the purpose that the feasibility of the proposed projects can be examined from the technical and financial point of view and the work load for financial analysis such as the CRMC can be saved. Responding to the request submitted from the Investment Department, the IDCOL Board may extend the preliminary approval to them. Based on the all of appraisal results and recommendations, IDCOL makes the final approval.



Source: IDCOL, "Credit Risk Management Guidelines"

Figure 3.1-5 Flowchart of IDCOL's Approval Process for RE Projects

(2) Criteria for Entitlement for the Project Sponsors

The Project Sponsors should be creditworthy, serious parties, and capable of fulfilling their responsibilities. The Project Sponsors should have the experience to successfully operate the Project based on its track record with the proposed technology as well as its ability to conduct business in Bangladesh and/or the South Asia and Southeast Asia region.

It is generally assumed that the project Sponsor will be a corporate entity, joint venture, or a partnership. Therefore, IDCOL analyzes the following information:

- Name of the Sponsor as well as the country under whose laws it was incorporated;
- Date and place of incorporation;
- Registered office or seat;
- Principal place of business;
- Name, title, address, e-mail addresses, and contact numbers for correspondence purposes
- Nature of business activities;
- Names, nationalities, and addresses of directors and officers of the Company including the Company Secretary;
- Nature of organizational documents (i.e. articles of incorporation, memorandum of association, etc.);
- Number and nature of issued shares of each class;

- Amounts paid with respect to issued shares of each class;
- Details of any stock exchanges (if any) on which shares of each Project Sponsor are listed, quoted or traded;
- If subsidiary, name of the ultimate holding company;
- If joint venture or partnership, the names of other members of the joint venture or partners;
- Details of bankers;
- Any interest that each Sponsor (or related company) has in the project company other than that of a shareholder;
- Audited financial statements for the last three years.

Source: IDCOL, Credit Risk Management Guidelines

(3) Checklist for evaluating Project Sponsors

The followings are the checklist which IDCOL should keep in mind in selecting Project Sponsors in the abovementioned criteria.

- Who are the project sponsors and what are their ownership interests in the project?
- What is their financial status?
- Who are the investors in the project?
- What experience does a project sponsors have with the development, construction, start-up and operation of similar projects? In Bangladesh? In Southeast Asia? In other emerging countries?
- What will project sponsors contribute to the project? Equity? Development experience? Construction and start-up expertise? Technology? Operating abilities? Experience in Bangladesh? Experience in Southeast Asia?
- What management control does a project sponsors have in the project company? How are the votes allocated? Is there one consortium member or partner with veto power?
- What are the income, loss, and capital contribution allocations of the consortium members or partners?
- What limited recourse liability does a project sponsors have? For construction cost overrun? For other events?
- What are the funding commitments of the project sponsors during the project development period?
- What are the funding commitments of the project sponsors during the construction period?
- If there are several sponsors, is the funding commitment joint and several?
- What are the conditions to these funding commitments?
- What events trigger funding obligations? Are these events consistent with the project's financing plan?
- Are the sponsors creditworthy enough to meet their project obligations?
- What rights does a project sponsors have to sell its interest in the project company?
- What restrictions do the laws of the sponsor's home country place on equity ownership in the project?

Source: IDCOL, Credit Risk Management Guidelines

(4) Eligibility Criteria for RE Projects

In this step, the IDCOL Financial officer will analyze the information, documentation submitted by the Project Sponsor, and prepare a project appraisal for review by the CEO-IDCOL prior to its presentation to the IDCOL Board of Directors. The purpose of this step is to i) assist the Board in making a decision whether or not to proceed further with the project, ii) identify any weak spots in the project, and iii) initiate discussions of potential risk mitigation measures with the Project Sponsors.

In conducting its project appraisal, the IDCOL staff should focus its efforts on the analysis of the materials provided by the Project Sponsors for the purpose of judging regarding the following:

- Compliance with GoB, World Bank and IDA environmental guidelines and procedures. If a recent EIA has not been prepared, IDCOL will request that study to be conducted and planned for addressing any issues identified in the EIA be included. The Sponsor should provide a resettlement plan that is consistent with the GoB, World Bank, IDA social, and resettlement policies, and guidelines as appropriate.
- Procurement of goods, services, and equipment must be in compliance with ICB guidelines and procedures established by the World Bank and IDA. If the project is unsolicited, IDCOL should satisfy itself that either the goods/services needed for the project or up to 40 percent of the total cost of the project, can be procured through ICB procedures.
- Evidence that projects financing plan can be achieved.
- Ability of the Sponsor to meet the milestones established in the financing plan for equity infusions into the project. This could be through standby letters of credit from a commercial bank backing up these infusions.
- Sponsors must have a proven track record of operating similar projects in Southeast Asia or other emerging countries under conditions similar to those that exist in Bangladesh. IDCOL should seek descriptions of the progress made on these projects.
- The project can meet an EIRR requirement of 12.0 percent.[72]
- Technology proposed by the project has a track record of being successfully implemented and used in other emerging countries under conditions similar to those that exist in Bangladesh or Southeast Asia.
- The cash flows are predictable, reliable, and sufficiently robust to support the financial feasibility of the project and ensure that the IDCOL loan will be repaid.
- At the conclusion of the review, the financial officer will prepare a preliminary project appraisal report based on the above checklist.
- Once the financial officer has completed the preliminary appraisal report, it will be reviewed by the CEO and submitted to the IDCOL Board of Directors for approval or rejection. In the event that IDCOL decides to reject an application, the CEO will inform the Sponsor of the rejection.

Source: IDCOL, Credit Risk Management Guidelines

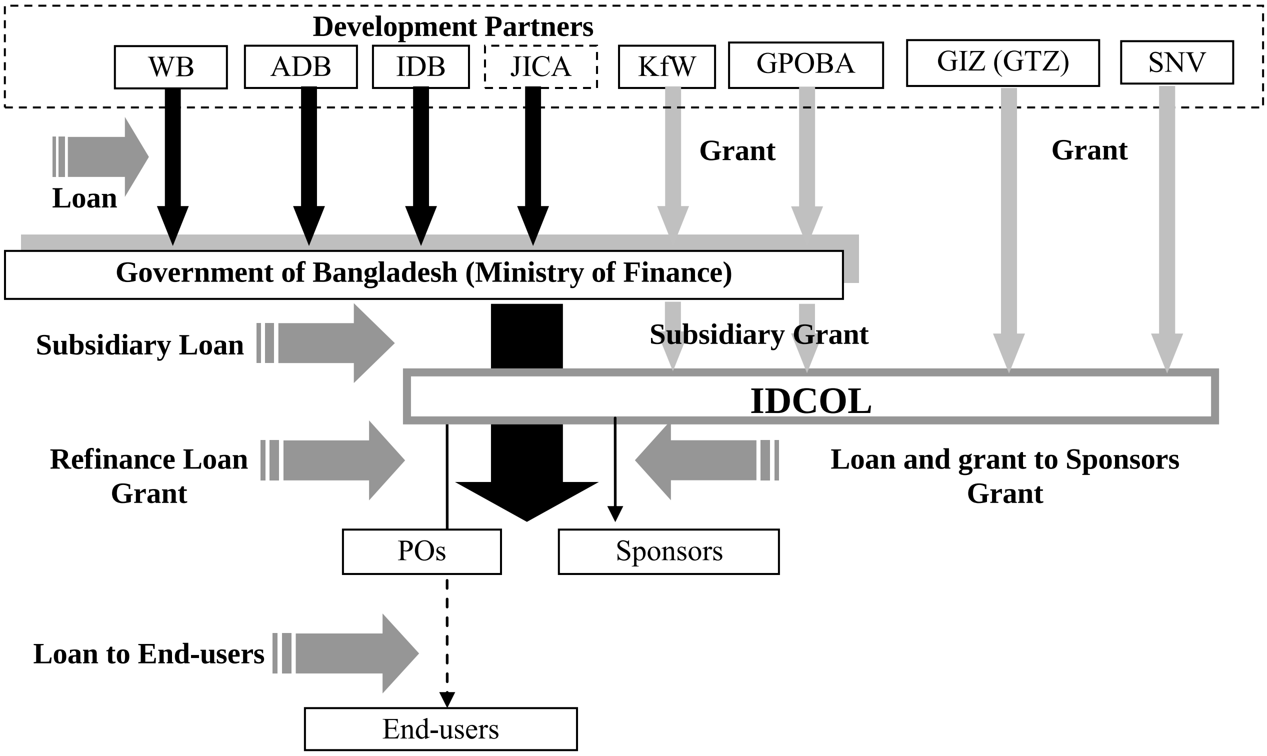
3.2. Financial Arrangements for IDCOL's Programs and Projects

3.2.1. Outline of the Whole Financial Arrangement

The whole financial arrangement can be described in 4 arrangement steps. The first step is 1) Loan from development partners to the GoB; the second is 2) Loan from the GoB to IDCOL loan; the third step is 3) Loan from IDCOL to sponsors (which are POs in the case of RE Programs such as the SHS Program and NDBMP); and the fourth step, which is exclusive for the RE Programs, is 4) Loan from the Sponsors (POs) to the end-users. The first step is called literally as "Loan" or "Grant", the second step is called as "the Subsidiary Loan". The third step

[72] "EIRR" is as expressed in the original document. It is thought to signify project internal rate of return in terms of finance (FIRR).

is called as “Refinance Loan” for RE Programs while it does not have a specific name for other RE Projects. The structure of the arrangement is as shown below:



Source: Compiled by the Survey Team based on loan/grant agreement documents made between IDCOL and the World Bank, ADB, IDB, KfW, GTZ, GIZ and SNV

Figure 3.2-1 Financial Arrangements

Lending terms of the loan for each of the financial steps were extracted based on the following actual loan agreement documents shown below:

(1) World Bank

- Development Credit Agreement (Rural Electrification and Renewable Energy Development Project) between GoB and IDA, July 16, 2002
- Financing Agreement (Additional Financing for Rural Electrification and Renewable Energy Development Project) between GoB and IDA, Sept. 2nd, 2009
- Subsidiary Loan Agreement (for Additional Financing for Rural Electrification and Renewable Energy Development Project, agreed on Sept. 2nd, 2009) between GoB and IDA, Nov. 18th, 2009

(2) Asian Development Bank

- Loan Agreement (ordinary operations) Public-Private Infrastructure Development Facility Project between GoB and ADB, Oct.21, 2008
- Subsidiary Loan Agreement between GoB and IDCOL, Nov.30, 2008

(3) Islamic Development Bank

- Loan Agreement between GoB and IDB, June 3, 2009 regarding participation in the financing of improving household livelihood through Solar Energy Project in Bangladesh – ISDF (Islamic Solidarity Fund for Development)
- Subsidiary Loan Agreement between GoB and IDCOL, Nov.26, 2009

Funding development partners are informed about IDCOL's progress through monthly SHS Operations Committee meetings to which development partners are invited. As for the RE Projects, the development partners are informed through a withdrawal application sent from IDCOL. These withdrawal applications are prepared when IDCOL requests the development partners for authorization to utilize the money.

3.2.2. Lending Terms

(1) Loan from Development Partners to GoB (MOF)

The lending terms of for each development partners are shown as follows:

Table 3.2-1 Lending terms of the Loan from Development Partners to GoB

Development Partners	Loan tenure	Grace period	Interest rate
World Bank[73]	25 years (Including Grace Period)	8 years	1.75% (during grace period) 2.00% (after grace period)
	Standard IDA terms		
	40 years (including 10 years grace period)	10 years	0.75% (Standard service charge)
ADB	20 years (Including Grace Period)	7 years	LIBOR + 0.6% (1.70% by and large)
IDB	25 years (Including Grace Period)	7 years	less than 2.5% (as a service charge)

Source: Compiled by the Survey Team based on loan agreement documents made between IDCOL and the World Bank, ADB, and IDB

The tenure of the loan provided by the above development partners is more or less 20 to 25 years, except for the standard IDA loan tenure of 40years. The grace period is 7 to 10 years and the interest rate is 1.7 to 2.5 percent, except standard IDA interest rate of 0.75 percent.

(2) Subsidiary Loan from GoB (MOF) to IDCOL

The lending terms of "Subsidiary Loan" corresponding to each Development Partners are shown as follows:

[73] The World Bank adopts the standard IDA terms in most cases. The above "25 years as loan tenure" case was applied to Rural Electrification and RE development project dated September 2, 2009. Such loan condition is adopted on the basis of standard terms taking account of individual project condition.

Table 3.2-2 Lending terms of the Loan from GoB to IDCOL

Corresponding Development Partners 1)	Loan tenure	Grace period	Interest rate
the World Bank	20 years (Including Grace Period)	5 years	3.00%
ADB	Ordinary Capital Resources (OCR) loan		
	20 years (Including Grace Period)	5 years	LIBOR + 1.0% (2.10% by and large)
	Special Fund (Asian Development Fund: ADF) loan		
	20 years (Including Grace Period)	8 years	3.00% - 5.00%
IDB	20 years (Including Grace Period)	5 years	3.00%

Footnote 1) The "Subsidiary Loan" corresponds to each development partner which provides GoB with loan.
Source: Compiled by the Survey Team based on loan agreement documents made between IDCOL and the World Bank, ADB, and IDB

The tenure of the subsidiary loan is 20 years, irrespective of corresponding Development Partner loan tenure. The grace period is 5 years as flat value except the loan corresponding to ADB special fund loan of 8 years. The interest rate is 3.0 percent, as the flat value except the loan corresponding to the ADB Ordinary Capital Resources of LIBOR plus 1.0 percent and ADF which is ranging from 3 to 5 percent.
As a whole, the lending terms of the "Subsidiary Loan" are almost the same as the flat value in spite of the fact that the lending terms of the loan from each Development Partners are different with each other.

A designated bank account is opened for every funding development partners. These accounts are called the Imprest Accounts. The accounts can be opened at any bank, and not necessarily the Bangladesh Bank. An account is expected to be opened also for JICA-REDP.

(3) Loan from IDCOL to Sponsors (POs for SHS Program)

IDCOL extends loan to the sponsors for RE projects as well as infrastructure projects. In the case of SHS Program and NDBMP, the POs, will be the sponsors who will then on-lend the loan to the end-users. These loans are meant to cover a part of the debt portion of the projects.

1) General Lending Terms

IDCOL's general lending term policy is articulated for both 1) Foreign Currency Loans and 2) Local Currency Loans. All loans for RE Programs and RE Projects are local currency loans.
(a). Lending Terms for Foreign Currency Loans
(i) Interest rate
- For senior loans, a variable rate equal to the prevailing six month United States dollar LIBOR plus minimum 400 basis points;
- For subordinated loans, a variable rate equal to the prevailing six month United States dollar LIBOR plus minimum 450 basis points;
- A fixed rate based on the maturity of the Sub-loan and the market swap rate between variable and fixed interest rates for the United States dollar debt at the time the Sub-loan is fully

drawn, plus “a spread of minimum 400 basis points for senior loans”, or “a spread of minimum 450 basis points for subordinated loans”

(ii)Final maturity

In the case of both senior and subordinated loans, it is a maximum of fifteen (15) years including up to three (3) years grace period.

(b). Lending Terms for Local Currency Loans

(i) Interest rate

In case that projects will be implemented in rural areas or renewable energy projects that will receive grants or subsidies from multilateral agencies and/or GoB, or renewable energy/energy efficiency/urban environmental services projects that are not feasible with commercial loans, or pilot/demonstration projects of similar types, the minimum annual interest rate are as follows:

i) 6.0 percent for: Rural and off-grid solar/wind/hydro/ other renewable energy projects i.e. mini-grids, irrigation pumps, driers, cold storage, charging stations, and biomass gasification based power plants etc.

ii) 9.0 percent for: Urban renewable energy projects i.e. telecom BTSs, roof-top solar systems, solar powered transportation, grid-connected RE projects etc., energy efficiency projects i.e. energy efficient brick kilns, brick kiln modernization, rice parboiling system, etc., urban environmental services i.e. effluent treatment facility, water treatment facility, solid waste management, etc., commercial biogas digesters / biogas based power plants, solar module assembling and manufacturing industries.

iii) 12.0 percent for: Accessories having renewable energy applications i.e. batteries, inverters, charge controllers, CFL lights, LED lights and accessories, and other similar manufacturing facilities

As for the loan extended to POs in the SHS Program, it will be extended in the form of “refinance loan”, for the reason that the loan covers a part of the loan offered by the POs to the end users. “Refinance Loan” is a term used exclusively for RE Programs (SHS Program and NDBMP). Lending terms of the refinance loan differs from a PO to PO. The condition is defined in accordance with the total cumulative amount a PO has borrowed from IDCOL.

Table 3.2-3 SHS Program Refinance Loan Terms

Cumulative Refinance Amount (BDT)	Interest Rate (on outstanding balance)	Loan Tenure including grace period	Grace period
Up to 250 million	6% per annum	Up to 7 Years	1 year
From 250 million up to 500 million	7% per annum	Up to 6 Years	1 year
From 500 million up to 1 billion	8% per annum	Up to 6 Years	1 year
From 1 billion	9% per annum	Up to 5 Years	0.5 year

Source: IDCOL, Renewable Energy Programme Participation Agreement between POs and IDCOL (Amended) July 2012

2) Loan Ceiling

For projects implemented in rural areas or renewable energy projects that receive grants or subsidies from multi-lateral agencies and/or GoB, or renewable energy/energy efficiency/urban environmental services projects that are not feasible with commercial loans, or pilot/demonstration projects of similar types, the ceiling of the “Refinance Loan” are as follows:

- IDCOL will finance the entire loan portion to the projects;
- However, IDCOL’s loan will not exceed to 80 percent of the project cost in any case.

3) Loan Coverage

IDCOL’s loan is stipulated, in its operation manual, to cover the total project cost. However, the definition of this “Total Project Cost” does not include any recurrent cost at the operation and maintenance stage. The loan therefore may cover 1) Land preparation costs, 2) Construction costs, 3) Equipment cost and 4) Consulting service fees.

Land acquisition costs will be included neither in loan or grant portion. IDCOL requires the land acquisition costs, if these were to arise, to be borne by the sponsors within the equity portion.

4) Loan Tenure and Grace Period

The loan tenure and grace period vary depending on the project type and financial conditions of the project executing entities shown as follows:

Table 3.2-4 Loan Tenure and Grace Period of the Loan from IDCOL to Sponsors

Loan tenure	Grace period
5 - 10 years	6 months to 2 years

Source: Compiled by the Survey Team based on IDCOL information

(4) Loan from Sponsors (POs) to End-Users in SHS Program

The lending terms of the loan offered by the POs to the end-users vary from a PO to another. This is due to the fact that IDCOL does not regulate the POs' lending terms offered to the end-users from the viewpoint of promoting competition. IDCOL loans vary depending on the project type and financial conditions of the end-users shown as follows:

Table 3.2-5 Lending terms of the Loan from Sponsors to End-users

Loan tenure	Grace period	Down-payment[Note1)] rate [Amount of down-payment] /[Total project cost]	Interest rate
1 - 3 years	None	Typically 10% [with some cases 5 - 100%][Note2)]	Typically 8%, With cases up to 16%[Note3)]

Note1: Down payment = Initial amount to be paid by end-users.
Note2: 5% down-payment rate is applied to extremely low income end-users while 100% is applied to extremely high income end-users. However numerical criterion with respect to income level does not exist.
Note3: Interest rate of 16% is applied to relatively high income end-users.
Source: Compiled by the Survey Team based on information provided by IDCOL (July 2012)

3.2.3. IDCOL's Lending Terms compared with Other Financial Institutions

(1) Lending Terms of the Commercial Banks

IDCOL's lending terms can be favorable to the borrowers comparing to the commercial bank's loan conditions of which lending rate varies from 13.0 percent to 19.5 percent as shown in the following table and short loan tenure of 6 months to 2 years and no grace period.

Table 3.2-6 Announced lending rate (annum interest rate: %) of the commercial banks

Banks	Term Loan to large & medium scale industry	Term Loan to small Industry
SONALI	15.0000	15.0000
JANATA	15.0000	13.5000
AGRANI	15.5000	15.5000
RUPALI	15.0000	15.0000
BKB	15.0000	15.0000
RAKUB	12.5000	13.0000
BASIC	15.0000	15.00-16.00
BDBL	15.0000	15.0000
PUBALI	14.0000	14.0000
UTTARA	14.00-15.50	15.5000
AB-BANK	14.0000	15.5000
IFIC	14.0000	15.5000
ISLAMI	13.50-14.00	14.5000
NBL	14.0000	14.0000
THE CITY	14.0000	18.0000
UCBL	14.0000	14.0000
ICB	16.5000	17.0000
EBL	13.0000	14.5000
NCCBL	14.0000	14.0000
PRIME	14.0000	18.5000
SOUTHEAST	14.0000	14.0000
DHAKA	14.0000	18.00-19.50
AL-ARAFAH	14.0000	14.0000
SIBL	15.5000	15.5000
MERCANTILE	14.0000	16.0000
ONE BANK	14.0000	15.5000
EXIM	14.0000	16.5000
PREMIER	16.00-17.00	16.00-17.00
FIRST SECU	14.0000	14.0000
STANDARD	14.0000	17.0000
TRUST BANK	14.0000	14.0000
MUTUAL TRUST	14.0000	14.0000
BANK ASIA	15.5000	14.0000
BCBL	15.5000	17.0000
JAMUNA	15.5000	17.0000
SHAHJALAL	14.0000	17.5000
BRAC	14.0000	18.0000
STAN.CHART	12.5000	18.5000
HABIB	14.0000	15.5000
SBI	15.5000	17.0000
NBP	14.5000	14.5000
WOORI	12.00-13.00	13.00-15.00
AL FALAH	15.5000	16.5000

As of June, 2012
Source: Bangladesh bank Web-site

3.3. Risk Mitigation for IDCOL's Programs and Projects

3.3.1. Risk Identification

Generally, the risks including credit risk, economic risk, and force majeure, are shouldered by the borrowers in terms of the interest rate associated with risk premium. Two interest rate options are available for IDCOL loans. It is determined from time to time by the Board of Directors:

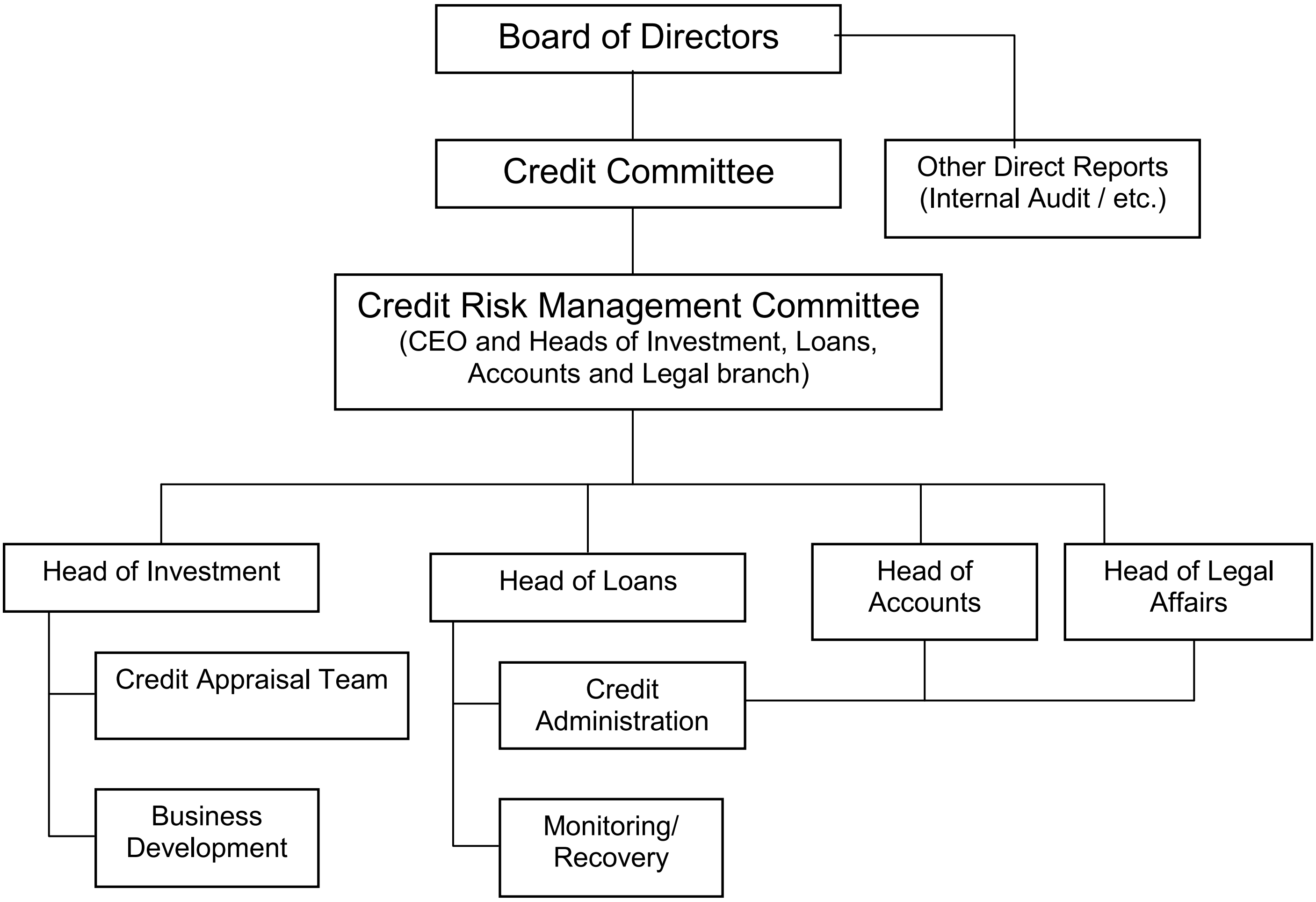
- Variable rates based on 6 months US$ LIBOR plus a risk premium.
- Fixed rates based on the term of the loan and the appropriate US dollar swap rate, plus a risk premium.

Risk premium is decided by the Credit Committee of the IDCOL Board and it is determined based on the following:

- The specific risks associated with each individual project,
- Risks associated with the industry or sector in which the project is being implemented such as the strength of regulatory structure.
- Country or political risk associated with doing business in Bangladesh.
- Risks associated with the length of loan maturity.

3.3.2. Credit Risk Management

IDCOL has its own credit management structure shown as follows:



Source: IDCOL, Credit Risk Management Guidelines

Figure 3.3-1 IDCOL Credit Risk Management Structure

The IDCOL "Board of Directors" has overall responsibility over the management of risks. The Board will decide the risk management policy of IDCOL and set limits for liquidity, interest rate, foreign exchange, and equity price risks.

The "Credit Committee" is the subcommittee including the CEO and the members of the Board of Directors. In general, all credit proposals shall originate from the investment department of IDCOL. The Credit Risk Management Committee shall conduct a thorough credit and risk assessment prior to forwarding any proposal to the Credit Committee. Nevertheless, the credit proposal should clearly state that all instructions and guidelines of the credit policy are complied.

The Credit Committee shall analyze the credit proposal to see whether the proposal is consistent with IDCOL's credit polices and credit norms, guidelines/regulations of the Bangladesh Bank, relevant laws etc. and has been presented observing all the required formalities. The Committee, in the light of its analysis shall consider the positive and negative sides of the proposal and shall give its opinion/recommendation. It is mentioned that Credit Committee shall only give recommendations/opinion about a proposal and the credits will be finally approved by the IDCOL Board.

The "Credit Risk Management Committee" is headed by the CEO and comprises the investment, loans, accounts, and legal affairs. The functions of the Credit Risk Management Committee are:

- To be responsible for the implementation of the credit risk policy/strategy approved by the Board;
- To monitor credit risk and ensure compliance with the limits approved by the Board;
- To recommend to the Board for its approval, clear policies on standards for presentation of credit proposals, financial covenants, rating standards and benchmarks;
- To take decisions in terms of capital allocation and defining limits in line with the risk strategy;
- To decide delegation of credit approving powers, prudential limits on large credit exposures, standards for facility collateral, portfolio management, facility review mechanism, risk concentrations, risk monitoring and evaluation, pricing of facilities, provisioning, regulatory/legal compliance etc.;
- To lay down risk assessment systems, develop MIS, monitor quality of facility/investment portfolio, identify problems, correct deficiencies and undertake facility review/audit and;
- To undertake portfolio evaluations and conduct comprehensive studies on the environment to test the resilience of the facility portfolio.

3.3.3. Security for Lending to the Sponsors

The SHS Program requires the POs to reserve approximately 40 percent of the refinance amount as security. The security is partly kept as cash in bank accounts and partly in the form of guarantee.

On the other hand, RE Projects are funded under a full recourse finance scheme. A mixture of various instruments is utilized for IDCOL to secure the value equal to the loan that will be extended from IDCOL to the sponsors. Instruments include land mortgage, letter of hypothecation issued by banks, personal guarantee of the directors, and others.

Table 3.3-1 Security for the SHS Program and RE Projects

	SHS Program	Other RE Projects
Security	1) A reserve of four quarterly repayment installments in the Debt Service Reserve Account (DSRA); 2) Either a legal mortgage of land or a bank guarantee for 20% of the outstanding refinance amount.	The combination of the following means of guarantee is up to full recourse of funding: - Mortgage of land; - A letter of hypothecation; - Personal guarantee of the directors; - Corporate guarantee by affiliated companies; - Lien on project accounts.
In case of defaults	Security will be in favor of IDCOL	Security will be in favor of IDCOL

Source: IDCOL

3.4. IDCOL's Capacity to Execute RE Programs and RE Projects

3.4.1. Financial Resources for RE Programs and Projects

(1) Fund Disbursed for IDCOL's SHS Program

The following table shows the past record of Loans and Grants disbursed for the SHS program by the development partners. The total amount of loans as of 2012 in terms of US dollar is 229 million, while the amount in terms of EURO is 0.1 million. As for the amount of the Grants, The total Grants as of 2012 in terms of US dollar is 16 million, which is 7.0 percent of the total amount of US dollar loan, while total Grant in Euro is 22.3 million, which is far beyond the amount of Euro loans.

Table 3.4-1 Loan and Grant received by IDCOL under IDCOL SHS Program

[Unit: million]

Source (Project Code)	Grant/Loan	Currency	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL
IDA 3679	Loan	USD	1.800	3.400	5.300	8.000	13.400	21.200	1.100	-	-	-	54.200
IDA 4643	Loan									29.600	47.000		76.600
IDA 50130	Loan											7.400	7.400
ADB-REP	Loan								3.100	23.600	4.200	40.600	71.500
ADB-SMIP	Loan								4.900				4.900
IDB BD-151	Loan									1.600	5.000	7.900	14.500
IDA 50130	Grant												0.000
ADB-Grant	Grant												0.000
GEF-TF	Grant		1.000	1.700	2.000	1.200	0.700	0.400	0.200	0.100			7.300
GPOBA-DFID	Grant										7.200		7.200
GROBA-SIDA	Grant											1.600	1.600
KfW	Loan	EURO					0.100						0.100
GIZ	Grant					1.100	0.500	0.100	1.900	3.400	0.700		7.700
KfW	Grant						0.400	4.000	0.900	3.600	4.100	1.700	14.700

Source: IDCOL

(2) Further Fund Requirement for IDCOL renewable Energy Program up to 2016

In July 2012, IDCOL revised the RE additional fund requirement up to 2016. The new requirement for implementation of RE Programs and RE Project from 2012 to 2016 is amounting to USD 610 million of which grants comprised of USD 92 million and loans of USD

518 million. Out of the required USD 92 million, IDCOL claims to have USD 72 million already available while the remaining USD 20 million is yet to be sought. Similarly, out of the total USD 518 million requirement of loan, USD 246 million is already available, with the outstanding USD 271 million additionally required.

Table 3.4-2 IDCOL's Fund Requirement for RE Programs and RE Projects

	Average Capacity	Number (2012-16)	Grant (USD million)				Loan (USD million)			
			Required	Total Requirement	Available (including proposed)	Additional requirement	Required	Total Requirement	Available (including proposed)	Additional requirement
Solar Mini-Grid	150 KW	50	15				9			
Solar Water Pump for Irrigation	400m3/day	1,550	25				19			
Solar PV Based Cold Storage	1000 m3	34	4				2			
Solar dryer	80 kg	12,250	2	50	43	7	2	44	18	26
Biogas based Power Plant	20 KW	450	3				7			
Biomass Gasification Based Power Plant	200 KW	28	2				5			
IDCOL SHS Program	<30 Wp + all sized SHS in 2012	1,268,562		28	17	10				
	For all sized SHS	2,679,732		-	-	-		458	225	233
IDCOL Biogas Program	2.4 m3	77,431		15	11	3		16	4	12
Total				92	72	20		518	246	271

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects Up to 2016 (July 2012)

The SHS Program is the largest in scale in terms of funding requirement with a total of USD 486 million required among which USD 458 million is the requirement for the loan. Its grant requirement is USD 28 million, limited to small SHS installations.

3.4.2. Support by External Resources

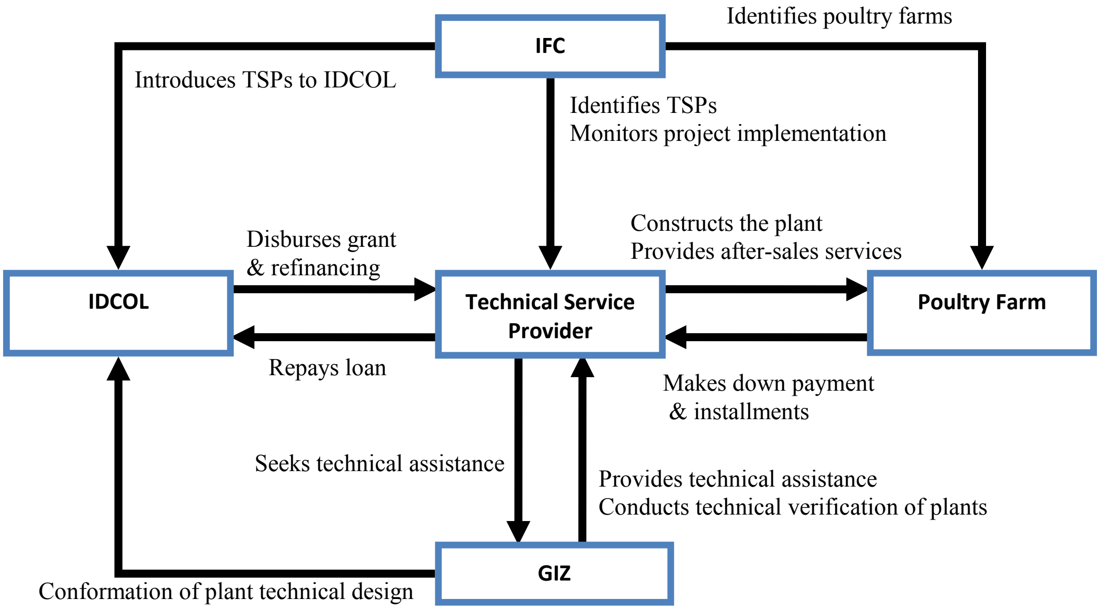
(1) Technical Advice from Development Partners

According to information obtained through interviews with IDCOL's Directors, IDCOL seeks for the technical advice from some of international development partners. Most commonly referred to GIZ, by which the Program Coordinator and Senior Advisors offer advice during the appraisal process of biomass derived RE projects applying for financing. Furthermore, KfW also supports technical appraisal of solar PV RE projects that are applying for financing. Some of the specific technical inquiries are conveyed to KfW headquarters at Frankfurt.[74] World Bank Energy Specialists also frequently give technical advice to IDCOL for each RE project. These technical consultations are usually conducted through queries and not on fee basis.

There is one arrangement between IDCOL, GIZ (signatory being GTZ), and the International Finance Corporation (IFC) on the "Poultry Waste to Energy Programs in Bangladesh", which was signed in 2010. The agreement requires the IFC to raise awareness of the poultry farms to

[74] According to an interview with the KfW Office Dhaka.

encourage them to participate in the project, while GIZ is responsible to provide technical support by identifying appropriate technology and designs for each needs. IDCOL is expected to offer finance to creditworthy clients. Based on this trilateral agreement, an NGO named "Seed Bangla Foundation" was approved to receive funds from IDCOL to proceed with the installations of their small scale 10 kW biogas power generation facilities.



Source: IDCOL, Presentation "Financing Bio-electricity Plants under IDCOL-IFC-GIZ Cooperation Agreement"

Figure 3.4-1 Structure of IDCOL-IFC-GIZ Cooperation Agreement

IDCOL as financial institution resorts to external expertise for technological information and understanding. IDCOL conducts formal and informal consultations with the development partners and also with university academics to supplement their technological knowledge. The IDCOL-IFC-GIZ agreement is an example of a mechanism that will formally facilitate such consultations. However, the agreement has resulted only in one client being approved for small scale installation, implying that the introduction of a mechanism is not necessarily a solution to supplementing IDCOL's lacking expertise.

(2) Professional Technical Consultants

Apart from ad-hoc consultations with the development partners and academic experts, IDCOL seeks for technological support from professional consultants on contractual basis. These consultants are hired for the purpose of providing technological advice in appraisal for requested RE projects. Consultants were hired for the appraisal of Gazipur and Thakurgaon gasification RE projects as well as for the appraisal of Mymensingh and Phoenix biogas power generation RE projects. Consultants were also hired for solar PV RE projects with the appraisal of Sandwip Island solar mini-grid. Furthermore, apart from appraisal there was a study outsourced to a Bangladeshi consultant for identification and collection of data from 100 potential locations for solar pump irrigations.

Consultants hired on these occasions are usually funded from IDCOL's own fund resources and not from development partners. There is also one case when an international development partner (KfW) extended their technical expertise by employing professional consultants on their expense.

Table 3.4-3 Professional Technical Consultants Hired by IDCOL for RE Projects

Project/Activities Name	Consultant/Advisor
250 kW Biomass Gasification Project at Kapasia, Gazipur	Foreign Consultant
400 kW Biomass Gasification and precipitated Silica Plant at Thakurgaon	Bangladeshi Consultant
Collection of Irrigation data of 100 upazillas (sub-district) of Bangladesh	
100 kW Solar Mini-Grid Project at Sandwip	Foreign Technical Consulting Firm (Funded by KfW)
50 kW Biogas Based Power Plant at Trishal, Mymensingh	Bangladeshi Consultant
3 Solar PV Assembling Plants	Bangladeshi Consultant (University)
Two Solar based Telecom BTS Project	
Phoenix 400 kW Biogas Based Plant	GIZ (as technical advisor)

Source: Compiled by the Survey Team based on information from IDCOL

(3) Technical Assistance Budget in RERED Project

The technical assistance budget from the World Bank RERED Project is extended to IDCOL in the form of a Grant. The total grant amount is USD 5.3 million. The major items for TA funded in the form of grant are as follows:[75]

1) Quality assurance:

- PV systems testing consulting services:
  Consulting Services is to achieve ISO accreditation. RERED also supports the establishment of a testing laboratory.
- Collection Efficiency Inspection:
  To support IDCOL oversight, it ensures that the POs' loan collection and procedures are in compliance.
- Field and Lab Audits and Testing:
  To conduct random laboratory and field testing of SHS, it ensures that the products are delivering the promised level of service at a required reliability.

2) Training and Outreach:

- Customer Training and raising Awareness:
  This TA will be conducted in order to support IDCOL, PO efforts to train SHS users, and to increase their awareness of SHS.
- Staff Training:
  This TA will be done in order to support capacity development of PO so that they will improve the quality and responsiveness of services offered to SHS customers. Also this TA will support training and capacity development of IDCOL staff to improve their effectiveness in managing the renewable energy investment program.
- Technician Accreditation Program:
  It will support the implementation of the technician accreditation program.

[75] Information from interview with IDCOL Director

- Training and exposure Visits:
  The program funds study tours and field visits inside and outside of Bangladesh for IDCOL staff, POs and some other relevant persons.

3) Environment:

- Battery Recycling Support:
  Support the POs to continue their battery recycling efforts, and to cover the incremental cost of recycling.
- CFL recycling program design:
  This item will support IDCOL in efforts to promote careful use and disposal of CFL bulbs.

4) Studies and Planning

- SHS Impact Evaluation:
  To undertake an impact evaluation of SHS and other RE technologies to assess user outcomes and benefits.

(4) Consultants for Implementation of RE Programs and RE Projects

IDCOL's basic policy for implementation of RE Programs (SHS Program and NDBMP) was to manage everything alone. Hiring consultants was not a preferred option for IDCOL.[76] Nevertheless, KfW in providing fund for IDCOL's SHS Program suggested that making use of consultants for monitoring while the World Bank required IDCOL will utilize external consultants for capacity development of the stakeholders. These suggestions and requirements were found to contribute the reinforcement of IDCOL's capacity to implement the SHS Program. Following are the assignments for outsourcing in line with the operation of SHS (from 1 to 3). There is another consultant assigned to function as an expert to support IDCOL to establish the Solar PV testing laboratory.

1) Monitoring Consultants Funded by KfW

On behalf of IDCOL, since 2009 KfW has been hiring consultants whose functions are to conduct technical monitoring of the SHS installed (1.5 percent sample rate), and financial monitoring of the POs active in the SHS Program (top 5 POs plus additional 1 PO). The consultants are mandated to report on quarterly basis to KfW.

IDCOL claims that the contribution of the KfW consultants for IDCOL to structure its own technical monitoring system has been significant. IDCOL also mentions that the reporting of KfW consultants were valuable inputs for IDCOL to implement the program through its own information source as opposed to information given from the POs.

2) Training Consultants Funded by the World Bank

IDCOL sees that intensive and continuous training for POs are essential to maintain the high rates of SHS penetration. Against this background, IDCOL commissioned an international consulting firm to conduct training aimed at training the trainers that will instruct SHS equipment installation skills. The consultants develop training contents, design a training program, and conduct 3 day training for the potential trainers.

The fee for hiring the consultants are paid by IDCOL from a fund obtained as a grant from the MOF. This grant from the MOF is a part of the World Bank RERED Project loan disbursed to MOF, and then extended to IDCOL in the form of a grant.

[76] According to an interview with a IDCOL Director.

3) Commercialization Consultant funded by the World Bank

IDCOL sees that the SHS Program will gradually shift to a commercial business that will require neither a grant nor concessional loan support. In view of this transition, IDCOL has assigned international consultants to conduct a study on the feasibility of this transition and to recommend to IDCOL based on the findings.

Consultants are contracted and paid by IDCOL. IDCOL is utilizing the grant money obtained from the MOF, supported by the World Bank RERED Project loan, as payment to the consultants for training.

4) Solar PV Component and Systems Test Capacity Development Consultant funded by the World Bank

IDCOL is currently planning to establish its own solar PV equipment testing center. This is due to IDCOL's desire to ensure the higher quality of SHS equipment by being capable to conduct testing by itself. International consultants are being assigned to conduct tasks such as: (i) test equipment procurement assistance; (ii) setting up of testing center and training the staff; (iii) undertake demonstration laboratory and field test, and (iv) prepare programs for ISO/IEC 17025 accreditation.

The costs for hiring these consultants are paid by IDCOL from the grant money obtained from MOF, supported by the World Bank RERED Project loan, as training and commercialization consultants.

3.4.3. Assessment of IDCOL's Capacity to Conduct RE Programs and RE Projects

Based on the organization, management, resources, and activities conducted by IDCOL, the company's capacity to execute RE Programs and RE Projects is assessed. The capacity for conducting RE Programs is observed from the following stages: program structuring, program execution, operation management, and program funding. The capacity for conducting RE Project is observed from the viewpoint of: designing, call for candidates, appraisal of sponsors and projects, monitoring, and funding stages.

1) RE Programs

The IDCOL's RE Programs are the SHS Program and NDBMP. It is both designed to be replicable throughout the country. Technology and equipment are standardized but with room for selection that would encourage competition. Looking at the number of POs involved in the RE Programs, the system attracting the implementing entities like PO can be said to be functioning successfully. The Survey team sees that the incentive structure in the POs can enjoy better condition after attaining certain number of sales. It is one of the key factors that make the system function.

RE Projects are executed in a decentralized manner, which makes the operation of a large scale program possible even with a limited number of staff in IDCOL. IDCOL's capacity to manage numerous financial transactions (payment and repayment of refinancing loans) is one of the keys to enable the smooth execution of the SHS Project. Another strength is the IDCOL's means to communicate with the POs through the monthly Operations Committee. This enables IDCOL to oversee the progress of the SHS Program.

The SHS Program is managed through a built-in annual cyclic management system where IDCOL management can Plan – Do – Check – and Act on the Program. First, each PO prepares an annual business plan, and then shares the plan among the stakeholders in an annual meeting.

Second, the POs conduct the SHS Program at their own discretion. Third, the result of annual activities is reported to IDCOL management. Fourth, the IDCOL management considers necessary improvements and modifications to the SHS Project. Hence, the cyclic improvement is endowed in the program.

The IDCOL's utmost strength in conducting RE Programs is the capability to attract funding. This is especially true when the company is compared with other institutions who are also conducting renewable energy deployment activities (REB, LGED, BPDM, etc.). So far, IDCOL has attracted more than 10 international development partners who provide both grants and loans for the programs.

2) RE Projects

In identifying potential project, IDCOL sets a funding scheme for specific technology and under certain rules. A trilateral agreement between the IDCOL, IFC, and GIZ is one of the typical arrangements to enable IDCOL to design a RE Project framework. However, the arrangement so far has not been successful in attracting appropriate sponsor candidates.

IDCOL will advertise the offer to attract attention of those who are in need. A comprehensive call for project candidates was done in 2004 when IDCOL issued an advertisement on a major national newspaper. Some of the offers were disclosed on the website. The method of call for applicants is not clearly defined. Therefore, it will require improvement.

Applications for funding are screened based on two aspects. One is the appraisal of the potential sponsors as a business organization while the other is the appraisal of the candidate RE project from the viewpoint of appropriateness of technology, equipment, and business model. Appraisal of the potential sponsorship is done by means of due diligence conducted by IDCOL based on the credit risk management guidelines, advice, and recommendations from accounting firms. While potential sponsor appraisal is conducted under a standardized procedure, appraisal of the technology and business model proposal cannot be conducted in a routine manner. Technological evaluation as well as the evaluation of the business model will have to be pursued with the support of external resources. IDCOL may have to reinforce its capacity on the technical and business model appraisal for RE Projects.

Once the RE Projects start operating, the status of these RE Projects will be monitored and verified. IDCOL, unlike with the RE Programs has not yet come up with an institutional structure to conduct monitoring for RE Projects.

Although IDCOL has been successful in attracting funds for RE Projects, the amount procured is still minimal compared with the SHS Program. The success of IDCOL's Projects is expected to further attract the attention of investors.

Table 3.4-4 Capacity Assessment of IDCOL (RE Programs and RE Projects)

Stages	Assessment
RE Program	
Program structuring	<u>Strength:</u> • The Program is well structured to involve numerous sponsors (POs) thus enabling the activities to be conducted in decentralized manner. • POs are given incentives to show better performance. • Technologies and equipment are standardized while flexibility is also given to encourage competition. <u>Weakness:</u> • A major portion of the credit risk is borne by the POs, resulting in dissatisfaction from the POs.
Program execution	<u>Strength:</u> • POs are given discretion in executing the Program. • An Operation Committee functions allows IDCOL to oversee the progress of the Program.
Program operation management	<u>Strength</u> • Built-in P-D-C-A management system functions allows SHS to improve and evolve continuously. • Monitoring is conducted thoroughly.
Program funding	<u>Strength:</u> • So far IDCOL has attracted more than 10 international development partners. More funds are expected to be directed to IDCOL's RE Programs.
RE Projects	
Designing a funding funding framework	<u>Strength:</u> • A concrete structure, like the trilateral agreement with IFC and GIZ is expected to function to design an appropriate funding framework. • IDCOL conducted a study on the assessment of 100 Upazillas, showing that IDCOL is determined to design the RE Project funding Framework by itself. <u>Weakness:</u> • IDCOL lacks technological expertise to identify and to apply the right technology and business model for the framework.
Call for projects candidates	<u>Weakness:</u> • Advertisement and promotional information dissemination are conducted only on demand and not systematically.
Appraisal of the sponsors and projects	<u>Strength:</u> • Appraisal criteria for the applicant organization are already structured and established. <u>Weakness:</u> • Appraisal from the viewpoint of appropriateness of technology, equipment to be installed, and the feasibility of the business model are currently being conducted on a trial-and-error basis.
Monitoring	<u>Weakness:</u> • Monitoring mechanism is yet to be introduced.
Program funding	<u>Strength:</u> • Funds for various RE promotion activities is already available with IDCOL. <u>Weakness:</u> • Successful examples of RE Projects are yet to be found.

Source: Survey Team

With regard to the results of the assessment of IDCOL's capacity to conduct RE Programs and Projects, the Survey Team concludes that IDCOL's capacity to conduct RE Projects is lacking especially in the appraisal of potential projects, and monitoring mechanisms. The support for these weaknesses will be clarified as Technical Cooperation packages in Chapter 7 of this report.

3.5. Overall Evaluation Criteria for the Selection of Appropriate Components for IDCOL

In light of the Capacity of IDCOL to conduct RE Programs and RE Projects, the criteria for the selection of appropriate components that will comprise the JICA-REDP have been identified.

RE and EE&C components are selected based on the criterions for screening of the candidate technologies. Criterions for component selection are formulated based on the information collected on deployment status of RE and EE&C promotions in Bangladesh including solar PVs, biomass energy sectors, development issues, existing interventions, and overall policies. Furthermore, the viewpoint of the 5 evaluation criteria which are relevance, effectiveness, efficiency, impact, and sustainability are also referred in formulating the criterions.

The five categories that will comprehensively screen the potential component candidates are the feasibility, expected effect, economic and financial viability, applicability of the supporting scheme, and social and environmental considerations.

Table 3.5-1 Criteria and for RE components

Category	
Evaluation Criteria	Outline of the Evaluation Criteria
Feasibility of introduction and promotion (Sustainability)	
Applicability of technology	Maturity and reliability of the technology Availability of materials and equipment
Existence of proper implementation organization	Project ownership, cost, and risk sharing structure. Will and commitment of the implementing bodies.
Expected Effect (Effectiveness)	
Alternative energy-saving potential	Saving an amount of the consumption of alternative energy such as diesel fuel, candles, kerosene and so forth, which are expected to be saved especially in the household level in remote areas.
Development effects	Positive benefit to be brought to social and economic aspects of the stakeholders, preferably in the pro-poor context.
Economic and Financial Viability (Efficiency, Sustainability)	
Market size and demand Expenditure	Quantification of the sales amount of the equipments and stocks especially in rural areas.
Financial viability	Financial viability and sustainability, financial advantages against other means of interventions
Sustainable Operation	Existence of a mechanism or measures to ensure sustainable operation and maintenance of the structure/equipment
Applicability of the Supporting Scheme (Relevance)	
Conflict with existing interventions	Positioning of the components within the context of development assistance, and climate change mitigation
Conformity between category of borrower and the supporting scheme	Introductory end-user category will be identified e.g., households at the medium income level, business firm or individual and so forth. Conformity to each end-user categories will be examined.

Source: Survey Team

4. Components of Renewable Energy Development Project and Programs of EE&C Technologies

4.1. SHS Program Component

If it were not for financial support in grant and loan from international development partners, this SHS Program could not have been materialized. As the consequence of the continuous decline of the solar PV module price, potions of grant and loans within IDCOL's SHS Program have also been changing. Financial support for the SHS installation is also gradually decreasing. Nevertheless, there are still great number of demands even for rudimentary SHS, especially within households in regions without electricity, which commonly classified as the Base of Pyramid (BOP) layer households. Further support by extending concessional loans will still be a significant contribution to the effective deployment of SHS.

The GoB indicates the target for RE until the year 2015 in the Power and Energy Sector Road Map. According to the target, the Solar PV is expected to be 200 MW. IDCOL's new plan targets to install 4 million sets (equivalent to 174MW) by 2015.[77] This plan almost fulfils the entire requirement of the GoB's plan, although it misses the target by 26MW. If IDCOL's target is met, then 12.5 percent of the total households in Bangladesh will be electrified by SHS.

Table 4.1-1 Target of Electricity Generation Capacity by 2015

Classification	Production MW by2015
Solar PV	200
Wind Power	200
Biomass	45
Biogas	45
Others	10
Total	500

Source: MOF, Power and Energy Sector Road Map: An Update June 2011

4.1.1. Expected Effect from the Component

(1) Volume of Power Generated from the New Plan to Install Further 2.679 Million Sets (112.5MW)

IDCOL prepared a new plan to further add 1.5 million SHS sets onto the former plan (2.5million SHS installations), resulting in a target to install 4 million sets by 2015 (accumulated figure). According to this new plan, 2,679,732 SHS sets are planned to be installed by the end of 2015. Average capacity of all of the additional SHS is planned to be at 42W.

Table 4.1-2 Revised plan for SHS Installation

	Size (Wp)	No of Sets	Total capacity
Small SHS (SSHS)	Smaller than 30 Wp	1,268,562	
SHS	30 Wp and over	1,411,170	
Total		2,679,732	112.5 MW

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects up to 2016 (July 2012)

[77] Since an additional 1.5 million sets are planned to target the lower income households, the average wattage of these SHS is expected to be 42 W, which is lower than the average of SHS (50 W) that are already installed.

In calculating the total power to be generated from these SHS to be installed, the calculation method in 2.2.2. (3) of this report is applied. The annual power generated from the total capacity of 112.5MW will amount to 129,452 MWh. If battery efficiency (80 percent) is considered, the actual generated electricity becomes 103,562 MWh/year.

Table 4.1-3 Power Generation from112.5 MW Capacity of 2.7 million sets of SHS to be Installed

No. of SHS	42W × 2.679mill.sets
Total Capacity of Solar PV	112.5MW
Generated Electricity	129,452MWh/year
Actual Generated Electricity (Battery efficiency 80%)	103,562MWh/year

Source: Calculation by the Survey Team

This target to install 2,679,732 resulting in 112.5 MW of additional power generation capacity that will boost the country's total solar PV power generation capacity to 174 MW (existing 62MW + new 112.5 MW). However, there will be a gap of 26 MW for Bangladesh to attain its target of 200 MW that is set by the MoPEMR.

(2) Reduction of Gas Consumption

Consumption for fuel (natural gas) is calculated under the assumption that the equivalent amount of electricity generated by Solar PVs would be generated from a thermal power station. The annual amount of natural gas consumed would be equivalent to 17,399,395m3.

{35.7MJ/m3 = 8,530 kcal/m3   1 kWh = 860 kcal/h

103,562MWh / {8530 / (860 / 0.5)} [78] = 20,879,435 m3 (Equivalent to about 20.1 Million m3 in natural gas)}

(3) Effects of Kerosene Reduction

As described in section 2.2, a typical household in a non-electrified area will use 50 liters of kerosene for lighting per year, which is 4.2 liter per month (3.4 kg/month). Converting these figures into lightness, in the case of kerosene wick lamp which is 1.15klm-h/kg, it would produce 126 lm-h/day of lightness. If 2.67million SHS sets are installed, these could contribute to reducing 133,500 kL (50 x 2.67million) of kerosene.

(4) Effects of Emissions Reduction

Using the CO2 emission intensity from power generated from natural gas, which is 575kg-CO2/MWh,[79] CO2 emitted from the 20.87 million m3 of natural gas would amount to 59,548 tons per year (103,562MWh x 575Kg-CO2/MWh= 59,548 ton -CO2).

4.1.2. Implementation Structure

The SHS Program that will comprise one of the components of the Renewable Energy Development Project will be conducted within the existing implementation structure. Key elements of the existing structure are as follows:

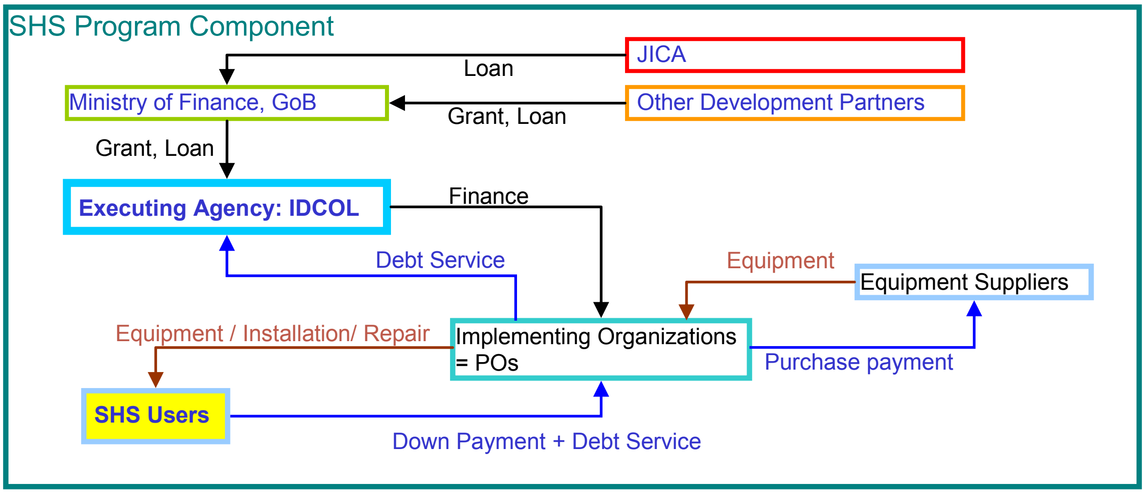
(1) Implementing Scheme

The Project Executing Agency (IDCOL) extends a loan (as two-step loan) to the Participating Organizations (POs). These POs having well-established relationship with the rural

[78] Efficiency of gas turbine generator assumed to be 50%.

[79] OECD/IEA (2011b)

communities are capable of reaching the individual customers for the SHS. POs conduct installation, maintenance, and repayment collection. POs procure the SHS from the equipment suppliers.



Source: Survey Team

Figure 4.1-1 Implementing Scheme of SHS Program

(2) Ownership

There are two types of ownership for SHS. One is the "fee for service" type (applied by REB) and the other is “buy and own using micro finance" (applied by IDCOL). The user of SHS under "fee for service" type is not required to pay the initial cost. He or she pays the flat rate utilization fee. The ownership of the equipment remains in the hand of the implementing organizations. The user of SHS under “buy and own using micro finance" will become the owner once the loan repayment is completed. The owner pays the down payment and then repays the rest of the amount by monthly loan for commonly 2-3 years.

IDCOL’s SHS Program offers the “buy and own using micro finance" type only. After the repayment of the loan (in 2-3 years) the system will belong to the owner. This type of ownership is proven to be more sustainable than the other as the users tend to care more in SHS.

(3) Operation and Maintenance

The operation of the SHS equipment will be under the responsibility of the individual owners. Participating Organizations (POs) of the SHS Program will also be responsible for the maintenance of the equipment upon request from the owners. Maintenance service is offered free of charge for the first three years from installation (i.e. loan tenor term). The local staff of PO office usually looks after approximately 100 units within the vicinity of the office. Maintenance is usually carried out on the occasion of loan repayment collection.

PO staffs that function to collect loan repayment and maintenance are trained to maintain and repair the equipment. The staff also plays a role to further popularize the SHS to other households in the villages. After the loan terms, individual users may choose to pay BDT 300 per year (excluding repairing, and exchanging parts) for continued maintenance services.

4.1.3. Business Plan

(1) Potential Demand for SHS

The most commonly provided type of SHS is the 50 W type. End-user who obtain the equipment by personal finance, pay a monthly amount of approximately USD 10 for three consecutive years. Therefore, a total of USD 120 (BDT 9,960) is paid in a year. Against this price the end-user enjoys three lamps and a black and white TV set, together with a mobile phone charger. As this type of SHS is the most commonly offered, potential demand is calculated by assuming that the households in need will uniquely acquire this 50 W type SHS.

According to JICA Study, the Power System Master Plan 2010 (PSMP 2010), off-grid area demand is 1,335 MW, 1,649 MW in year 2015 and 2021 respectively.[80] IDCOL will install 4 million SHS about 190 MW by end of 2015. This is only 14.2 percent of the off-grid demand in 2015. Based on the PSMP study, it could be considered that many of the current SHS equipment acquirers are those around the off-grid area.

Table 4.1-4 Grid System Demand and Off Grid Demand

FY	Grid system demand with DSM for MP (MW)	Off grid demand (MW)	Total demand (MW)
2012	7,518	1,093	8,611
2013	8,349	1,166	9,515
2014	9,268	1,246	10,514
2015	10,283	1,335	11,618
2016	11,405	1,433	12,838
2017	12,644	1,542	14,186
2018	14,o14	1,662	15,676
2019	15,527	1,794	17,322
2020	17,304	1,515	18,819
2021	18,838	1,649	20,488

Source: Power System Master Plan 2010 JICA Feb. 2011(Original: PSMP Study team and BPDB)

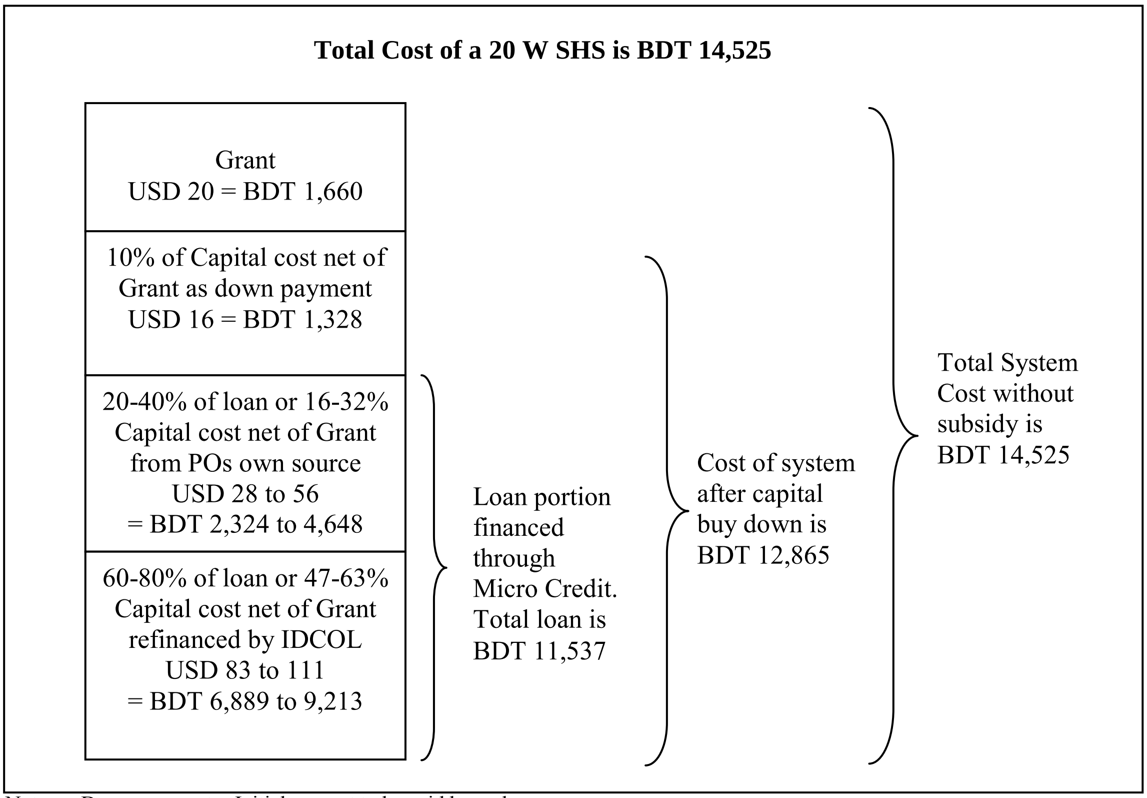
(2) Financing Structure for SHS Program

The SHS Program is financed from four major sources which are: (i) down payment by the end-users (mostly households and shops); (ii) buy down grant provided by various development partners through IDCOL to lower the initial investment cost; (iii) loan extended by the participating organizations (POs) to the end-users; and, (iv) IDCOL refinancing loan to subsidize certain portion of the loan extended from the POs. The financing structure of a small 20 W system as a representative case is as follows:

The capital cost of a 20 W system is approximately USD 175 (= BDT 14,525). This capital cost would be reduced by providing a buy down grant of USD 20 which is approximately BDT 1,660. A PO will charge the household a down payment of about 10 percent (USD 16 = BDT 1,328) of the system cost net of grant. The remaining 80 percent of the cost (USD 139) would be covered by a loan. This loan will initially be arranged by the PO (PO, itself may provide financing or through its affiliated micro financing institutions). A part of this loan will then be refinanced by IDCOL. IDCOL refinances between 60 percent and 80 percent of the loan (USD 83-111 or BDT 2,324 - 4,684) depending on the size, track record and performances of the PO. Therefore, the PO will provide 20 percent to 40 percent (USD 28-56 or BDT 6,889 - 9,213) of the loan.[81]

[80] JICA (2010)

[81] Further detailed information will be available in IDCOL's revised Operating Guidelines

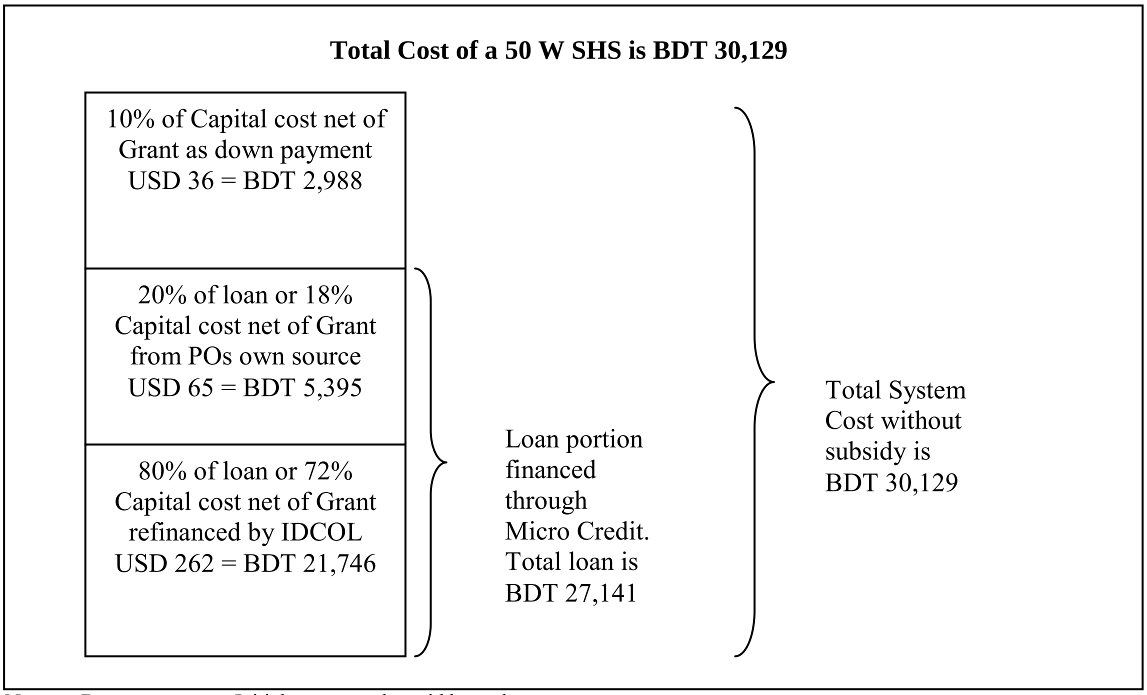


Note: Down payment = Initial amount to be paid by end-users.
Buy down grant = grant support provided from the development partners through IDCOL, with the aim to lower the acquisition cost of SHS.

Source: IDCOL, SHS Program Operating Guidelines (Figures are updated)

Figure 4.1-2 Financing Structure of a SHS

Financing structure explained above is an example of a small 20 W SHS. Percentages of each of the funding element will vary from case to case. From 2013 onwards, the buy down grant will only be applicable to smaller sized SHS (less than 30 W). The introduction of small sized SHS is meant to provide affordable SHS for people with less purchasing power. The financing structure of conventional types of SHS will become different. As an example, the capital cost of a 50 W system is approximately USD 363 (= BDT 30,129). A PO will charge the household a down payment of about 10 percent (USD 36 = BDT 2,988) of the system cost. The remaining 90 percent of the cost (USD 327 = BDT 27,141) would be covered by a loan. This loan will initially be arranged by the PO (The PO itself may provide financing or through its affiliated micro financing institutions). A part of this loan will then be refinanced by IDCOL. IDCOL refinances up to 80 percent of the loan (USD 262 = BDT 21,746) depending on the size, track record, and performances of the PO. Therefore, the PO will provide at least 20 percent (USD 65 or BDT 5,395) of the loan.



Note: Down payment = Initial amount to be paid by end-users.
Buy down grant = grant support provided from the development partners through IDCOL, with the aim to lower the acquisition cost of the SHS.

Source: IDCOL, SHS Program Operating Guidelines (Figures are updated)

Figure 4.1-3 Financing Structure of a SHS

(3) Fund Requirement for SHS Program

IDCOL is seeking for new loans for 2,679,732 SHS. It is set to be installed during 2012 to 2015 to reach the total target of 4 million sets. The total fund requirement is USD 788 million. Among this requirement figure, USD 458 million (58 percent of total) is the refinancing loan requirement. USD 28 million (4 percent of total) is the requirement for buy down grant. The remaining USD 302 million will be covered by either down payment of the end-users or the POs loan extended to the end-users.

1) Loan Requirement

IDCOL's requirement of USD 458 million is expected to be disbursed as shown in the following table. Approximately USD 100 million per year will be the constant requirement from 2012 to 2015.

Table 4.1-5 Number of SHS and Year wise Loan Requirements

	Unit	2012	2013	2014	2015	Total
Refinancing fund required for SHS Program	No. of SHS	486,149	674,500	731,500	787,583	2,679,732
	USD million	92	113	121	131	458

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects up to 2016 (July 2012)

Among the loan requirement of USD 458 million, USD 225.2 million has been extended (or committed) by other development partners (ADB, IDA for RERED, and RERED II). Therefore, the additional outstanding requirement of IDCOL is USD 233 million.

Table 4.1-6 Loan Fund Status for SHS Program

Development Partners	Total	IDA RERED	ADB	IDA RERED II (proposed)	Sub total	Additional requirement
Fund requirement (USD million)	458	120.5	9.8	(94.9)	225.2	233
% of total requirement		26%	2%	(21%)	49%	51%
No. of SHS		705,039	57,338	(555,255)	1,317,632	1,363,270

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects up to 2016 (July 2012)

2) Grant Requirement

The grant value is USD 25 per set in 2012. It is expected to decrease to USD 20 per set from 2013 onwards. The total fund requirement is USD 28 million among which USD 17.4 million is either disbursed or committed to be disbursed by the international development partners, i.e., IDA, GPOBA (SIDA), ADB, USAID (proposed), and GIZ (proposed). The outstanding additional requirement is USD 10 million.

Table 4.1-7 Grant Fund Status for SHS Program

	IDA RERED	GPOBA (SIDA)	ADB (ACEF & CCF)	USAID (proposed)	GIZ (proposed)	Sub Total	Additional requirement
Fund Requirement (USD million)	7.0	4.4	2.0	(2.4)	(1.6)	17.4	10
% of total requirement	26%	16%	7%	(9%)	(6%)	64%	36%
No. of SHS	684,603	430,322	195,601	(234,721)	(156,481)	1,701,728	978,004

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects up to 2016 (July 2012)

4.2. Solar Irrigation Pump Component

Specifications given by IDCOL are as follows. The discharge of the pump is said to be 400m3/day.

Table 4.2-1 Specifications of Solar Pump Plan by IDCOL

No. of Pumps	1,551
Ave. Capacity (m3/day)	400
Ave. Pump Capacity (kW)	8
Ave. Solar Capacity (kW)	11
Total Ave. Pump Capacity (kW)	12,400
Total Ave. Solar Capacity (MW)	17.05
Total Generation (MWh / year)	18,637
Fuel Saving Volume (kL)	5,828
CO2 Reduction Volume (ton/year)	15,345
Cost of Construction	USD 40,000/system Total USD 62 million
Loan Request	USD 18.6 million
Grant Request	USD 24.8 million

Source: IDCOL

The objective of the Solar Pump is to boost agricultural production by enabling 3 harvests to increase the food supply. The reduction of energy & CO_2 is secondary but also an essential factor. In countries like Bangladesh, where population density is high and the availability of land is limited, an increase of the food supply is a crucial factor for sustainable growth. The installation of the solar pump is a significant measure to promote development, same with SHS. Therefore, the replacement of the diesel irrigation pumps to solar pumps may deem to be an appropriate component for JICA-REDP to be applied.

4.2.1. Expected Effect from the Component

(1) Electricity Generated

The equivalent capacity for the Solar PV 400 m3/day Pump (about 5-11 kW, average value of 8 kW) was 11 kW. The annual energy generated from 11 kW is 12,024 kWh. Calculation method is identical to that of Calculation Method in sun-section2.2.2. (3) of this report.

Table 4.2-2 Electricity Generated by Solar PV for Irrigation Pumps

Pump Capacity	Solar PV Capacity	Generated Electricity
8kW	11 kW	12,024kWh/year

Source: Calculation by the Survey Team

(2) Effect of the Reduction of Fuel

Fuel Reduction is amounting to 5,828kL (3.76kL × 1,550). The effect of the reduction of fuel was calculated based on the following conditions:

- 1 set uses 3.76 kL of Diesel Oil per year.
- Supposition: Efficiency of Diesel Engine: 30 percent
- Calorific Value of Diesel Oil: 9200 kcal/L
- 12,024/ {9,200 / (860 / 0.3)} = 3,757 L

(3) Effect of Emissions Reduction

CO_2 emission was calculated as 15,600 (10.1ton × 1550) tons of CO_2 per year. Following conditions were applied:

- CO_2 Emission intensity of diesel oil = 2.7kg-CO_2/L (EIA, 2011)
- 3.76kL x 2,7Kg-CO_2/L =10,152 kg-CO_2/ year/set.

4.2.2. Implementation Structure

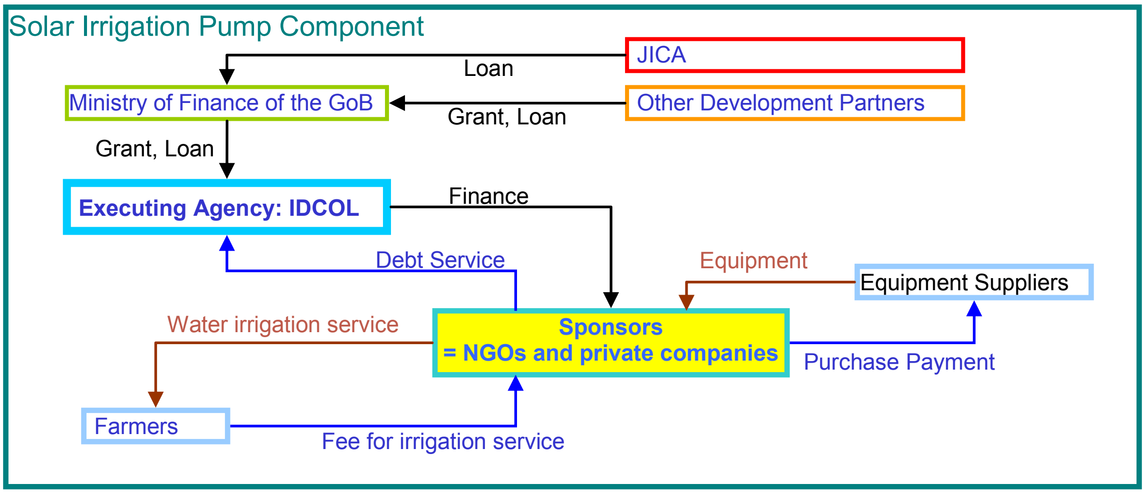
The current implementation structure for the solar irrigation pump project is in line with the typical structure for implementing pilot projects where IDCOL conducts appraisals for individual cases proposed by the project sponsors. A new structure similar to the SHS Program is being planned to be introduced, while the details are yet to be defined. Implementation structure illustrated here is the current ongoing cases, and this is liable to change in a short while.

(1) Implementation Scheme

Sponsors for the solar irrigation pump project are private entities that can be NGOs and registered as the POs or any new entrants. IDCOL is currently welcoming proposals not only from the POs for the SHS Program and the NDBMP but also from other private companies that are interested in the business.[82] Sponsors will prepare, submit a proposal for installation and

[82] According to an interview with an IDCOL Director

operation of a solar irrigation system, and consults with IDCOL for finance, which is the combination of a loan and a grant.
Once the proposal is approved by IDCOL, the sponsors will receive a soft loan and grant from IDCOL to a certain percentage of the total capital cost of the sub-projects. There is always a self financing portion for the sponsors to bear a part of the capital cost (equity portion). In all existing cases, it is the implementing organizations that design each sub-projects. Operation and maintenance including service provision and money collection from the farmers is either conducted by the sponsors or outsourced to other organizations based on the agreement.



Source: Survey Team

Figure 4.2-1 Implementing Scheme of the Solar Irrigation Pump Component

Japan has experience installing solar pumps for drinking water in various developing and emerging countries.[83] These solar pumps have helped improve the quality of life in rural areas where safe drinking water is scarce. The considerations for sustainable use of wells by examining the capacity and water level of the wells are the key know-how that makes these interventions successful.

As the solar drinking water pumps and the pumps for irrigation use the similar sorts of technology and equipment, JICA's experience can provide valuable implications for the activities to be financed by IDCOL, to install numerous solar irrigation pumps during a limited time span. Therefore, the Survey Team recommends that JICA's expertise should be offered to IDCOL in implementing the component. An expert experienced with solar PV pumps can be designated as an advisor to IDCOL, to collaborate with the Component Unit for JICA-REDP. Another option is to have JICA expert assigned, but also an advisor to the Component Unit who will be liaising between IDCOL and the JICA headquarters with regards to the solar irrigation technologies. The role of this JICA expert may also include technical transfer to the sponsors.

(2) Ownership

Sponsors design the solar pump system to meet the demands of the farmers to irrigate their farmlands. The implementing organizations procure the equipment from suppliers (there are cases where equipment suppliers play a role as the sponsors and procure their own equipment). The sponsors erect and install the solar pump system using its own source of money (equity portion), together with the loan and grant from IDCOL. The ownership of the equipment will be with the sponsors from the beginning till the end of the project life.

[83] JICA, former JBIC and JICS have installed solar pumps for various purposes.

(3) Operation and Maintenance

The operation of the equipment providing irrigation service to the farmers, and collecting the fees for the irrigation service will be the major tasks which the sponsors will have to conduct. To pursue the task of operation, the sponsors assign trained staff who will operate the equipment, distribute the water, and collect money from the farmers. There are also cases where maintenance of the equipment will be outsourced to the equipment suppliers.

4.2.3. Business Plan

(1) Potential Demand for Solar Irrigation Pump

If irrigation facilities are not available, 3 harvest times in a year may not be possible in Bangladesh. To enable the farmers to harvest 3 times a year, irrigation pumps powered by diesel engines are commonly installed. By converting the diesel engine pump to solar pump, there are merits such as the reduction in irrigation water costs, reduction in CO2 emissions, preservation of the field environment, and relief from engine maintenance costs. Bangladesh imports 100 percent of its oil. The rising price is giving a blow to the economy.

According to the statistics provided by BADC, the total number of irrigation pumps throughout the country numbers to 1,756,488. Among this number, approximately 15 percent (268,708 units) are pumps powered by grid electricity. 85 percent (1,487,780 units) are irrigation pumps powered by diesel engines. Most of these diesel powered pumps (75% or 1,321,441 units) are pumps for shallow tube wells (STW).[84] The diesel shallow tube well pumps are candidates for replacement to solar irrigation pumps.

Table 4.2-3 Number of Irrigation Pumps by Water Level and Tractions

	Deep Tube Well (DTW)			Shallow Tube Well (STW)			Low Lift Pump		
	Electric	Diesel	Area Irrigated (hectare)	Electric	Diesel	Area Irrigated (hectare)	Electric	Diesel	Area Irrigated (hectare)
Dhaka	6,537	1,260	175,680	75,707	335,612	909,220	2,972	26,693	174,545
Rajishahi	19,562	882	430,256	98,707	617,328	1,614,435	1,939	12,315	81,348
Chittagong	2,226	106	46,556	27,703	36,296	150,664	4,218	43,330	271,024
Khulna	2,251	711	65,309	24,066	324,941	810,511	199	33,117	190,060
Sylhet	108	26	1,391	1,525	7,264	20,457	574	33,161	203,325
Barisal	1	0	14	0	0	0	413	14,738	89,679
Total	30,685	2,985	719,206	227,708	1,321,441	3,505,287	10,315	163,354	1,009,981

Source: BADC/DAE, Minor Irrigation Survey Report 2010-11.

Taking into account the massive number of existing irrigation pumps in the country, IDCOL is proposing to finance the installation of 1,551 solar pumps with the minimum pumping capacity of 400 m3/day by 2016. As their first step to promote solar irrigation pumps, IDCOL has identified 100 candidate locations (Upazillas) to install the equipment during 2012.[85]

Criteria employed for selecting these locations are as follows:

- Farmers can cultivate at least 3 crops per year;
- Existence of ground water within 10 meters of depth and with diesel operated irrigation pumps currently under use;

[84] BADC/DAE (2011)
[85] IDCOL internal report "Final Report of The Study for Collection of Data Related to Irrigation in 100 Upazillas of Bangladesh" prepared by Engr. (Agril) M A Baqui, Ph D

- Site is beyond the reach of national grid electricity supply;
- Existence of certain amount of water requirement for irrigation.

IDCOL has requested some POs and other organizations to seek their interests in implementing the solar irrigation pump sub-projects. Few POs and other organizations are seen to have submitted their expression of interest to IDCOL.[86] The move shows that IDCOL has started to push forward on their target to install 1,551 pumps by 2016.

(2) Financing Structure for Solar Irrigation Pump Component

The capital cost for the solar irrigation pump sub-projects will be borne by three sources of funds, which are the sponsors own fund (equity portion), grants, and soft loan. The sponsors are expected to fund at least 30 percent of the capital cost through their own fund. Grants can be given to up to 40 percent of the total capital expenditure, while the remainder will be appropriated by soft loan. The same structure and conditions are applied to both 4SL and NUSRA sub-projects.

Table 4.2-4 Funding Structure and Requirement for Solar Irrigation Pump Component

	Percentage (%)	Estimated fund requirement (USD)
Own fund (equity portion)	30%	18,600,000
Grant	40%	24,800,000
Loan (Interest rate 6%)	30%	18,600,000
Total	100%	62,000,000

Source: Compiled by the Survey Team based on information collected from IDCOL

The condition of soft loan provided by IDCOL to the implementing organizations for the existing cases (4SL and NUSRA) is 6 percent interest rate, tenure of 10 years.

(3) Fund Requirement for Solar Pump

IDCOL is planning to introduce the 400m3/day (minimum size) solar irrigation system to 1,550 locations. The capital cost for one system is amounting to USD 40,000. Therefore, the total cost amount is approximately USD 62 million. The requested loan by IDCOL is USD 18.6 million, while the grant is at USD 25 million.

1) Loan Requirement

IDCOL's total request for the solar irrigation pump installation is USD 18.6 million. Among this amount, IDA in the context of RERED Project has already committed to extend USD 0.6 million, with an additional due of USD 3.6 million. Therefore, the remaining requirement amount is USD 14.4 million.

Table 4.2-5 Loan Fund Status for Solar Pump

	Total	IDA RERED	IDA RERED II (proposed)	Sub total	Additional Requirement
Fund Requirement (USD million)	18.6	0.6	(3.6)	4.2	14.4
% of total requirement	100%	3%	(20%)	23%	77%
No. of pumps	1,550	50	(300)	350	1,200

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects up to 2016 (July 2012)

[86] According to interviews with IDCOL and BRAC Foundation

2) Grant Requirement

IDCOL's request for grant concerning the solar irrigation pump installation is USD 24.8 million. Apparently, the amount of USD 1.2 million has already been pledged by four development partners (KfW, IDA, GPOBA (DfID), ADB (ACEF & CCF)). Further to support, USD 23 million has been expressed to be borne by the Bangladesh Climate Change Resilience Fund (BCCRF). USAID and KfW are proposing to fund USD 0.3 million. Therefore, the grant requirement is fully met when these proposals are committed.

Table 4.2-6 Grant Fund Status for Solar Pump

	Total	4 development partners	BCCRF (proposed)	USAID (proposed)	KfW (proposed)	Sub total	Additional requirement
Fund Requirement (USD million)	24.8	1.2	(23)	(0.3)	(0.3)	24.8	0
% of total requirement	100%	3%	(93%)	(1%)	(1%)	100%	0%
No. of pumps	1,550	75	(1,437)	(19)	(19)	1,550	0

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects up to 2016 (July 2012)

4.3. Solar Mini-Grid Component

4.3.1. Expected Effect from the Component

(1) Volume of Power Generated

The volume of power generated will be calculated, if all the planned 50 systems –150 kW are installed. The calculated method is the same with the indication on 2.2.2 (2) 2). One system generates 172,600 kWh of power a year.[87] The total volume of power generated for the 50 sub-projects will be 172 MWh x 50 = 8,630 MWh/year. The actual generation is 6,900 MWh considering battery efficiency (8,630 × 0.8 batteries efficiency).

Table 4.3-1 Power Generated from 150kW Mini-Grid

Mini-Grid	System	Generated electricity
1 Market	150 kW	172,600 kWh/year Actual generation (Battery efficiency80%: 138,080kWh)
50 Market	150 kW x 50 = 7,500 kW	8,630 MWh/year Actual generation (Battery efficiency80%: 6,900MWh)

Source: Calculation by the Survey Team

(2) Diesel Oil Reduction

The following calculations are based on aforementioned assumptions. The total amount of diesel oil to be consumed per year by 50 systems will be equivalent to 2,155 kL.
Efficiency of Diesel Engine: 30 percent,
Diesel oil calorific values = 9,200 kcal/L.
138,080/ {9200 / (860 /0.3} = 43,150 L/year

[87] c.f. Calculation Method in 2.2.2 (3) of this report.

(3) Effect of CO2 Emissions Reduction

The volume of the CO2 emission was calculated based on the following coefficient for CO2 emission. The emission reduction amounts to 5,800 tons of CO2 per year.

Emission intensity of diesel oil = 2.7kg-CO2/L (EIA, 2011)

43kL x 2.7kg-CO2/L = 116ton -CO2 / year.

The total reduction from 50 sites amounts to 5,800 ton/ year.

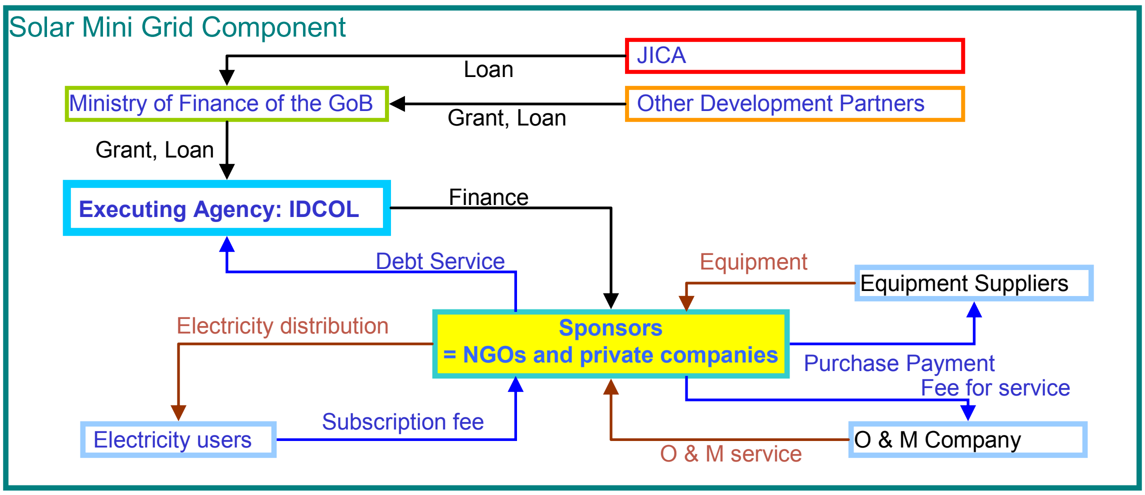
4.3.2. Implementation Structure

So far there has only been one mini-grid sub-project implemented. The structure for implementation is still to be defined. The description below is mostly based on the current structure. It is liable to be changed as the facilities are more actively deployed.

(1) Implementing Scheme

Sponsors for mini-grids are private entities that can be NGOs that are registered as the POs or any new entrants. IDCOL is currently considering implementing mini-grid sub-projects in line with the scheme to be designed for the solar irrigation pump sub-project.[88] Sponsors will prepare, submit a proposal for the installation and operation of a solar irrigation system, and consults with IDCOL for finance, which are the combination of a loan and a grant.

Once the proposal is approved by the IDCOL, the executing agency will receive soft loan and a grant from IDCOL to a certain percentage of the total capital cost of the sub-projects. There is always a self financing portion for the sponsors to bear a part of the capital cost (equity portion). In all of the existing cases it is the sponsors who design each of the sub-projects. Operation and maintenance including service provision and money collection from the electricity users is either conducted by the sponsors or outsourced to other organizations based on an agreement.



Source: Survey Team

Figure 4.3-1 Implementing Scheme of the Solar Mini-Grid Component

As with the solar irrigation pump, IDCOL's Solar Mini-Grid Component has an ambitious target to deploy 50 of the facilities that have only been demonstrated in one example. The Survey Team suggests IDCOL to seek expertise in conducting this component.

[88] According to an interview with IDCOL

JICA, with the Solar Irrigation Pump has extensive experience of installing similar facilities in various developing countries. First of these facilities were constructed in Lao PDR by the New Energy and Industrial Technology Development Organization (NEDO) almost 15 years ago, and is a well proven technology. These mini-grids have contributed in helping the rural residents and merchants to improve their living conditions, small business activities, and the performance of public utilities.

The Survey Team recommends IDCOL to make full use of JICA's experience in installing solar mini-grids. The know-how that JICA possesses is not only the technology but also the operation of a business. Such know-how is based on experiences in other developing countries in designing the equipment and business structure in accordance with the local context and available resources. The expertise can be also used in Bangladesh to structure the sub-project in an optimum and efficient manner.

A sponsor will have to make arrangements with the local people on the terms of use. As well as the setting of appropriate tariff. The designing of the system is not only a technical issue but also of social issue as layout of the equipment is dependent on the area's activities. Safety for operation and maintenance will also have to be considered. JICA's expert preferably with the expertise is suggested to participate in the implementation of the component as an advisor to the JICA-REDP Component Unit of IDCOL. The transfer of technology and knowledge onto IDCOL and the sponsors will also be expected as a benefit of having such an expert.

(2) Ownership

Implementing organizations design the mini-grid system to meet the demand of the users who are concentrated in the designated area (market tenants for example). The sponsors (In the case of the Sandwip Island mini-grid, the sponsors is PGEL) procure the equipment from suppliers (there are cases where equipment suppliers play a role as the sponsors and procure their own equipment). Sponsors erect and install the solar mini-grid system using its own source of money (equity portion), together with the loan and grant from IDCOL. The ownership of the equipment will be with the sponsors from the beginning till the end of the project life.

(3) Operation and Maintenance

The operation of the equipment, connecting distributing electricity to the subscribers, and collecting fees for these subscribers will be the major tasks which the sponsors will have to conduct.

The existing example of the Sandwip Island mini-grid charges the subscribers with the actual amount of electricity consumed by each subscriber. Therefore, each distribution line is equipped with individual meters. In this case, the operator will check the meters when collecting usage fees. There will also be an option to charge the subscribers under flat tariff regardless of the actual consumption amount. This will enable the installation of the distribution line to be done with fewer resources without the need for meters. Fee collection will also be simpler and more efficient. Furthermore, uncertainty on the operators' income will be relieved regardless of the consumption patterns of the subscribers.

To pursue the task of operation, the sponsors should assign trained staff who will operate the equipment, check the demand/supply status of electricity, and collects money from the subscribers. There will also be cases where maintenance of the equipment is outsourced to the equipment suppliers. In the case of the Sandwip Island mini-grid, all the operation and maintenance tasks are borne by the sponsor themselves.

4.3.3.Business Plan

(1) Potential Demand for Solar Mini-Grid

The Mini-Grid for the Sandwip Island marketplace drastically changed the place, not only the change of the source of power but also environmental benefits was observed. Furthermore, economic benefits are also reflected in the electricity cost. There are at least 5,000 market places without grid electricity in Bangladesh where small scale diesel engine generators for lighting, ceiling fans, TV etc. are used. The electrification of these non-electrified marketplaces will contribute to Bangladesh's economy as well as to the preservation of the environment through the reduction of Diesel Oil and the reduction of CO2 emissions.

(2) Financing Structure of Mini-Grid

The capital cost for the mini-grids will be borne by three sources of funds, which are the executing agency's own fund (equity portion), a grant, and a soft loan. The executing agencies are expected to fund at least 20 percent of the capital cost through their own funds. Grants can be given to up to 50 percent of the total capital expenditure, while the remainder will be appropriated by soft loan. The same structure and conditions are applied to the example of Sandwip Island mini-grid installed by the PGEL.

Table 4.3-2 Funding Structure and Requirement for Solar Mini-Grid Component

	Percentage (%)	Estimated fund requirement (USD)
Own fund (equity portion)	20%	6,000,000
Grant	50%	15,000,000
Loan (Interest rate 6%)	30%	9,000,000
Total	100%	30,000,000

Source: Compiled by the Survey Team based on information collected from IDCOL

The conditions of the soft loan provided by IDCOL to the implementation organizations for the existing cases (PGEL) is of 6 percent interest rate, with a tenure of 10 years.

(3) Fund Requirement for Solar Mini-Grid

IDCOL is planning to finance 50 of 150kW mini-grid systems. The cost of one system is USD 600,000 (calculated from unit cost of BDT 332,000 per kW). Within the total required amount of USD 30 million, a loan of USD 9 million and a Grant of USD 15 million is required.

1) Loan Requirement

IDCOL's total loan request for solar mini-grid installation is USD 9 million. IDA, within the context of RERED, has already allocated USD 0.7 million. IDA further expressed its intention to bear an additional USD 3.1 million as REREDP II fund. The remainder to be sought by IDCOL is USD 5.2 million.

Table 4.3-3 Loan Fund Status for Solar Mini-Grid

	Total	IDA RERED	IDA RERED II	Sub total	Additional requirement
Fund Requirement (USD million)	9	0.7	(3.1)	3.8	5.2
% of total requirement	100%	8%	(34%)	42%	58%
No. of facilities	50	4	(17)	21	29

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects up to 2016 (July 2012)

2) Grant Requirement

IDCOL's grant request for solar mini-grid installation is USD 15 million. KfW and GPOBA (DfID) have already pledged to fund USD 0.6 million each. ADB also has allocated USD 0.3 million. Furthermore, USAID and KfW are proposing to offer USD 3.0 million and USD 10.5 million each. Therefore, the grant requirement will be fully met when these proposals are realized.

Table 4.3-4 Grant Fund Status for Solar Mini-Grid

	Total	KfW	GPOBA (DfID)	ADB (ACEF & CCF)	USAID (proposed)	KfW (proposed)	Sub total	Additional requirement
Fund Requirement (USD million)	15	0.6	0.6	0.3	(3.0)	(10.5)	15	0
% of total requirement	100%	4%	4%	2%	20%	70%	100%	0%
No. of facilities	50	2	2	1	10	35	50	0

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects up to 2016 (July 2012)

4.4. Gasification of Biomass Component

Whether in Bangladesh or elsewhere, biomass based electricity power production projects in many cases is difficult to financially sustain by electricity sales revenue only. Even if a gasification power generation plant is located in the grid connected area, which is mostly the case, the frequent load shedding makes it difficult to feed the generated power into the grid as a means for obtaining revenue. Another disadvantage in Bangladesh, there is currently no financial incentives to promote biomass power generation. A way to obtain revenue is to sell electricity to demands around the gasification power generation plant, or even to substitute oil generated electricity.

Nevertheless, there is a need to consider a subsidiary revenue source with the precipitated silica production and sales in Thakurgaon. Taking this into account, a possible candidate site for further installation of biomass gasification and silica production plant would be in Naogaon, Rajshahi division, which can obtain operational and maintenance cost by selling silica and electricity.

The Thakurgaon gasification project takes advantages of precipitated silica production and sales toward the inland industry which contributes to generating a large portion of the project income.

Since the sales of electricity to the surrounding rural areas do not provide enough income (as with 250 kW, Gazipur plant), another profitable source of revenue needs to be combined.

A common issue with rice husk gasification technology is silica that damages the gasifier machine. Technical consideration to avoid damages should carefully be considered.

4.4.1. Expected Effect from the Component

(1) Volume of Power Generated

Each facility of rice husk gasification produces at least 924,000 kWh for local use, which is based on the calculation of 200 kW × 14hour (operational hours per day) × 330 day=924,000 kWh. Therefore, the total power generation is 18,480,000 kWh (924,000 kWh × 20 facilities).

(2) Reduction of Natural gas consumption

The consumption for fuel (CNG) is calculated under the assumption that the equivalent amount of electricity generated by rice husk gasification would be generated from a thermal power station. The annual amount of natural gas consumed would be equivalent to 3,726,331m3.
{35.7MJ/m3 = 8,530 kcal/m3 1 kWh = 860 kcal/h
18,480 MWh / {8530 / (860 / 0.5))} = 3,726,331 m3

(3) Effect of CO2 Emissions Reduction

CO2 reduction volume will be 15,939 t CO2 for 20 facilities.
924,000 kWh × 575kgCO2/MWh × 20 facility =10,626 t-CO2.

(4) Job Creation on Operation & Maintenance

The rice husk gasification facility needs 9 employees in each plant for operation and maintenance. The total job creation is 180 employments (9 employment × 20 facility).

(5) Unused Biomass Utilization

Rice husk is used for raw material. The usage for rice husk gasification is new. Under a 20 hour operation, the gasifier needs 12.8t rice husk per day. In this estimate the operation hour is 14hours. The total rice husk utilization volume is 12.8 × 14/20 × 330 × 20=59,136 tons of rice husk. Rice husk is dealt with 4~5 BDT/kg at rice mills. This volume equals to BDT 266,112,000.

4.4.2. Implementation Structure

Financial sources from development partner organizations will be brought to the MOF at first and then brought to the IDCOL. Financial support will be brought to rice mill companies or cooperatives. They pay debt service toward IDCOL.
In the stage of design and construction, the fee is paid to equipment suppliers. Equipment includes rice husk gasifiers, and silica precipitation facilities, etc. In the case operation and maintenance are outsourced, the service is provided from O&M companies and fees are paid. The gasification and silica precipitation facility generates products (electricity, silica, calcium, and carbonate). Product users will pay for the product usage.

(1) Implementing Scheme

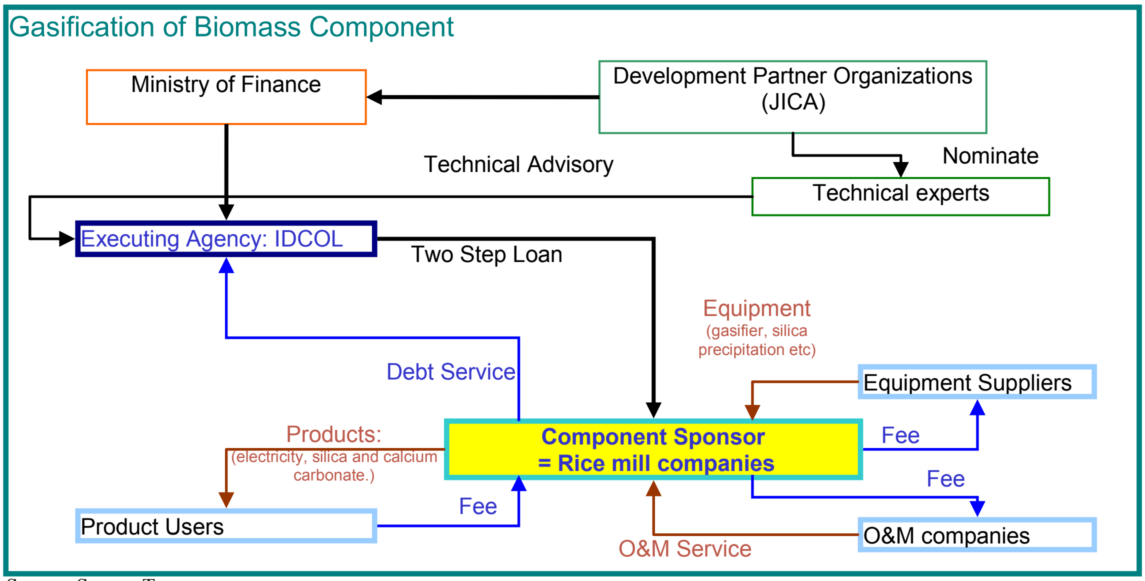
A rice mill companies that wants to install rice husk gasification facilities should write a proposal to IDCOL. There is an announcement to recruit applicants at IDCOL's homepage. If the proposal is approved by IDCOL, financial support will begin. Financial sources should be equity and loan. A grant will be only counted in case that silica production is not contained in the proposal or the rice mill company size is small.

(2) Ownership

The facility is usually owned and operated by rice mill companies. The rice mill companies repay their loans through facility operation.

(3) Operation and Maintenance

The facility is usually operated by 1) O & M companies, 2) equipment suppliers or rice mill companies. If there is a mechanical breakdown that occurs and it's not fixed right away, equipment suppliers are required to take care of the maintenance. The maintenance cost is BDT 650,000 per year.



Source: Survey Team

Figure 4.4-1 Implementation Structure of Gasification of Biomass Component

Technical issues on rice husk gasification that have to be considered are as follows:

- Consideration for safety on syngas treatment as combustible gas (H2,CO);
- Consideration for clinker removal problem from machinery with rice husk gasification;
- Consideration for continuous operation for cost effective operation.

On the implementation of the Gasification of Biomass Components, the above technical issues are most likely to occur. Rice husk gasification technology needs special technical knowledge and even in JICA, the number of specialists is very limited. However, JICA needs to support IDCOL on these technical issues.

One possible solution is to find senior specialists from research organizations in Japan or to find experienced technical experts from Japanese private engineering companies. Outsourced technical experts visit Bangladesh and conduct studies to advice. If technical issues occur, technical experts and technical staff in IDCOL will communicate each other to solve the problems.

Another solution is to hold regular meetings in Japan or Bangladesh, where technical problems and the Component status information will be shared. In case of holding in Japan, technical staffs will be invited and attend the meeting and conduct study at research organizations or private companies.

4.4.3. Business Plan

(1) Demand for Rice Husk Gasification

With consideration for the relative complexity of the technological aspect of the gasification plants, the Survey Team sees that IDCOL's capacity to approve and extend finance to the development of gasification plant should be 5 to 7 plants a year. This coincides with IDCOL's target to finance 28 more plants by 2016.

IDCOL expects that the average size of a gasification plant will be 200kW, which is half of the Thakurgaon plant. It should be noted that the rice mill in Thakurgaon is one of the largest rice mills in Bangladesh.

According to recent research, the rice mill distributions are listed in the following table. The targets for gasification plants will be the middle and large size rice mills which add up to 540 altogether:

Table 4.4-1 Adequateness of Biomass RE Activities as Component

Size	Capacity		Number of rice mills
Small	20t-25t/day	0.83~1.04t/hour	About 90,000
Middle	25-50t/day	1.04~2.08t/hour	490
Large	More than 50t/day	More tan 2.08t/hour	50

Source: Bhuiyan, A. M. W, M. R. R. Mojumdar and A.K.M.K. Hasan.2011. An improved method to generate electricity and precipitated silica from rice husk: perspective Bangladesh. International Journal of Environmental Science and Development, 2(4), August 2011

200kW biomass gasifiers need raw material (rice husk) of 1.7 kg / kWh, under the assumption that the facility operation hour is 16 hours per day.
The raw material of biomass needed is 3,200kWh × 1.7 kg/kWh=5,440kg/day.
Taking into account, that one kg of rice results in 0.22 kg of rice husks, 24.7 tons per day of rice will be required to obtain 5,440 kg of rice husk.

(2) Investment Cost of Rice Husk Gasification

IDCOL's fund requirement shows that the unit cost of 200 kW gasification plants is USD 285,000 (= BDT 23.7 million), resulting in the total amount of USD 8.0 million for 28 new installation targets. The Initial cost for the 400 kW plant at Thakurgaon is BDT 92 million (USD 1.1 million). Considerable cost cutting in initial investments will be required.

(3) Fund Structure for Gasification of Biomass Facilities

The capital cost of the rice husk gasification will consist of three kinds of fund sources, which are the sponsor's own funds (equity portion), a grant and a soft loan. The rice mill companies are expected to fund at least 20 percent of the capital cost through their own funds. A grant can be provided to up to 20 percent of the total capital expenditure, while the remainder (60 percent) will be appropriated by soft loan.

Table 4.4-2 Funding Structure and Requirement for Gasification of Biomass Component

	Percentage (%)	Estimated fund requirement (USD)
Own fund (equity portion)	20%	1.6 million
Grant	20%	1.6 million
Loan (Interest rate 6%)	60%	4.8 million
Total	100%	8.0 million

Source: Compiled by the Survey Team based on information collected from IDCOL

(4) Fund Requirement for Gasification of Biomass Facilities

1) Loan Requirement

IDCOL's loan request for Gasification of Biomass Component is USD 4.8 million. IDA, (as RERED II) has expressed its intention to extend USD 1.4 million of the total. The remaining requirement amount is USD 3.4 million.

Table 4.4-3 Loan Fund Status for Gasification of Biomass Component (USD million)

	Total	IDA RERED II (proposed)	Sub total	Additional requirement
Fund Requirement (USD million)	4.8	(1.4)	1.4	3.4
% of total requirement	100%	(29%)	29%	71%
Number of facilities	28	(8)	8	20

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects up to 2016 (July 2012)

2) Grant Requirement

IDCOL's request for grants concerning the Gasification of Biomass Component is USD 1.6 million. USD 0.1 million has been allocated from the available ADB Grant. Two other development partners have further expressed their intention to fund USD 1.5 million. Therefore, a grant requirement is fully met by these three development partners.

Table 4.4-4 Grant Fund Status for Gasification of Biomass Component (USD million)

	Total	ADB (ACEF & CCF)	USAID (proposed)	KfW (proposed)	Sub total	Additional requirement
Fund Requirement (USD million)	1.6	0.1	(0.6)	(0.9)	1.6	0
% of total requirement	100%	6%	(38%)	(56%)	100%	0%
Number of facilities	28	2	10	16	28	0%

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects up to 2016 (July 2012)

4.5. Biogas Power Generation Component

Biogas obtained from the fermentation of livestock wastes, if constantly obtainable in large masses, becomes a valuable source for power generation. In the case of poultry farming, there is also a constant demand for electricity in poultry farms for lighting and ventilation. Electricity generated from biogas, even without being sold, can generate virtual income by offsetting current electricity bills that are being paid to either grid electricity or own diesel power generation.

The component aims to introduce poultry waste biodigesters and power generation equipment that will produce not only electricity but also slurry that can be utilized as fertilizer.
IDCOL has implemented 50kW, 350kW, and 400kW scale of power generation through poultry waste biodigesters. Electricity generated will be utilized to meet the high demand of electricity consumption at the poultry farms. Slurry after fermentation will become valuable by-product which can be utilized as fertilizer or aquaculture feed.

4.5.1. Expected Effect from the Component

(1) Volume of Power Generated

Each plant has 20kW generators. The average operational hour per day is about 8 hours.
The total electricity generated at plant is 20kW × 8hour × 365days × 60facility=3,504,000kWh.

(2) Effect of CO2 Emissions Reduction

A poultry house needs a lot of electricity demand for air conditioner, and lightning etc. The electricity demand per day is 160kWh (20kW × 8 hours). The CO2 reduction volume will be 2,014,800 CO2 kg for electricity usage at 60 facilities.

(3) Reduction of Natural Gas Consumption

Consumption of fuel (CNG) is calculated under the assumption that the equivalent amount of electricity generated by poultry waste power generation would be generated from a thermal power station. The annual amount of natural gas consumed would be equivalent to 353,275m3.
{35.7MJ/m3 = 8,530 kcal/m3   1 kWh = 860 kcal/h
3,504 MWh /2 / {8530 / (860 / 0.5))} = 353,275 m3

(4) Diesel Oil Reduction

The following calculations are based on aforementioned assumptions. The total amount of diesel oil to be consumed per year will be equivalent to 545,913L.
Efficiency of Diesel Engine: 30 %,
Diesel oil calorific values = 9,200 kcal/L.
3,504 MWh /2 {9200 / (860 /0.3} = 545,913 L/year

(5) Reduction of Chemical Fertilizer Usage

20kW power generation has about 20,000 heads of poultry. Bio slurry can replace chemical fertilizer. The amount of chemical fertilizer replaced is 1,788kg/year and also can save purchasing costs of BDT 77,500 per year.
The total reduction of chemical fertilizer is 1,788 × 60=107,280kg and the cost saved is BDT 77,500 × 60 facility =BDT 4,650,000.

(6) Job Creation on Operation & Maintenance

For the job creation on operation & maintenance, 1 employment for slurry agitator maintenance and 1 employment for generator maintenance are expected at 50kW scale plant. It will be the same people required if the facility size is 20kW. 60plants × 2 employments = 120 employments.

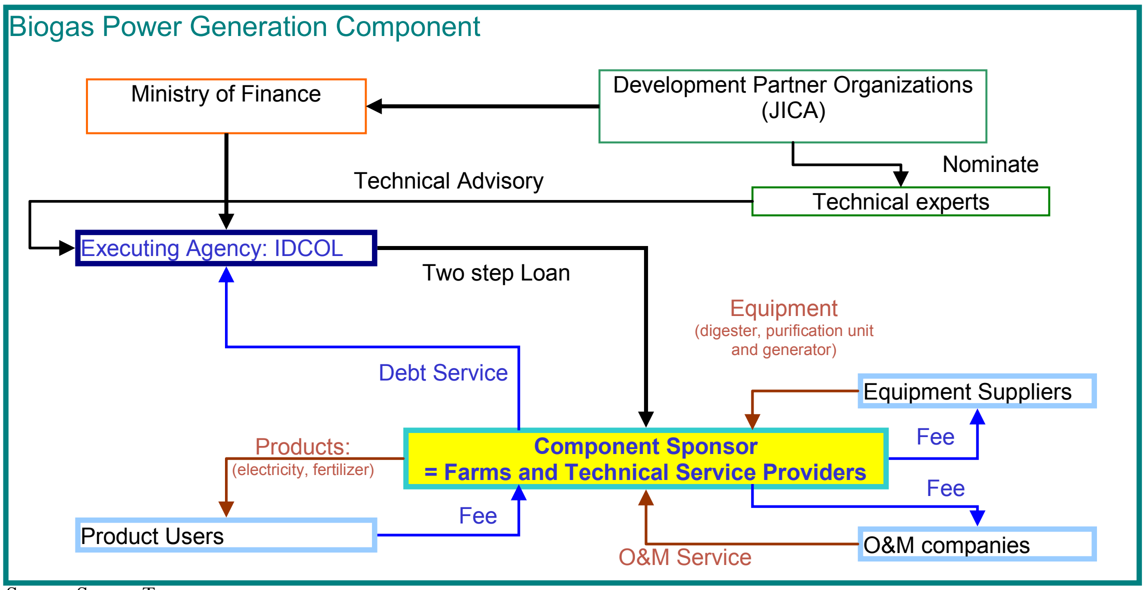
(7) Unused Biomass Utilization

If this facility does not exist, the poultry waste or cattle waste is land filled or discharged into rivers. Unused poultry waste is utilized by biodigester installations.
In case of 20,000 poultry scales, the total waste volume after water addition is about 4t per day.
The total waste utilization volume is 4t ×60 ×365=87,600t.

4.5.2. Implementation Structure

Finance from development partner organizations will be offered to MOF then onward to IDCOL. IDCOL extends through a two step loan, financial support to the sponsors of the sub-projects, who can be the poultry farmers or the Technical Service Providers, as stipulated in IDCOL-IFC-GIZ agreement. Sponsors pay back the debt service to IDCOL based on their sales or from savings.

In the stage of design and construction, a fee is paid for equipment suppliers. Equipment includes biodigester tanks, biogas purification units, and generators etc. In the case operation and maintenance are outsourced, the service is provided from O&M companies and fee is paid. The biodigester and power generation facility generates products (electricity, liquid fertilizer and fish feed). Product users will pay for the product usage.



Source: Survey Team

Figure 4.5-1 Implementation Structure of Biogas Power Generation Component

(1) Implementing Scheme

Poultry farmers who want to install poultry waste biodigesters should write a proposal to IDCOL. There is an announcement to recruit applicants at IDCOL's homepage. If the proposal is approved by IDCOL, financial support will begin. Financial sources are equity and loan. Grant will only be provided in case of poultry farmer size is small.

(2) Ownership

The facility is usually owned and operated by poultry farmers. The poultry farmers repay their loans through facility operation.

(3) Operation and Maintenance

The facility is usually operated by workers in poultry farm. If mechanical breakdown which is not fixed easily occurs, equipment suppliers are required to take care of its maintenance. The total maintenance cost of the plant per year is BDT 75,000.

Technical issues on poultry biogas power generation which have to be considered are as follows:

(i) Consideration for NH3 ratio in biogas leading to long duration fermentation process time;
(ii) Consideration for continuous operation for cost effective operations;
(iii) Consideration for biogas purification against H2S;
(iv) Consideration for poultry health safety.

On the implementation of the Biogas Power Generation Component, (1) to (3) technical issues are very likely to occur. For smaller poultry farmers, it is technically more difficult to install poultry waste biodigesters.
As for methane fermentation technology, although JICA might have few technical experts, there are many technical experts in Japanese research organization and private engineering companies.

One possible solution is to find a senior specialist from research organizations in Japan or to find an experienced technical expert from Japanese engineering private companies. Outsourced technical experts visit Bangladesh and conduct advisory studies. If technical issues occur, technical experts and technical staffs in IDCOL will communicate with each other to solve the problems.

Another solution is to hold regular meetings in Japan or Bangladesh, where technical problems and the Component status information will be shared. In case of holding it in Japan, technical staffs will be invited and attend the meeting and conduct study at research organizations or private companies.

Regarding the fourth issue mentioned above, this is different from technical methane fermentation field. This issue concerns the poultry industry and JICA might have many technical experts on this field.

4.5.3. Business Plan

(1) Demand for Biogas Power Generation Facilities

There are 1,500 poultry farms identified to have the size of 20,000 heads according to the Ministry of Food. Among them, IDCOL has set a target for installing average size of 20 kW biodigester to 450 farms. The proportion of the size of a poultry farm and the size of biogas power generation plant is a minimum of 10,000 heads against 20kW, operating for eight hours a day.

The table below reflects poultry farm distribution per size according to BCAS data. For the sake of higher viability of the projects, the initial step should be targeted to 60 large scale poultry farms with more than 50,000 heads. Afterwards, the size of the plants can be downsized to be applicable to medium scale farms with over 10,000 heads.

Table 4.5-1 Poultry Farmer Distribution

Poultry heads	%	Number of poultry farmer
From 5,000 to 10,000 heads	6.88	10,320
From 10,000 to 50,000 heads	1.03	1,545
More than 50,000 heads	0.04	60

Source: BCAS, 2005: Report on Feasibility Study on Biogas from Poultry Droppings. Bangladesh Centre for Advance Studies.
Zaman, S.A.U.2007. The potential of electricity generation from poultry waste in Bangladesh. a case study of Gazipur district

(2) Investment Cost of a Biogas Power Generation Facility

Initial Cost per each facility for 20kW is USD 32,000 (= BDT 2,656,000). Total necessary initial cost for the installation of 450 facilities is USD 14.4 million (BDT 1,1952 million).

(3) Funding Structure for Biogas Power Generation Facilities

Capital cost of the poultry waste biodigester will consist of three kinds of fund sources, which are the sponsors' own fund (equity portion), grant and soft loan. The poultry farmers are expected to fund at least 30 percent of the capital cost through their own fund. The grant can be given to up to 20 percent of the total capital expenditure, while the remainder (50 percent) will be appropriated by soft loan.

A poultry farmer who has less than 10,000 heads will be eligible for smaller 10kW plants. However, the financial viability of smaller scale power generation is expected to be under difficult conditions without a grant. Therefore, the funding structure is expected to vary according to the size of the facility.

Table 4.5-2 Funding Structure and Requirement for Biogas Power Generation Facilities

	Percentage (%)	Estimated fund requirement (USD)
Own fund (equity portion)	30%	4.3 million
Grant	20%	2.9 million
Loan (Interest rate 6%)	50%	7.2 million
Total	100%	14.4 million

Source: Compiled by the Survey Team based on information collected from IDCOL

(4) Fund Requirement for Biogas Power Generation Facilities

1) Loan Requirement

IDCOL's loan request for Biogas Power Generation Component is USD 7.2 million. From this amount, IDA as (RERED II) has expressed its intention to lend USD 6.2 million. The remaining requirement amount is therefore USD 1.0 million.

Table 4.5-3 Loan Fund Status for Biogas Power Generation

	Total	IDA RERED II (proposed)	Sub total	Additional requirement
Fund Requirement (USD million)	7.2	(6.2)	6.2	1.0
% of total requirement	100%	(86%)	86%	14%
Number of facilities	450	390	390	60

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects up to 2016 (July 2012)

2) Grant Requirement

IDCOL's request for grant concerning the Biogas Power Generation Component is USD 2.9 million. From this amount, USD 0.1 million has already been allocated by an ADB grant. Two other development partners have further expressed their intention to jointly fund USD 1.7 million. The remaining required amount of grant is therefore USD 1.1 million. IDCOL is actively seeking for support from development partners to fill the gap of this grant requirement.

Table 4.5-4 Grant Fund Status for Biogas Power Generation

	Total	ADB (ACEF & CCF)	USAID (proposed)	KfW (proposed)	Sub total	Additional requirement
Fund Requirement (USD million)	2.9	0.1	(0.4)	(1.3)	1.8	1.1
% of total requirement	100%	3%	(14%)	(45%)	62%	38%
Number of facilities	450	16	(62)	(202)	280	170

Source: IDCOL, Additional Fund Requirement for IDCOL Renewable Energy Programs and Projects up to 2016 (July 2012)

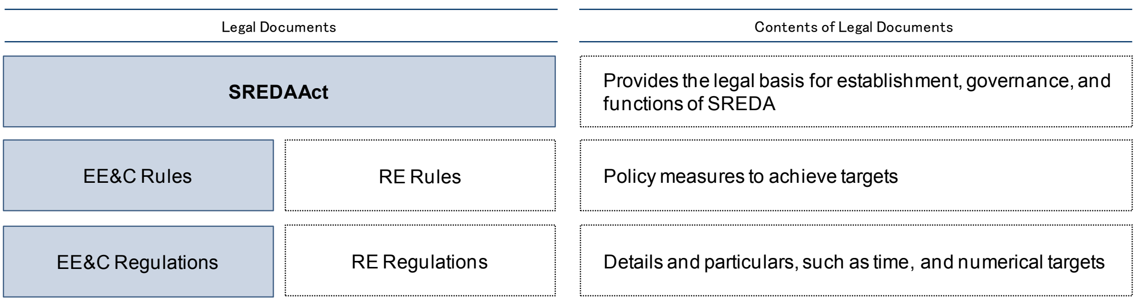
4.6. Development of a Policy Foundation to Promote EE&C Measures

As mentioned previously in section 2.4, candidate technologies for components in EE&C were omitted from the potential components list, since these are out of IDCOL's current scope for concessional loan extensions.

In order to increase the scope of IDCOL's concessional loans to EE&C components, a policy framework for EE&C promotion is necessary. This framework will be initiated by the SREDA Act, which is currently awaiting approval by Parliament. Under the provisions of this Act, the SREDA will be established under the Power Division of the MoPEMR as the regulatory authority for identification, promotion, facilitation and overall coordination of RE and EE&C measures.

4.6.1. The Need for Policy Measures under the SREDA Act

The SREDA Act only describes the establishment and functions of SREDA. Therefore, the Ministry should formulate Rules under the SREDA Act, which will describe detailed functions of SREDA in regard to EE&C promotion. Subsequently, SREDA will have the responsibility to formulate a list of EE&C Regulations that need to be implemented in the future. The structure of the SREDA legal documents is as summarized below.



Source: Survey Team

Figure 4.6-1 Overview of SREDA Legal Documents and Their Contents

The Power Division, in cooperation with international development partners, is currently considering the formulation of two sets of Rules under the SREDA Act, which are EE&C Rules and RE Rules. In this context, the MoPEMR requested JICA to assist formulating EE&C Rules, and the survey team has successfully completed drafting the EE&C Rules at the end of October

2012. In parallel, ADB was requested by MoPEMR to assist in the formulation of the RE Rules. As of October 2012, drafting of RE Rules has not commenced.

The scope of the EE&C Rules is limited to the demand side of energy. The RE Rules will primary cover the supply side. The RE Rules may also include demand side measures in cases where energy generated from renewable sources is consumed by the same generating entity.

	EE&C	Renewable Energy
Supply Side		Area covered under RE Rules
Demand Side	Area covered under EE&C Rules	

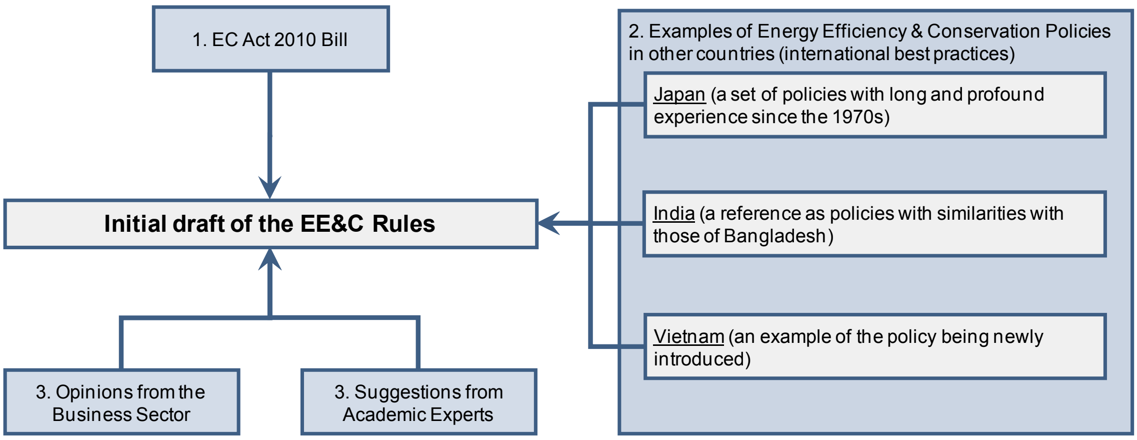
Source: Survey Team

Figure 4.6-2 Scope of the EE&C and RE Rules

4.6.2.Approach to Drafting the EE&C Rules

The survey team's methodology of drafting EE&C Rules suitable for the economic and social environment of Bangladesh consisted of two phases: structuring the Rules, and modifying the contents. The initial draft was then presented at the stakeholder discussion seminar, and was largely appreciated by the stakeholders. The EE&C Rules were finalized by the survey team upon review of the comments from stakeholders.

The references used by the survey team to formulate the initial draft of the EE&C Rules are summarized in the table below.



Source: Survey team

Figure 4.6-3 Methodology of creating the initial draft EE&C Rules

The procedures of the respective phases and contributions from references in table 4.6-3 are explained in the next sections.

(1) Structuring the Rules

The first phase of drafting the EE&C Rules served to create a structured body, and to outline the potential policy measures. For these purposes, the survey team used the Energy Conservation (EC) Bill 2010 Bill and EE&C policy structures in other countries as references.

1) The EC Bill 2010

The EC Bill 2010 functioned as the foundation of the EE&C Draft Rules. The Bill was originally planned to provide the policy framework for EC measures in Bangladesh. However, at the time of the EC Act 2010 formulation, the government also drafted the (Sustainable Energy Development Authority) SEDA Act. Since SEDA's responsibility included EE&C, it was decided to place EE&C Rules under the new SREDA Act, and thereby the EC Bill 2010 was not legislated.

The Bill gave a good understanding of what the Government of Bangladesh had originally intended to include as EE&C policy measures, and therefore provided a suitable foundation for the EE&C Rules. Therefore, the survey team decided to improve the EC Bill 2010 to formulate EE&C Rules. The components included in the Bill were as listed below.

Components							
Standards & Labelling of Equipment and Appliances	Regulated Energy Utilities	Designated Large Energy Consumers	EC in Buildings	EC in Government Operations	Training and Certification	Public Awareness and Promotion	Monitoring and reporting

Source: Survey team

Figure 4.6-4 Components of the EC Act 2010 Bill

2) Examples of EE&C Policy Structures in other Countries

The second reference was the EE&C Policy Structure in other relevant countries. The survey team used EE&C Policy Structures as a reference in order to restructure the EC Bill, add suggestions on policy measures, and evaluate the comprehensiveness. The policy structures of the following countries were used as a reference: Japan, India and Vietnam.

[1] Japan

The Japanese EE&C policy structure was used as an example of a well-established and successful policy structure. It consists of four sectors: Manufacturing & Commercial, Residential Buildings and Structures, Transportation Operators, and Machinery and Equipment. The regulations and a short description are summarized in the figure below.

Sector	Regulation	Description
Manufacturing and commercial	Energy reduction targets.	Voluntary average annual consumption reduction by 1%, or reach benchmark index for designated industries.
	Energy management system.	Appoint an energy manager.
	Reports to METI.	Submit energy usage report, medium- and long-term energy savings plans.
Residential Buildings and Structures	Energy Conservation Standards for Building Structures.	Enforce standards on insulation and energy conservation levels of elevators, hot water supply, air conditioning, lighting and ventilation.
	Energy Conservation Standards for Residences.	Enforce standards on insulation, air tightness, and heat shielding.
	Top Runner Standards.	Energy efficiency and conservation targets for house builders.
	Introducing Top Runner Program for building materials.	Add windows, insulation, kitchen and bathroom appliances to the program.
	Reports and notification to MLIT.	Periodical reports, and in case of building extension or large-scale reparations energy conservation measures must be reported.
Transportation Operator	Energy intensity reduction targets.	Voluntary annually energy intensity improvement by 1% in the mid-term.
	For rail, aviation, road, sea transport.	Introduce more efficient transportation models, increase loading ratio.
	For shippers/consignors.	Implement modal shift, training, better cooperation with transportation companies.
	Reports to MLIT (+METI for consignors).	Annual report on transportation capacity, CO_2 emissions, medium- and long-term energy savings plans, and periodical reports.
Machinery and Equipment	Top Runner Program efficiency regulation.	Increase energy conservation levels of appliances and fuel efficiency of automobiles.
	Energy saving label.	Show the achieved energy conservation level with respect to the Top Runner System targets.

Source: Survey team

Figure 4.6-5 EE&C Policy Structure in Japan

Comparing the Japanese policy structure with the Bangladeshi EC Bill 2010, the major difference was the transportation sector, which was not incorporated in the EC Bill 2010. As the transportation sector has high potential for EE&C, the suggestion to include the sector was considered.

Secondly, the survey team concluded that energy management and energy auditing system could be developed with reference to existing examples. International best practices from Japan and India, which already have working systems, will be referred to for application to Bangladesh. Thirdly, the threshold setting method for buildings was adopted from the Japanese policy structure. The threshold for buildings to be regulated will based on floor space.

[2] India

The Indian EE&C policy structure was used as an example of a country resembling Bangladesh. In India, the Bureau of Energy Efficiency (BEE) functions as quasi-regulatory body under the Ministry of Power responsible for EE&C policy measures. The functions of the Central Government, State Government and the BEE are as stated in figure below.

Sector	Central Government	State Governments	BEE
Standards and Labelling	Specify norms and standards Specify equipment or appliances Prohibit manufacturing, sales and import	NA	Recommendation to Central Government Develop testing methods Specify manners of display and particulars
EC Building Code (ECBC)	Prescribe Building Codes Amend BC to suit regional conditions	Direct DCs to comply with BC Amend BC to suit regional conditions	Prescribe guidelines
Designated Consumers (DCs)	Direct DCs to prepare and implement EEC schemes Amend list of energy intensive industries Direct DCs to submit reports	NA	Recommend notification of DCs to the Central Government
Energy Auditing	Direct DCs to conduct energy audit	Direct DCs to conduct energy audit	Specify regulations on time interval, procedure, and necessary certifications Maintain list of accredited agencies
Energy Management	Direct DCs to appoint energy manager Prescribe minimum qualifications	NA	Specify regulations on certifications
EEC Awareness	Take all measures necessary	Take all measures necessary	Take all measures necessary
Training	Arrange and organize	Arrange and organize	Arrange and organize
Miscellaneous	Direct State Governments and BEE	Designate any agency to enforce the Act in the State	Promotion of: R&D, innovative financing etc Implementation of: pilot projects, international cooperation programs etc

Source: Survey Team

Figure 4.6-6 Overview of the respective roles of the Central Government, State Governments and BEE.

Within this framework, a number of Programs have been implemented in India. The Ministry of Power and BEE are working together on the “NMEEE”, the National Mission for Enhancing Energy Efficiency. This program is part of eight National Missions, and consists of four proponents: Perform Achieve Trade (PAT), Market Transformation for Energy Efficiency (MTEE), Energy Efficiency Financing Platform (EEFP), and Framework for Energy Efficient Economic Development (FEEED).

The PAT scheme is a market-based trading system. Designated Consumers (DCs) from eight energy-intensive industries have been identified based on annual energy consumption. DCs must reach a set reduction target within a 3-year cycle, after which tradable certificates are awarded.

The MTEE aims to promote energy efficient appliances/equipment by establishing schemes. For financial support, the public sector will increase efforts to create national Clean Development Mechanism (CDM) schemes, which generate revenue by saving energy.

The EEFP aims to create strategies to set up and support Energy Service Companies (ESCOS).

Finally, the FEEED aims to develop fiscal measures to promote energy efficiency and attract investment. Money for the funds should be made available by the government. The figure below gives an overview of the NMEEE proponents.

Scheme	Policy Measures
Perform Achieve Trade (PAT)	Set targets through average and projected Specific Energy Consumption (SEC).
	DCs appoint an energy manager in charge of quarterly, annual and the final reports.
	Verification of the reports by accredited energy auditors.
	Issuance and trade of certificates. Penalties for non-compliance.
Market Transformation for Energy Efficiency (MTEE)	Standards & Labelling: Enforce minimum efficiency standards and mandatory labeling for frost free refrigerators, TFL, air conditioners and distribution transformers.
	Energy Conservation Building Code: set efficiency standards for new commercial buildings.
	Agricultural Demand Side Management: provide efficient water pumps, financed by investors and distribution companies.
	SMEs: offer workshops, preparation of projects and assistance in getting finance.
	Super Efficient Equipment Program: WB Climate Investment Fund finances manufacturers that produce super efficient ceiling fans.
Energy Efficiency Financing Platform (EEFP)	Standardize methodology of the project cycle and performance contracts of ESCOS.
	Standardize national certifications and examinations of energy auditors and managers.
	Accreditation of ESCOS by rating companies.
Framework for Energy Efficient Economic Development (FEEED)	Develop Partial Risk Guarantee Fund (PRGF)
	Develop Venture Capital Fund for Energy Efficiency (VCFEE)
	Lower VAT rates on BEE-rated goods and fiscal exemptions for investing in energy efficiency.
	Support utility providers with funds to promote their own DSM measures.

Source: Survey Team

Figure 4.6-7 Overview of the NMEEE proponents

[3] Vietnam

Vietnam's EE&C policy structure was used as an example of a country that has recently introduced such policy. JICA made significant contributions in the drafting of Vietnam's policy structure. An overview of the components is presented in figure below.

Component	Measures
State Management	Completing the legislative framework for EEC measures
Education and Dissemination	Raise public awareness about EEC through the media
	Integrate EEC into the school curriculum on all levels
	Pilot projects in households, providing training and information on EE methods
High Energy-Efficiency Equipment	Develop Standards & (voluntary) Labeling program
	Program to offer technical assistance to domestic lamp producers for switching production to efficient lamps
EEC in Industry	Develop energy management systems
	Support for industries to upgrade technology, conduct energy audits and identify energy saving potential
EEC in Buildings	Training and capacity building, and integrating EEC in building design and management of potential projects
	Pilot projects for EEC management of buildings
EEC in Transportation	Research on enhancing energy efficiency of public transport and increasing fuel economy of diesel ships
EEC in Industry	Develop EC plans, submit performance reports, modernize production lines. Covers production and manufacturing sites, mining areas, power plants.
EEC in Agriculture	Enhance rural power grid and irrigation systems

Component	Measures
EEC in Buildings & Lighting	Update the public lighting system
	Implement energy saving measures like: efficient lighting, ventilation, heating and cooling, insulation standards
EEC in Transportation	Encourage investment in public transport, regulation on vehicle maintenance, optimize fuel mix
EEC in Services and Households	Limit energy use during peak hours, use EE equipment
	Encourage households to save energy by taking advantage of natural light and ventilation, labeled appliances or limiting energy consumption
EEC in State Funded Projects	Submission of detailed EE plans and mandatory energy audits for government agency projects and facilities.
EEC in Energy-intensive Industries	Submit EC plans, performance notifications, appoint an energy manager, perform energy audits
Management of energy-using Vehicles and Appliances	Introduce mandatory labels, enforce minimum standards, expand research facilities
EEC Promotion	Introduce tax incentives and preferential loans
State Management Responsibilities	Create a national database on energy statistics

Source: Survey Team

Figure 4.6-8 Overview of Vietnam's EE&C policy structure

3) Review and Approval by the Power Division

Based on the review of the Bill and policy structures of the abovementioned three countries, the survey team came to the following suggestions on the structure and policy measure outline of the components:

- Restructure the components into four relevant sectors: Residential & Commercial, Industry & Services, Government, and Sector-Wide
- Removal of the regulated utilities sector, as it is not relevant to the demand side
- Including the transportation sector, as it is a major energy consumer
- In case of Bangladesh, policy measures should initially be on a voluntary basis

The proposal for the initial structure was reviewed and discussed with the Power Division. The Survey Team's suggestion to include the transport sector (operators) was not endorsed as it was deemed to be too early. The conclusions on the structure and policy measure outline of the EE&C Draft Rules were as follows:

- Approval on restructuring the components into four sectors
- Agreement on not including the regulated utilities sector
- Add SMEs as a new component
- Include the promotion of "Green Buildings"

The structure of the EE&C Rules as approved by the Power Division is summarized in the figure below.

EC Act 2010 Bill

3	Institutional Arrangements
Chapter	**Component**
4	Standards & Labeling of Equipment and Appliances
5	Regulated Energy Utilities
6	Designated Large Energy Consumers
7	EC in Buildings
8	EC in Government Operations
9	Training and Certification
10	Public Awareness and Promotion
11	Reporting and Monitoring

EE&C Rules Initial Draft Structure

Institutional Arrangements	
Sector	**Component**
Residential & Commercial	Standards & Labeling of Equipment and Appliances
	EC in Buildings
	New: EC in Small and Medium Enterprises (SMEs)
Industry & Service	Designated Large Energy Consumers
	Training and Certification
Public	EC in Government Operations
	Reporting and Monitoring
Sector Wide	Public Awareness and Promotion

Source: Survey Team

Figure 4.6-9 Structure of the EE&C Rules

(2) Modification to suit Local Requirements

The second phase for completing the Draft EE&C Rules was the modification of contents to suit Bangladeshi requirements. For this purpose, interviews were conducted with national stakeholders from various industries and academic experts.

The survey team conducted interviews with high-ranking members from industries, representatives from international development organizations, and academic experts. The purpose of these interviews was to disseminate information to the stakeholders on what the survey team was doing, to identify the concerns of the industry regarding EE&C, and to get suggestions or other comments from stakeholders on what could be incorporated into the Rules. Important comments included:

- Power supply in Bangladesh is very unreliable, and must be addressed first.
- Secondly, showcasing of good practices is important to show that investments in EE&C measures are profitable.
- Reward measures should also be considered as an incentive.

(3) Stakeholder Discussion Seminar Comments

The initial draft of the EE&C Rules was presented in a Stakeholder Discussion Seminar to all relevant stakeholders on 22 October 2012. The meeting was hosted by the Secretary of the Power Division, with the presence of the Additional Secretary, JICA Representative, Bangladesh Standards Testing Institute (BSTI), Bangladesh Energy Regulatory Commission (BERC), GIZ, USAID and others. In this discussion meeting, stakeholders gave their comments on the initial draft of the EE&C Rules and on the policy measures that the Ministry intended to implement.

4.6.3.Overview of the Drafted EE&C Rules

The overview of the finalized EE&C Rules is summarized in the figure below. A short summary on the individual components is given thereafter.

Sector	Component	Items
Residential & Commercial	Standards & Labelling of Equipment & Appliances	Set labelling formats and required standards for selected appliances
		Disclosure of public notice containing non-compliance list
	Energy Conservation in Buildings	Define the scope for enforcement based on floor space
		Set standards for building performance and equipment in line with the Building Code
		Introduce Concept of "Green Buildings" for voluntary application
	Small & Medium Sized Enterprises (SMEs)	Training, consulting and awareness raising with the support of the government
		Financial support mechanism for investment that will promote energy conservation
Industry & Service	Designated Large Energy Consumers	Define "Designated Large Energy Consumers", based on energy consumption and financial status.
		Energy audit by Accredited Energy Auditors and annual reporting obligation
	Training and Certification	Accreditation of Energy Auditors and Energy Service Companies (ESCOs)
		Certification and training for Energy Managers in Designated Large Energy Consumers
Public	Energy Conservation in Government Operations	Governmental organisations to implement EE&C programs in procurement and daily office activities
	Reporting and Monitoring	Analysis of reported data, monitoring of implementation status and recommending to the Ministry
Sector-Wide	Public Awareness, Promotion and Programmes	Promotion of education on EE&C by means of media and the school curriculum
		Identifying and showcasing good practices
	Supplemental Funding Source for EE&C Measures	Seek financial sources including, but not limited to CDM or Bilateral Offset Credit Mechanism (BOCM)

Source: Survey Team

Figure 4.6-10 Overview of the Drafted EE&C Rules

(1) Residential & Commercial Sector

The Residential & Commercial Sector consists of three components: Standards & Labeling of Equipment & Appliances, EE&C in Buildings, and SMEs. The general contents of the policy measures are explained below.

1) Standards & Labeling of Equipment & Appliances

SREDA will cooperate with the Bangladesh Standards Testing Institute (BSTI) to establish energy efficiency star labels for widely used consumer equipment and appliances. The labeling of products will initially be on a voluntary basis, before gradually moving to a mandatory system. After transition to the mandatory phase, Minimum Efficiency Performance Standards (MEPS) will also be implemented. SREDA will disclose a public notice with a list of non-compliant products and manufacturers.

2) EE&C in Buildings

SREDA will coordinate with the Ministry of Housing and Public Works to incorporate EE&C measures for new commercial and residential buildings over a certain threshold (based on floor space) into the Bangladesh National Building Code (BNBC). These measures may include the use of energy efficient equipment in common areas of the building, such as air conditioning, lighting or elevators, and the use of specific building materials to optimize energy efficiency of the building envelope.

In addition to this, a voluntary certification mechanism for “Green Buildings” will also be developed.

3) SMEs

SREDA shall aid in providing services such as: training Programs, technical assistance, raising awareness and consultation for entrepreneurs of small and medium sized enterprises (SMEs). Furthermore, public funds and other financing mechanisms for SMEs to promote EE&C measures will be developed.

(2) Industry & Service Sector

The Industry & Service sector consists of two components: Designated Large Energy Consumers, and Training and Certification.

1) Designated Large Energy Consumers

SREDA will set criteria for identifying Designated Large Energy Consumers. These Designated Large Energy Consumers will have duties to conduct energy audits in their facility on an annual basis, and to appoint an energy manager. The role of the energy manager is to monitor and report energy consumption, raise awareness on EE&C within the company, and to submit medium- to long-term energy conservation plans. This will ensure autonomous execution of EE&C plans.

Additionally, benchmarks and standards will be set for certain industrial equipment, such as boilers and furnaces.

2) Training and Certification

SREDA will establish accreditation mechanism for energy auditors and ESCOs so as to ensure sufficient competency for promoting EE&C measures. A program for Certification of energy managers who will be the interface within Designated Large Energy Consumers will also be developed by SREDA.

(3) Public Sector

The Public sector EE&C policy measures are divided into two components: EE&C in Government Operations, and Reporting & Monitoring.

1) EE&C in Government Operations

Under this component, government organizations of all kinds will be required to implement EE&C measures within their operations, such as the procurement of star-labeled equipment and appliances.

2) Reporting & Monitoring

The Reporting & Monitoring component explains SREDA's responsibility to maintain, compile, analyze and report detailed data including energy consumption, energy losses, and audit reports on a nation-wide, sector-wide and, if possible, facility-wide level to the Ministry. These data will be made available on the internet.

(4) Sector Wide

1) Public Awareness, Promotion and Programs

This component includes several promotional and capacity building functions of SREDA. First of all, SREDA will carry out Programs to raise awareness and promote EE&C. The educational curriculum will be edited to include efficient use of energy and energy conservation. Furthermore, SREDA will issue guidelines on good practices and develop pilot projects to showcase good practices ranging from the domestic sector to industry and government operations.

2) Supplemental Funding Source for EE&C Measures

SREDA shall seek supplemental financial sources to encourage EE&C measures, including (but not limited to) emissions credit like Clean Development Mechanism (CDM) or Bilateral Offset Credit Mechanism (BOCM).

4.6.4.Pre-requisites for drafting Regulations

After formulation of the EE&C Rules, SREDA has to formulate the regulations. The regulations will include all details to implement the policy measures, such as quantitative targets, benchmarks, and time lines. However, a profound quantitative understanding of the current energy consumption status, and appliance and equipment market status in Bangladesh is required in order to set targets and criteria in the regulations. Currently, various databases in Bangladesh contain insufficient data and statistics. Therefore, conducting extensive surveys per sector will be necessary to obtain the required data and statistics. These surveys will be conducted by the survey team under the EE&C Master Plan.

Additional technical cooperation projects to further promote EE&C technologies in Bangladesh may include the following:

- Development of EE&C Master Plan Formulation for Bangladesh; Major components of this project are following:

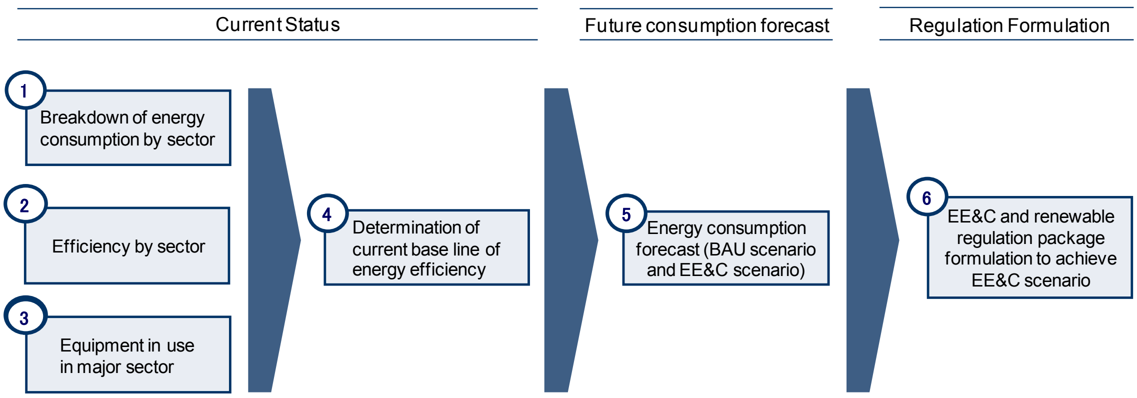
Understanding the Current Level of Energy Efficiency;
Future Energy Demand-Supply Status Forecast;
Formation of EE&C Master Plan;

Skill Development through Co-working to Formulate EE&C Master Plan;
- Demonstration Project for Absorption Chiller (which uses waste heat from power stations) for Food Storage in Rural Areas.

4.7. Development of EE&C Master Plan for Bangladesh

With increasing living standards, and a booming population, electricity shortage in Bangladesh is expected to continue. It is possible that this will become worse in the near future. In order to cope with this electricity supply shortage, the promotion of EE&C is indispensable in tandem with power generation capacity additions. However, so far, little EE&C related policies have been implemented in Bangladesh.

In this context, the Government of Bangladesh is preparing to establish SREDA, the regulatory authority for renewable energy and energy conservation promotion. The proposed "EE&C Master Plan Formulation for Bangladesh" project is aimed to provide a complete roadmap of EE&C policies best suited for the conditions and environment of Bangladesh. This roadmap will also clarify energy savings potential for each proposed policy, and therefore policy makers in Bangladesh will be able to select and prioritize from these sets of EE&C policies. The Master Plan will therefore be essential for the country to rationally identify and socialize the high priority EE&C policies and measures.



Source: Survey team

Figure 4.7-1 EE&C Master Plan Project Outline

The figure above shows the outline of this project. The details are explained below.

(1) Project Objective

Primary project components and objectives are explained below.

1) Understanding of Current Level of Energy Efficiency

First of all, it is important to understand how energy is used and wasted by each sector as well as the current levels of energy efficiency. The following items will be studied to quantify the current energy balance and efficiency:
- Breakdown of Energy Consumption by Sector
- Determination of Current Base Line of Energy Efficiency

2) Future Energy Demand-Supply Status Forecast
Several scenarios of future energy consumption will be created, including the BAU (business as usual) scenario and the EE&C scenario to quantify the effect of the package of EE&C regulations. Study items are follows:

- Scenario Formulation (BAU and EE&C scenarios)
- Determination of assumptions for each scenario
- Forecast of Future Energy Consumption
- Quantify the Effect of the Package of EE&C Regulations

3) Formation of EE&C master plan
A package of EE&C regulations to achieve the EE&C scenario will be proposed. The package will be a comprehensive package of regulations covering the power, industrial, residential and commercial sectors.

Sector	Measure	Responsible division
Power	Electricity tariff reform	Utility Division
Industrial	Energy management	Energy Division
Residential/Commercial	Roof-top PV	Energy Division
	Appliance standards Labeling	Energy Division
	Building code	Architecture Division
Sector wide	Financial incentives	Multiple Divisions
	Awareness raising	Multiple Divisions

Divisions in charge of legal implementation should be decided by the Government of Bangladesh.
Consultants will only recommend the package of regulations

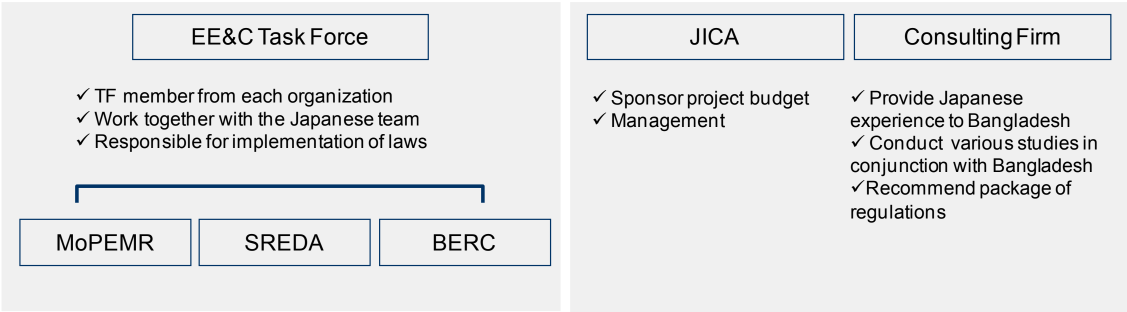
Source: Survey team

Figure 4.7-2 Proposed Implementation Structure for EE&C Measures

(2) Implementation Organization Candidate

The main stakeholders are SREDA, MoPEMR, and BERC. It is recommended that an EE&C task force from these concerning authorities be established and counterparts for each expert from the Japanese side be assigned. Through such assignment, the structure would ensure knowledge transfer from the Japanese side to the Bangladesh side.

As SREDA is under preparation for its establishment, this proposed study was discussed by the survey team with MoPEMR. MoPEMR highly appreciates this proposal and is expecting urgent commencement of this project.



Source: Survey team

Figure 4.7-3 Example of an Implementation Arrangement for EE&C Master Plan

(3) Expected Benefit

The proposed master plan will be a first of its kind in Bangladesh. The implementation of the said package of regulation is key to address energy savings, and consequently, to address energy shortages. As such, the expected benefit is huge.

5. Financial Analysis of the Components

5.1. General Preconditions

The common preconditions for all five components that comprise the Renewable Energy Development Project are based on conditions commonly employed in IDCOL's project appraisal stage. Inflation rate, general increase in tariff, and cost escalation were all assumed to be five percent. Depreciation and amortization were calculated with straight line method.

Table 5.1-1 Common Preconditions for Financial analyses of all Components

Indicators	Amount in BDT
Inflation rate	5%
Tariff increase	5%
Cost escalation	5%
Expected return on equity (ROE)	9%
Capital cost depreciation (straight line)	5%/year
Amortization (straight line)	20%/year

Source: Set by the Survey Team based on analysis of IDCOL appraisal reports

5.2. SHS Program Component

5.2.1. Preconditions for SHS Program Component

POs offer various kinds of SHS in size and specifications. It is up to the POs' discretion to offer any kind of SHS in response to the needs of the end-users. IDCOL therefore does not have a future estimation of demand of SHS by size and types. Financial analysis was conducted based on the assumption that a typical 50 W SHS, which cost BDT 28,800 is being acquired by a household.

As the possession of SHS does not generate income by itself, an analysis of a virtual project in which income is generated from saving of kerosene cost was also conducted. The assumptions used for a SHS are disclosed in the following table. Ten percent of the initial cost is borne out of the acquirer's down payment. The rest is financed by loan from the POs. WACC for the sub-project is therefore calculated at 13.5 percent.

Table 5.2-1 Preconditions for Financial analysis of SHS Program Component

Item	Condition
SHS size	50 W
Project life	10 years
Household Kerosene consumption	6.15 liters /month
Price of a 50Wp SHS	BDT 28,800
Buy down grant (percentage and amount)	0% - BDT 0
Down Payment (percentage and amount)	10% - BDT 2,880
Loan amount (percentage and amount)	90% - BDT 25,920
Loan interest rate	15%
Loan Tenure	36 months
Battery replacement	Every 5 years at BDT 8,900
Lamp and charge controller replacement	Every 3 years at BDT 3,150

Source: IDCOL assumptions

Among others, the SHS user would enjoy financially quantifiable benefits as calculated by the virtual income of the sub-project. Savings from elimination of kerosene, purchase of kupies and harikanes (both are types of kerosene lamp), cost of replacing flat batteries due to use of TV set, and elimination of battery recharging costs compose such quantified financial benefits.

Table 5.2-2 Quantified Financial Benefit of SHS a User

	Saving amount
Savings from elimination of expenditures on kerosene	BDT 4,502 / year
Savings from purchase of kupies and harikanes	BDT 160 / year
Saving from flat battery used in connection with TV[89]	BDT 5650 every 2 years
Saving from elimination of battery recharging costs	BDT 2,880 / year

Source: IDCOL assumptions

5.2.2. Financial Analysis of SHS Program Component

The financial analysis assumes a cash flow where expenditure is the debt service which includes both principal and interest. IRR was calculated based from the incremental cash flow is 36 percent, which surpasses WACC as well as the social discount rate. If battery recharging costs were to be excluded from the benefit (under assumption that the SHS user was not utilizing battery at all), IRR would then become 12 percent, which would then be short of WACC.

Table 5.2-3 Simple Financial Analysis of a SHS Sub-project

Year	Annual savings from elimination of expenditures on Kerosene	Annual savings from purchase of kupies and harikanes	Annual Saving from flat battery used in connection with TV	Annual Saving from elimination of Battery Re-charging Costs	Total Investment		Operation Expenditure			Incremental cash flow
					Down payment	Installment of Loan	Battery	Charge Controller	Lamp	
0	0	0	0	0	-2,880	0	0	0	0	-2,880
1	4502	160	0	2880	0	-10,584	0	0	0	-3,042
2	4502	160	0	2880	0	-10,584	0	0	0	-3,042
3	4502	160	5650	2880	0	-10,584	0	-750	-2,400	-542
4	4502	160	0	2880	0	0	0	0	0	7,542
5	4502	160	5650	2880	0	0	-8,900	0	0	4,292
6	4502	160	0	2880	0	0	0	-750	-2,400	4,392
7	4502	160	5650	2880	0	0	0	0	0	13,192
8	4502	160	0	2880	0	0	0	0	0	7,542
9	4502	160	5650	2880	0	0	0	-750	-2,400	10,042
10	4502	160	0	2880	0	0	0	0	0	7,542

Source: Calculation based on IDCOL assumptions

5.2.3. Comparison with Kerosene lighting

Financial analysis conducted above takes into account various benefits brought by introducing SHS. If a similar analysis is conducted excluding benefits other than the cost saving of kerosene, seven year accumulation of the annual savings of BDT 4,502 amounting to BDT 31,514, will be sufficient to reimburse the initial cost of SHS which is BDT 28,800. Introduction of SHS will

[89] Batteries are assumed to be renewed every two years due to heavy usage without recharging.

therefore be worthwhile by its 7th year of operation even if kerosene saving is taken into account as the benefit.

5.3. Solar Irrigation Pump Component

5.3.1. Preconditions for Solar Irrigation Pump Component

IDCOL assumes that the minimum size system for the Component has a 400 m3/day capacity, due to the fact that smaller system will be disadvantageous in financial viability. A typical system is therefore assumed to be the 400 ton/day capacity solar irrigation pump system capable of irrigating 63 bighas or paddy field during required seasons. It is assumed that the system will be utilized for watering vegetable cultivation during the low demand season.

Per season, fees charged to the farmers who benefit from the use of a solar irrigation pump was set at BDT 3,000 per bigha. This tariff is set to become slightly below BDT 3,100 per bigha per season (Two seasons per year: Boro and Aman), which is the fee charged for existing diesel powered irrigation pump users.[90]

As there will be no requirement of any material inputs such as fuels, operation and maintenance (O&M) costs were set at a minimal amount of BDT 5,500 per month. Out of this monthly O&M cost,. BDT 5,000 will be allocated as payment for the operation staff.

Table 5.3-1 Preconditions for Financial analysis of Solar Irrigation Pump Component

Item	Condition
Pump capacity	400 ton/day
Project life	20 years
Average operating hours of pump in a day	4.5 hours
Minimum coverage in Boro and Aman	63 bighas
Annual operation for vegetable cultivation	414 hours
Annual operation for partial irrigation	196 hours
Fee charged for irrigation	BDT 3,000 / bigha / season
Maintenance cost	BDT 500 / month
Operating staff cost	BDT 5,000 / month

Source: Set by the Survey Team based on analysis of IDCOL appraisal reports

Supply capacity was also taken into consideration. The supply ceiling is calculated from solar irradiation data and the groundwater of a given location, Naogaon, as an example.[91]

Table 5.3-2 Maximum Water Supply Solar Irrigation Pump

(Unit: m3)

Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
9,109	11,532	11,660	11,429	8,400	8,039	8,060	7,660	8,866	8,460	8,701	8,866

Source: Set by the Survey Team based on analysis of IDCOL appraisal reports

Capital cost of the system was estimated to be BDT 1,555,750, of which 30 percent will be financed by a concessional loan from JICA through IDCOL. It is assumed that the balance of this amount will be financed through the executing agency's own fund (30 percent) and grant (40 percent). This structure is in line with IDCOL's existing solar irrigation pump sub projects.

[90] According to interviews conducted by the Survey Team at Dhamrai solar irrigation pump installed by NUSRA
[91] Ground water data taken from BADC (2005), Ground water Monitoring Data Book

Table 5.3-3 Funding Structure of a Unit in Solar Irrigation Pump Component

Indicators	Percentage	Amount in BDT
Own fund (equity portion)	30%	466,725
Grant through IDCOL	40%	622,300
Loan through IDCOL	30%	466,725
Total	100%	1,555,750

Source: Set by the Survey Team based on IDCOL's existing project

The borrowing condition of loan from IDCOL is set to be identical with the existing project financed by IDCOL. The loan has an interest rate of six percent, tenure of ten years, and a grace period on the first 12 months. Installment is semi-annual.

Table 5.3-4 IDCOL Loan for the Solar Irrigation Pump Component

Indicators	Condition
Interest rate	6%
Tenure	10 years
Grace period	12 months
Installment	Semi-annual

Source: Set by the Survey Team based on IDCOL's existing project

5.3.2. Financial Analysis of Solar Irrigation Pump Component

Financial analysis is conducted under preconditions set in the previous sub-section. Profit-loss and cash flow statements are as attached in the appendix of this report. The profit-loss statement shows that the net initial cost (sponsor's own fund + loan financed amount = BDT 1,089,025) will be recovered as cumulative retained earnings on the fifth year of the project. Gross initial cost (total investment = BDT 1,555, 750), on the other hand, will be recovered on the ninth year of the project.

The result of the analysis shows that the sub-project IRR is 24 percent, which is well above WACC of 4.5 percent, exhibiting the robust financial viability of this sub project. NPV at discount rate equivalent to social discount rate is positive at BDT 677,847, showing that the sub-project is socially worthwhile even without taking into account external benefits. Minimum DSCR is 3.2, signifying that the sub-project is sustainable from the viewpoint of debt service payment.

Table 5.3-5 Result of Financial Analysis on the Solar Irrigation Pump Component

Indicators	Rate
Initial cost recovery* (net) (gross)	5th year 9th year
WACC	4.5%
Sub-project IRR	24%
NPV at discount rate of 12%	BDT 677,847
DSCR (minimum) (average)	3.2 3.3

Note *: "Gross" is the recovery of the total initial investment while "net" is the recovery of investment less grant.
Source: Analysis conducted by the Survey Team based on preconditions set by IDCOL

The overall result of the financial analysis on a sub-project as an element of the Solar Irrigation Pump Component shows that the component will be financially viable, and sustainable from the viewpoint of financing.

5.3.3.Comparison with Diesel Irrigation Pumps

The solar irrigation pump system will now be compared with the conventional diesel powered irrigation pump. A 2hp (equal to 1.5 kW) diesel generator costing BDT 20,000 is taken as the comparison. The pump is being used for irrigating 15 bighas. Five of these pumps will be required to be comparative in size with a 400 m3 / day solar irrigation pump. Diesel engines that power these pumps will have to be renewed every five years. The total cost of equivalent system powered by diesel engines is computed at BDT 400,000.

Fuel consumption for irrigation of one bigha of paddy requires 4.5 hours of operation by five of these diesel engines. As one diesel engine consumes 0.5 liter per hour of diesel oil, the consumption for one bigha of paddy is calculated as 11.25 liters. As a liter of diesel costs BDT 61, the fuel cost for irrigating 1 bigha of land add up to BDT 686 per bigha. Converting the total function of solar irrigation pump to the area to be irrigated, it will become approximately two times the irrigated paddy area of 63 bighas, therefore it becomes 126 bighas. Total annual fuel consumption will therefore amount to approximately BDT 86,500 (BDT 686 per bigha × 126 bighas).

Fuel cost savings upon system conversion from diesel pump to solar irrigation is BDT 86,500 per year. Another difference in operation and maintenance cost is the input materials for diesel engines such as lubricants. Maintenance cost of five diesel engines is BDT 6,000 more than the solar PV irrigation system. The annual saving on O&M by utilizing the solar PV irrigation pump system in place of the conventional diesel pump will amount to BDT 92,500 (158,5000 – 66,000).

The net difference in capital expenditure of the two different traction methods is BDT 533,450 (Initial investment cost of solar PV system BDT 1,555,750 minus grant of BDT 622,300 – Total cost of diesel powered irrigation pump system BDT 400,000). This amount will be reimbursed on the sixth year of operation through savings from difference in O&M cost, which will become BDT 555,000 (92,500 x 6).

Table 5.3-6 Cost Comparison of Solar Irrigation Pump with Simple Diesel Pumps

	Pump specification		Capital Investment	Annual cost (BDT)		
Traction	Flow rate	Capacity		Fuel	Expenses	Total
Solar PV	400 m3/day	7.5 kW	BDT 1,555,750 - BDT 622,300 = BDT 933,450	0	66,000	66,000
Diesel	400 m3/day	1.5 kW x 5	BDT 20,000 x 5 = BDT 100,000 to be renewed every 5 years: = BDT 400,000	86,500	72,000	158,500
Difference	-	-	+BDT 533,450	-86,500	-9,000	-92,500
Recovery of difference in initial investment = 6 years						

Source: Calculations by the Survey Team based on preconditions obtained from field survey

5.4. Solar Mini-Grid Component

5.4.1. Preconditions for Solar Mini-Grid Component

IDCOL is yet to identify standardized specifications for a mini-grid to be deployed. In this scenario, the Component is assumed to be comprised of approximately 800 kWh capacity equipment (48V × 18,000 Ah), which is almost equivalent to the size of the currently operating Sandwip Island system. The system is assumed to be utilized by 400 subscribers as with the existing system.

Fees charged to the subscribers who benefit from the use of a solar irrigation pump was set at BDT 32 per kWh[92], Connection charge at BDT 6,000, and line rent of BDT 100 per month. Operation and maintenance cost is calculated BDT 726,000 per year.

Table 5.4-1 Preconditions for Financial analysis of a Solar Mini-Grid Component

Item	Condition
Battery capacity	48 V × 18,000 Ah
Project life	20 years
Average duration of electricity supply in a day	9 hours
Electricity tariff	BDT 32 / kWh
Connection Charge (one-off)	BDT 6,000
Monthly line rent	BDT 100
Operation and Maintenance cost	BDT 726,000

Source: Set by the Survey Team based on analysis of IDCOL appraisal reports

Monthly power generation from 100kW solar PV system installed on the 800 kWh mini grid and charged into its battery is just as shown in the following table (under the assumption that the battery efficiency is 80 percent). The generated amount is approximately 253 kWh per day (simple average of monthly generated electricity amount), and the total generation volume is 92,120 kWh per year.

Table 5.4-2 Electricity Generated and Charged at a Mini-Grid

Jan	Feb	Mar	Apr	may	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
231	301	294	289	285	219	239	226	213	219	279	238	92,120 kWh

Unit: kWh /day
Source: calculation by the Survey Team based on irradiation data at Sandwip Island

Capital cost of the system was estimated to be BDT 50,000,000 of which 50 percent will be financed by grant through IDCOL. The remainder of the amount is assumed to be financed by the sponsor's own fund (20 percent) and the JICA loan through IDCOL (30 percent). This structure is in line with IDCOL's existing Solar Mini-Grid sub projects.

Table 5.4-3 Funding Structure of a Unit in Solar Mini-Grid Sub-Project

Indicators	Percentage	Amount in BDT
Own fund (equity portion)	20%	10,000,000
Grant through IDCOL	50%	25,000,000
Loan through IDCOL	30%	15,000,000
Total	100%	50,000,000

Source: Set by the Survey Team based on IDCOL's existing project

[92] According to the actual tariff at Sandwip Island mini grid observed during the Survey in June 2012

The borrowing condition of loan from IDCOL is set to be identical with the existing project financed by IDCOL. The loan has an interest rate of six percent, tenure of ten years, and a grace period on the first 12 months. Installment is semi-annual.

Table 5.4-4 IDCOL Loan for the Solar Mini-Grid Component

Indicators	Condition
Interest rate	6%
Tenure	10 years
Grace period	24 months
Installment	Semi-annual

Source: Set by the Survey Team based on IDCOL's existing project

5.4.2. Financial Analysis of Solar Mini-Grid Component

Financial analysis is conducted under preconditions set in the previous sub-section. Profit-loss and cash flow statements are as attached in the appendix of this report. The profit-loss statement shows that the net initial cost (sponsor's own fund + loan financed amount = BDT 25,000,000) is recovered as cumulative retained earnings on the sixth year of the project, while the gross initial cost (total investment = BDT 50,000,000) is recovered on the 14th year of the project.

The result of the analysis shows that the sub-project IRR is 19 percent, which is well above WACC of 3.6 percent, exhibiting the robust financial viability of this sub project. NPV at discount rate equivalent to social discount rate is positive at BDT 12,190,251, which is 24 percent of the initial investment amount showing that the sub-project is socially worthwhile even without taking into account external benefits. Minimum DSCR is 1.8 signifying that the sub-project is sustainable from the viewpoint of debt service payment.

Table 5.4-5 Result of Financial Analysis on the Solar Mini-Grid Component

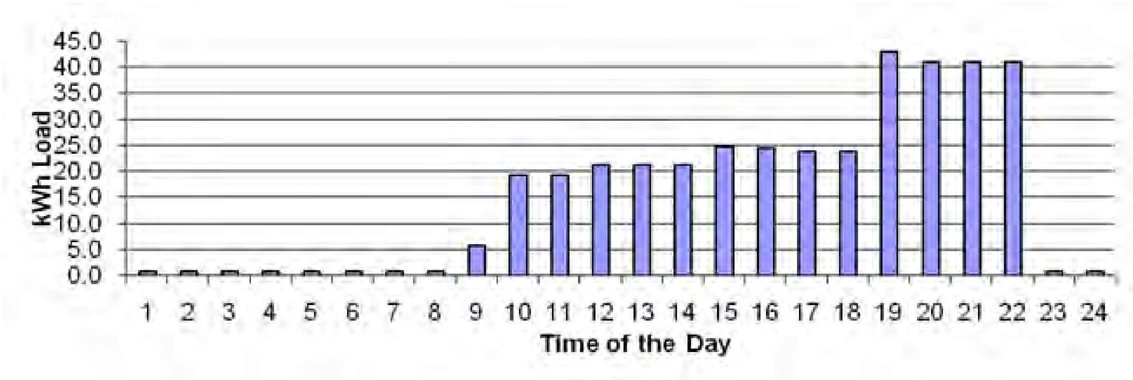
Indicators	Rate
Initial cost recovery* (net)	6th year
(gross)	14th year
WACC	3.6%
Sub-project IRR	19%
NPV at discount rate of 12%	BDT 12,190,251
DSCR (minimum)	1.8
(average)	2.1

Note *: "Gross" is the recovery of the total initial investment while "net" is the recovery of investment less grant.
Source: Analysis conducted by the Survey Team based on preconditions set by IDCOL

The overall result of the financial analysis on a sub-project as an element of the mini-grid component shows that the component will be financially viable, and sustainable from the viewpoint of financing.

5.4.3. Comparison with Diesel Local Electrification

The solar mini-grid will now be compared with the conventional diesel powered local area electrification. With reference to the hourly load data from Sandwip Island mini-grid, the size of comparable diesel powered traction will be a 50kW diesel generator. This will cost approximately BDT 500,000. Two of these generators are assumed to be acquired, with one serving as the backup.



Source: IDCOL, PGEL 100 kW Solar Mini-Grid at Sandwip Island – Appraisal Report

Figure 5.4-6 Hourly Load Profile of Sandwip Island Mini-Grid (Reference)

The project cost of a diesel powered local electrification system is assumed to be BDT 5 million, which is one-tenth of the cost of a solar mini-grid. Cost estimation was conducted based on information gathered from suppliers of relevant items and equipment in Dhaka.

Table 5.4-7 Project Cost of Diesel Powered Local Area Electrification System

	Cost (BDT)
Civil Construction	100,000
Backup Diesel Generator (50 kW)	500,000
Emergency engine generator	500,000
Accessories	100,000
Batteries	30,000
Transportation	50,000
Distribution line (5km)	1,050,000
AC Household Meters	1,000,000
Control Room , Structure and others	800,000
Import Duty	550,000
Technical Assistance	240,000
Contingency	130,000
Total	5,050,000

Note: Shaded thee elements are common to both diesel and solar mini-grid

Source: Survey Team estimation based on IDCOL, PGEL Solar Mini-Grid Appraisal Report and field survey

The O&M cost of a diesel generator is assumed to be BDT 2,588,500 which is 3.6 times the cost for the a solar mini-grid. The factor that makes the difference in O&M cost is mostly the fuel cost which amounts to BDT 1,881,500.

Table 5.4-8 O&M of a Cost of Diesel powered Local Electrification

Particulars		Solar PV 100 kWp Plant (BDT)		Diesel Generator Plant (BDT)
Salary	Manager (1)	10,000 / month	130,000 /year*	130,000
	Accountant (1)	8,000 / month	104,000 / year*	104,000
	Line man (2)	6,000 / month	156,000 / year*	156,000
	Engine Overhaul (2)	7,000 / month		14,000 (7,000 × 2)**
	Guard (2)	4,000 / month	104,000 / year*	104,000
General & Administrative expenses		88,000		88,000
Insurance 0.25% of total cost		125,000 (50,000,000 × 0.25 %)		12,600 (5,050,000 × 0.25 %)

Fuel oil cost	-	1,873,000 {(92,120/3) × 61} Generation (kW/year) / diesel oil generation ratio (kWh/L)*** × diesel cost (BDT)****
Lub oil cost	-	6,900 {92,120×0.0003}×250} Lub oil consumption (L/Kwh) × Lub oil cost (BDT)
Maintenance cost of engine	-	100,000
Total	707,000	2,588,500

Note: (*) Salary per year includes one month bonus paid in Eid ul Fitr Holiday therefore becomes 13 month
(**) Additional line person for diesel powered equipment overhaul
(***) Generation per liter = 3 kWh/L
(****) Cost of diesel oil = BDT 61 / L
Source: Survey Team estimation based on IDCOL, PGEL Solar Mini-Grid Appraisal Report and field survey

If the net difference in investment (Total investment cost of solar mini-grid BDT 50,000,000 minus grant of BDT 25,000,000 – Total cost of diesel Mini-Grid BDT 5,050,000 = BDT 19,950,000) is to be reimbursed by accumulation of advantage in O&M cost (BDT 2,588,500 – 707,000 = 1,881,500), 11 years will be required, when accumulated savings of O&M cost reaches BDT 20,606,300.

Table 5.4-9 Initial Cost recovery Period for a Solar Mini-Grid Sub-project

	Solar PV mini-grid (BDT)	Diesel mini-grid (BDT)	Difference (BDT)
Initial Investment Cost	– 50,000,000 + 25,000,000	5,050,000	–19,950,000
O/M Cost	707,000	2,588,500	+ 1,881,500
Recovery of difference in initial investment = 11 years			

Source: Calculation by the Survey Team

5.5. Gasification of Biomass Component

5.5.1. Preconditions for Gasification of Biomass Component

IDCOL Plans to fund 28 of 200 kW scale biomass gasification power generation plants by 2016. Fund requirements are grants amounting to USD two million and loans amounting to USD five million. Further USD three million is expected to be funded from the sponsors' resources as the equity portion. In total, USD ten million is being required, implying that the initial investment cost per unit is approximately BDT 30 million (USD 360,000 per unit).

Biomass gasification plants are few in Bangladesh. A 400 kW rice husk gasification facility in Thakurgaon is the only example that can be considered as the model for further deployment. A 200 kW model biomass gasification and power generation plant is used for the financial analysis.

Past examples of the fund structures of IDCOL fund gasification plants varies on a case-to-case basis. The typical case is that of Thakurgaon plant which was funded 70 percent by loan and the remaining 30 percent from the sponsor's own fund, with no grant portion. Another case is that of the Gazipur plant, which was funded 50 percent by grant, 30 percent by loan, with the remaining 20 percent being funded from the sponsor's equity. The financial arrangement applied for the analysis is based on IDCOL's planned funding structure for the component, with 60 percent loan, 20 percent grant and 20 percent by own financing (equity portion).

Table 5.5-1 Preconditions for Financial Analysis of a Gasification of Biomass Sub-project

	Condition
Power generation capacity	200 kW
Project life	10 years
Operation hours per year	330 days
Rice husk required	2,000 tons / year
Rice mill capacity	22.5 kW ×4
Cost of grid power	BDT 4.5 /kWh
Precipitated silica production	300 ton / year
Maintenance cost of the plant	BDT 650,000 / year
Initial capital cost	BDT 43,216,000
Own finance (percentage – amount)	20% - 8,643,200
Grant (percentage – amount)	20% - 8,643,200
Loan (percentage – amount)	60% - 25,929,600
Loan interest rate	6%
Loan tenure	7 years
Loan grace period	1 year

Source: Set by the Survey Team based on analysis of IDCOL appraisal reports

The principal source of revenue in the biomass gasification sub-project is the revenue derived from selling precipitated silica. Additional revenue is expected from selling calcium carbonate, a by-product from the residue of gasification. Furthermore, virtual revenue from cost savings by generating electricity can be deemed to be another source or revenue for the sub-project.

Table 5.5-2 Revenue Assumption of the Biomass Gasification Sub-project

	Annual revenue (BDT)
Cost saving by generating electricity	1,610,053
Revenue from Selling of Silica	7,405,963
Revenue from Selling of Calcium Carbonate	433,125

Source: Set by the Survey Team based on analysis of IDCOL appraisal reports

5.5.2. Financial Analysis of Gasification of Biomass Component

Financial analysis of a sub-project with regard to the revenue including cost savings was conducted. Profit-loss and cash flow statements are as attached in the appendix of this report. The profit-loss statement shows that the net initial cost (sponsor's own fund + loan financed amount = BDT 34,572,800) will be recovered as cumulative retained earnings on the sixth year of the project. Gross initial cost (total investment = BDT 43,216,000), on the other hand, is recovered on the seventh year of the project.

The result of the analysis shows that the sub-project IRR is 27 percent, which is well above WACC of 5.4 percent, exhibiting the robust financial viability of this sub project. NPV at discount rate equivalent to social discount rate is positive at BDT 28,384,690 which is 66 percent of the initial investment amount showing that the sub-project is socially worthwhile, even without taking into account external benefits.

Table 5.5-3 Result of Financial Analysis on the Gasification of Biomass Component

Indicators	Rate
Initial cost recovery period* (net) (gross)	6th year 7th year
WACC	5.4%
Sub-project IRR	27%
NPV at discount rate of 12%	BDT 28,384,690
DSCR (minimum) (average)	1.2 2.4

Note *: "Gross" is the recovery of the total initial investment while "net" is the recovery of investment less grant.
Source: Analysis conducted by the Survey Team based on preconditions set by IDCOL

IDCOL requires that the minimum DSCR for RE projects should be at least 1.2. From the result of the sub-project financial analysis, the Gasification of Biomass Component was found to be financially viable from the viewpoint of debt coverage under IDCOL's lending terms for the component.

5.5.3.Comparison with Diesel Power Generation

The Gasification of Biomass sub-project can be compared with diesel power generation only on a limited scope. This is because production of precipitated silica and calcium carbonate will only be achieved through gasification process, and not by diesel power generation. Here, a comparison is assumed by recovering the extra cost incurred due to installing the gasification facility by cost saved from electricity generation. Annual cost saved by generating electricity is BDT 1,610,053. Additional cost incurred due to installation of gasification facility is BDT 11,933,000. This cost will be recovered by cost saving from electricity generation in the sub-project's eight year of operation.

Table 5.5-4 Initial Cost Recovery Period for a Biogas Power Generation Sub-project

	Gasification of Biomass (BDT)	Diesel power generation (BDT)	Difference (BDT)
Initial Investment Cost (power generation portion)	– 17,743,000	5,750,000	– 11,933,000
Annual cost saving	+ 1,610,053	-	+ 1,610,053
Recovery of difference in initial investment = 8 years			

Source: Calculation by the Survey Team

5.6. Biogas Power Generation Component

5.6.1. Preconditions for Biogas Power Generation Component

IDCOL has funded biogas power generation plants of sizes ranging from 6 kW to 400 kW. According to its funding requirement as of June 2012, the calculation is based on 20 kW plants that would be accommodated in medium sized poultry farms throughout the country. IDCOL sees that the demand for 20 kW biogas power generation plant will be the standard for deployment. Specifications and preconditions for the use of this 20kW are as shown in the following table:

Table 5.6-1 Preconditions for Financial Analysis of a Biogas Power Generation Sub-project

	Condition
Power generation capacity	20 kW
Project life	10 years
Operation hours per day	8 hours
Number of birds (heads) at the poultry farm	10,000
Biogas generated per day	72 m3/day
Cost of diesel generated power	20.3 kWh
Cost of grid power	BDT 4.5 /kWh
Maintenance cost of the plant	BDT 75,000 / year
Initial capital cost	BDT 2,656,000
Own finance (percentage – amount in BDT)	30% - 796,800
Loan (percentage – amount in BDT)	50% - 1,328,000
Grant (percentage – amount in BDT)	20% - 531,200
Loan interest rate	6%
Loan tenure	5 years
Loan grace period	1 year

Source: Set by the Survey Team based on analysis of IDCOL appraisal reports

By introducing a biogas power generation plant, owners of a poultry farm will enjoy cash revenue by selling by-products (fertilizer) and virtual revenue from savings in energy. Financial analysis conducted in this report quantifies both of these benefits as the virtual revenue of the sub-project. Virtual revenues, i.e., from energy cost savings, and real revenue by selling fertilizer, which is the by-product of power generation, are quantified as follows:

Table 5.6-2 Revenue Assumption of the Biogas Power Generation Sub-project

	Annual revenue (BDT)
Cost saving from replacing grid electricity	105,120
Cost saving from replacing diesel usage	474,987
Revenue from sale of fertilizer	65,570

Source: Set by the Survey Team based on analysis of IDCOL appraisal reports

5.6.2. Financial Analysis of Biogas Power Generation Component

Financial analysis of a sub-project with regard to the revenue, including cost savings, is conducted. Profit-loss and cash flow statements are attached in the appendix of this report. The profit-loss statement shows that the net initial cost (sponsor's own fund + loan financed amount = BDT 2,124,800) is recovered through the cumulative retained earnings on the eight year of the project, while gross initial cost (total investment = BDT 2,656,000) is also recovered on the same year.

The result of the analysis shows that the sub-project IRR is 18 percent, which is well above WACC of 5.7 percent, exhibiting the robust financial viability of this sub-project. NPV at discount rate equivalent to social discount rate is positive at BDT 2,139,785, which is 80 percent of the initial investment amount showing that the sub-project is socially worthwhile, even without taking into account external benefits.

Table 5.6-3 Result of Financial Analysis on the Biogas Power Generation Component

Indicators	Rate
Initial cost recovery* (net) (gross)	8th year 8th year
WACC	5.7%
Sub-project IRR	18%
NPV at discount rate of 12%	BDT 2,139,785
DSCR (minimum) (average)	1.2 2.2

Note *: "Gross" is the recovery of the total initial investment while "net" is the recovery of investment less grant.
Source: Analysis conducted by the Survey Team based on preconditions set by IDCOL

IDCOL requires that the minimum DSCR for RE projects should be at least 1.2. From the result of the financial analysis on the DSCR of the Biogas Power Generation Component, it is found that the IDCOL's lending terms for this component is suitable to have the sub-project financially viable from the viewpoint of debt coverage.

5.6.3. Comparison with Diesel Local Electrification

Major virtual revenue in a biogas power generation sub-project was the cost saving from offsetting the diesel oil usage. The biogas power generation plant will now be compared with the conventional diesel powered generator. Comparable diesel powered traction will be a 20 kW diesel generator.

If the net initial cost of biogas power generation plant (BDT 2,656,000 minus grant of BDT 1,062,400 = BDT 1,593,600) is to be recovered by accrued annual saving from replacing diesel generated power and grid electricity (BDT 95,776 + BDT 474,987 = 570,763), a simple calculation shows that 3 years will be sufficient for the recovery. The sub-project is therefore highly effective in cutting the cost of energy, reflecting the fact that poultry farms are energy intensive facilities.

Table 5.6-4 Initial Cost Recovery Period for a Biogas Power Generation Sub-project

	Biogas Power Generation (BDT)	Diesel power generation (BDT)	Difference (BDT)
Initial Investment Cost	– 2,656,000 + 1,062,400	0	–1,593,600
Annual cost saving	570, 763	-	+ 570,763
Recovery of difference in initial investment = 3 years			

Source: Calculation by the Survey Team

5.7. Summary of the Financial Analysis of the Components

Financial analysis results of the five components in the JICA-REDP are listed in the following table. All of the components are financially viable at given conditions. Minimum DSCR for two of the biomass derived RE component are seen to be low but equal to or more than 1.2, which is IDCOL's minimum requirement. The provision of lower interest rate loans is an option for an alternate condition that makes these components financially more robust.

Table 5.7-1 Financial Analysis Results of the Components

	SHS Program*	Solar Irrigation Pump	Solar Mini-Grid	Gasification of Biomass	Biogas Power Generation
Initial cost** (net) recovery period (gross)	-	5th year 9th year	6th year 14th year	6th year 7th year	8th year 8th year
WACC	13.5%	4.5%	3.6%	5.4%	5.7%
Sub-project IRR	36%	24%	19%	27%	18%
NPV at discount rate of 12% (BDT)	-	677,847	12,190,251	28,386,690	2,139,785
DSCR (minimum) (average)	-	3.2 3.3	1.8 2.1	1.2 2.4	1.2 2.2
Recovery period of difference in initial investment compared with diesel powered equipment	7 years	6 years	11 years	8 years	3 years

Note(*): Cost recovery period, NPV, DSCR were not calculated for the SHS Program due to the characteristics of its sub-projects not being investment and repayment type.
Note (**): "Gross" is the recovery of the total initial investment while "net" is the recovery of investment less grant.
Source: Calculation by the Survey Team

It should however be noted that the basis of financial analysis for the above five components differ from each other especially in terms of definition of the revenue of the projects and also in the definition of comparison with diesel power utilization scenarios. The above table, therefore, should not be regarded as a table of comparison.

6. Environmental and Social Considerations

6.1. Current Environmental and Social Conditions as the Baseline

6.1.1. Land Use, Forest Cover and Protected Areas

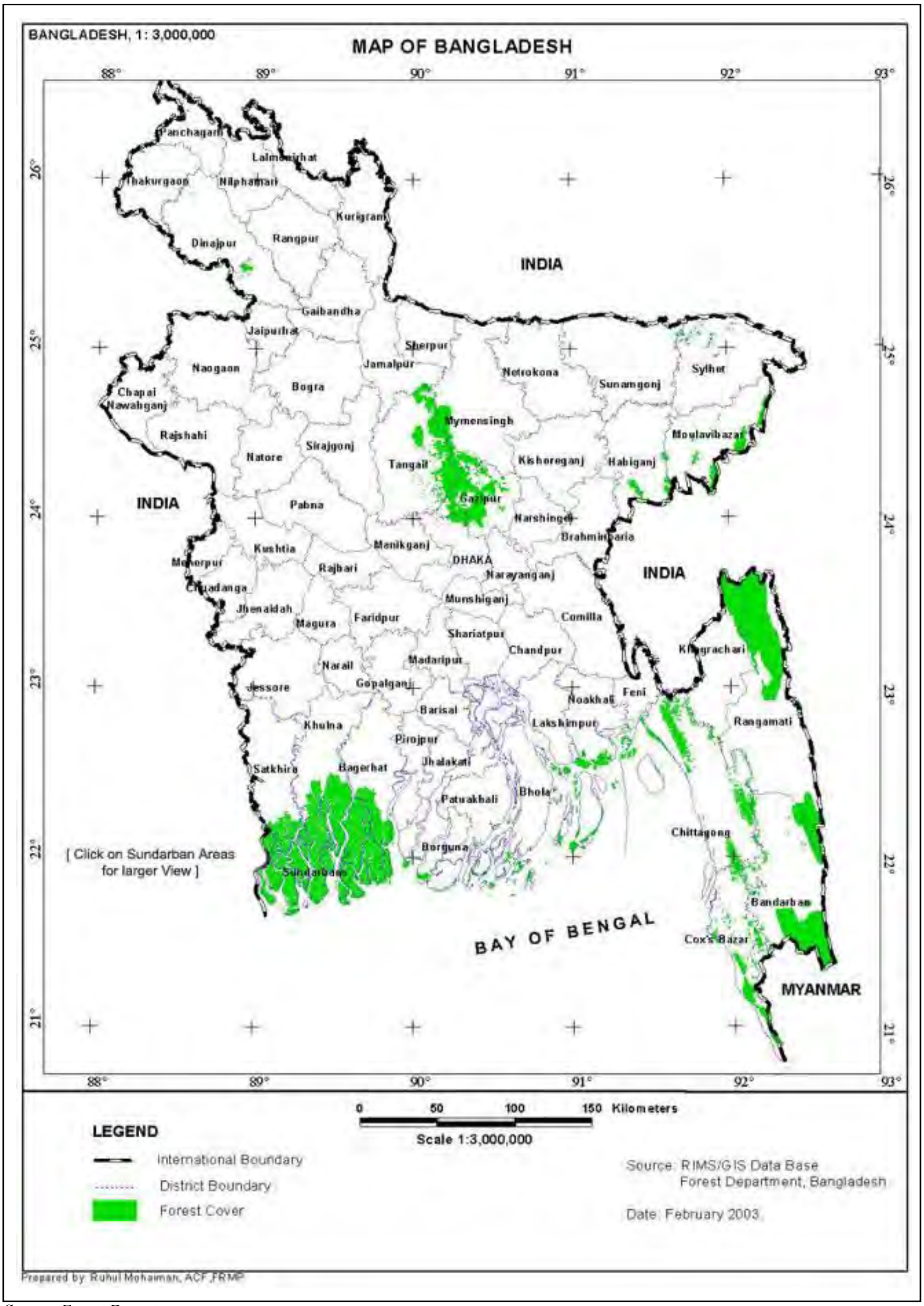
The following table and figures show areas by land use category and distribution of forest coverage in Bangladesh. Agricultural land makes up 65 percent of the total geographic surface area. Forest areas account for almost 17 percent. Hill forest areas that are 670,000 hectares or 4.54 percent of the total area are mainly situated in the Chittagong, Cox's Bazar, Rangamati, Khagrachari, Bandarban, and Sylhet Districts. The sandarac mangrove forest area, which is 601,700 hectares or 4.07 percent of the total area, is the world's largest contiguous natural mangrove forest. 'Sal (*Shorea robusta*)' forest areas, which are 120,000 hectares or 0.81 percent of the total area, are mainly situated in plain land of Gazipur, Tangail, Mymensingh, Sherpur, Jamalpur, Netrokona, Naoga, Rangpur, Dinajpur, and Panchagar Districts.

Table 6.1-1 Land Use Category of Bangladesh

Land Use Category	Area (Million Hectares)	Percent
Agriculture	9.57	64.9
State Forest		
Classified (Managed by Forest Department)	1.52	10.3
Unclassified (Managed by Ministry of Land)	0.73	5
Private Forest		
Homestead	0.27	1.8
Tea/Rubber Garden	0.07	0.5
Urban	1.16	7.9
Water	0.94	6.4
Other	0.49	3.2
Total	14.75	100

Source: Forest Department

The three types of protected areas are: the National Park, the Wildlife Sanctuary, and the Game Reserve, which are defined under "The Bangladesh Wildlife Preservation Act, 1974" and managed by the Forest Department. The total protected area is 261,891.5 hectares, 10.7 percent of the total forest area or 1.8 percent of the national land. The following table shows the list of the protected areas in Bangladesh. The Sundarban East Wildlife Sanctuary, the Sundarban South Wildlife Sanctuary, and the Sudarban West Wildlife Sanctuary, which all total 140,000 hectares, are also inscribed as a World Heritage Site.



Source: Forest Department

Figure 6.1-1 Forest Cover in Bangladesh

Table 6.1-2 Protected Areas of Bangladesh

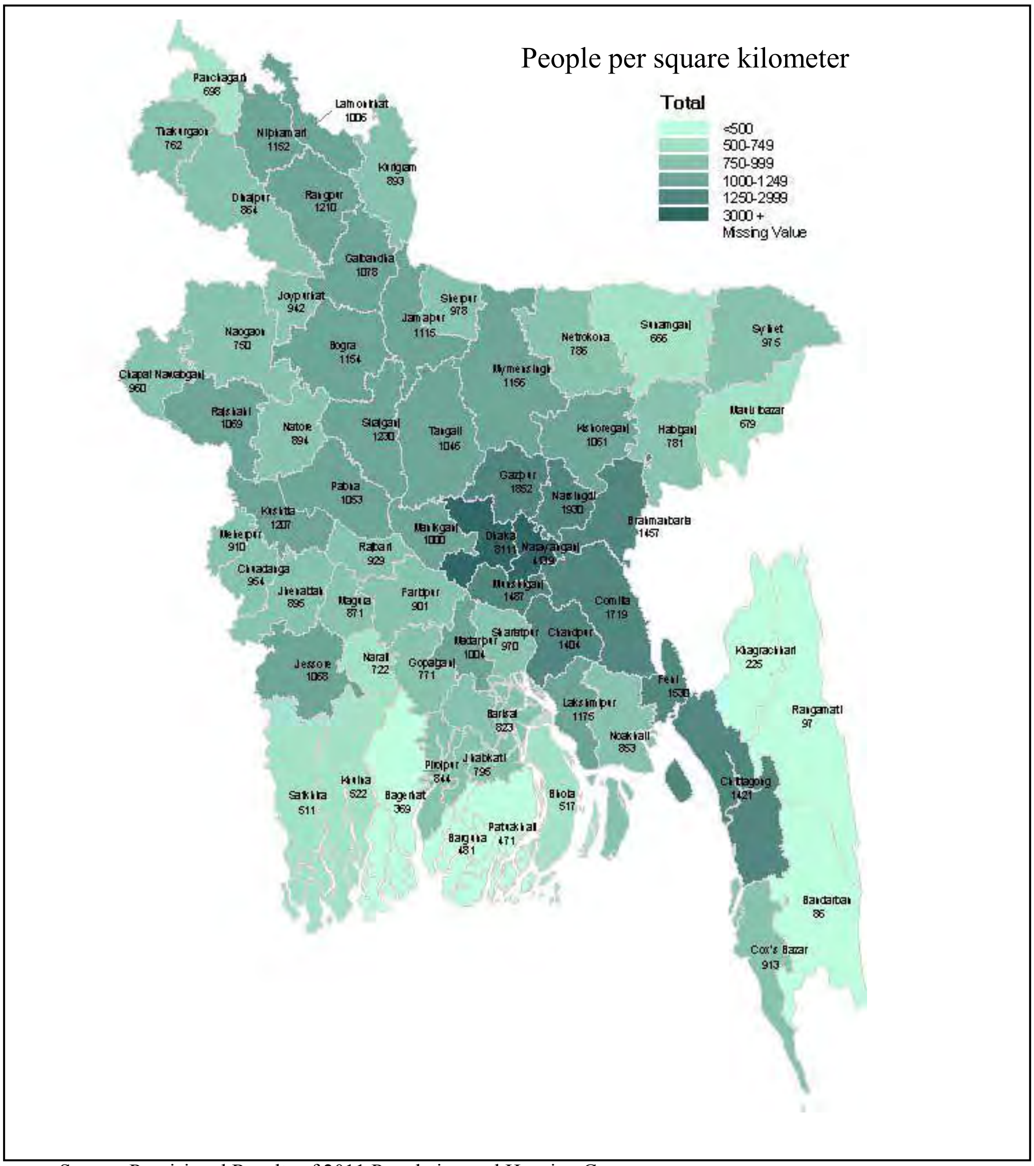
Name	Location	Area (ha.)	Established
Bhawal National Park	Gazipur	5,022.00	11-5-1982
Modhupur National Park	Tangail/ Mymensingh	8,436.00	24-2-1982
Ramsagar National Park	Dinajpur	27.75	30-4-2001
Himchari National Park	Cox's Bazar	1,729.00	15-2-1980
Lawachara National Park	Moulavibazar	1,250.00	7-7-1996
Kaptai National Park	Chittagong Hill Tracts	5,464.00	9-9-1999
Nijhum Dweep National Park	Noakhali	1,6352.23	8-4-2001
Medha Kachhapia National Park	Cox's Bazar	395.92	8-8-2008
Satchari National Park	Habigonj	242.91	15-10-2005
Khadim Nagar National Park	Sylhet	678.80	13-04-2006
Baraiyadhala National Park	Chittagong	2,933.61	06-04-2010
Kuakata National Park	Patuakhali	1,613.00	24-10-2010
Nababgonj National Park	Dinajpur	517.61	24-10-2010
Shingra National Park	Dinajpur	305.69	24-10-2010
Kadigarh National Park	Mymensingh	344.13	24-10-2010
National Park Sub-total		45,312.65	
Rema-Kalenga Wildlife Sanctuary	Hobigonj	1,795.54	7-7-1996
Char Kukri-Mukri Wildlife Sanctuary	Bhola	40.00	19-12-1981
Sundarban (East) Wildlife Sanctuary	Bagerhat	31,226.94	6-4-1996
Sundarban (West) Wildlife Sanctuary	Satkhira	71,502.10	6-4-1996
Sundarban (South) Wildlife Sanctuary	Khulna	36,970.45	6-4-1996
Pablakhali Wildlife Sanctuary	Chittagong Hill Tracts	42,087.00	20-9-1983
Chunati Wildlife Sanctuary	Chittagong	7,763.97	18-3-1986
Fashiakhali Wildlife Sanctuary	Cox's Bazar	1,302.43	11-4-2007
Dudh Pukuria-Dhopachari Wildlife Sanctuary	Chittagong	4,716.57	6-4-2010
Hazarikhil Wildlife Sanctuary	Chittagong	1,177.53	6-4-2010
Sangu Wildlife Sanctuary	Bandarban	2,331.98	6-4-2010
Teknaf Wildlife Sanctuary (Game Reserve)	Cox's Bazar	11,615.00	24-03-2010
Tengragiri Wildlife Sanctuary	Barguna	4,048.58	24-10-2010
Wildlife Sanctuary/ Game Reserve Sub-Total		216,578.90	
Grand-Total		261,891.50	

Source: Forest Department

6.1.2. Distribution of Population and Poverty Region

According to "Provisional Results of 2011 Population and Housing Census", the total population of Bangladesh in 2011 was 142,319,000. Compared to the population in 2001, about 18 million people were added, which represents a 14.4 percent increase and a 1.34 percent average annual growth rate.[93] The following figure shows the population density by districts.

[93] BBS (2011)



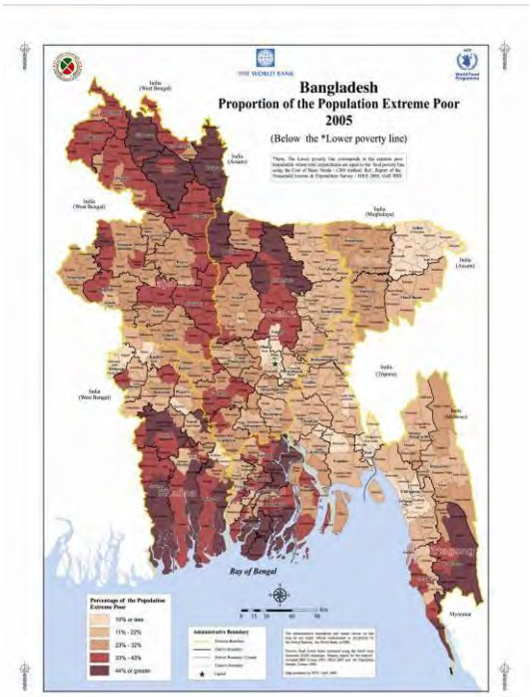
Source: Provisional Results of 2011 Population and Housing Census

Figure 6.1-2 Population Density in Bangladesh by District, 2011

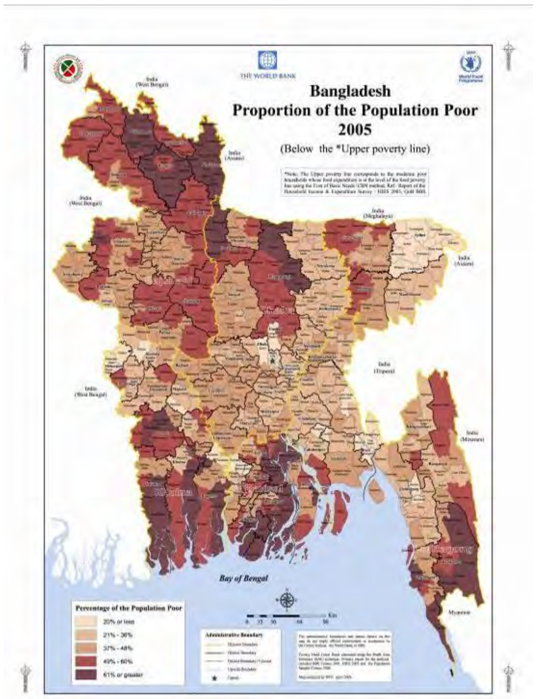
The official Bangladesh Poverty measurement includes two types of poverty lines: (i) Upper Poverty Lines and (ii) Lower Poverty Lines. The Cost of Basic Needs Method (CBN) is adopted for setting of the poverty lines. An upper poverty line represents a higher level of per capita household expenditure than a lower poverty line. In Bangladesh, the upper poverty lines are on average 20 percent higher than the lower poverty lines.

The following two maps are the Poverty Map (based on the upper poverty lines) and the Extreme Poverty Map (based on the lower poverty lines). Both maps indicate a similar spatial distribution of poverty. The Extreme Poverty Map displays relatively affluent areas between Dhaka and Chittagong more clearly than the Poverty Map. The areas around Dhaka record low poverty headcount rates. However, the absolute size of the poor population is large. The Bandarban District (the southeastern part), in contrast, has a high poverty rate. The size of its poor population, however, is relatively small. The Monga areas (the northwestern part) record high poverty headcount rates and also have large poor populations.[94]

[94] BBS (2001)



Extreme Poverty Map (Below Lower Poverty Line)



Poverty Map (Below Upper Poverty Line)

Source: Bangladesh Bureau of Statistics, Updating Poverty Map of Bangladesh 2009

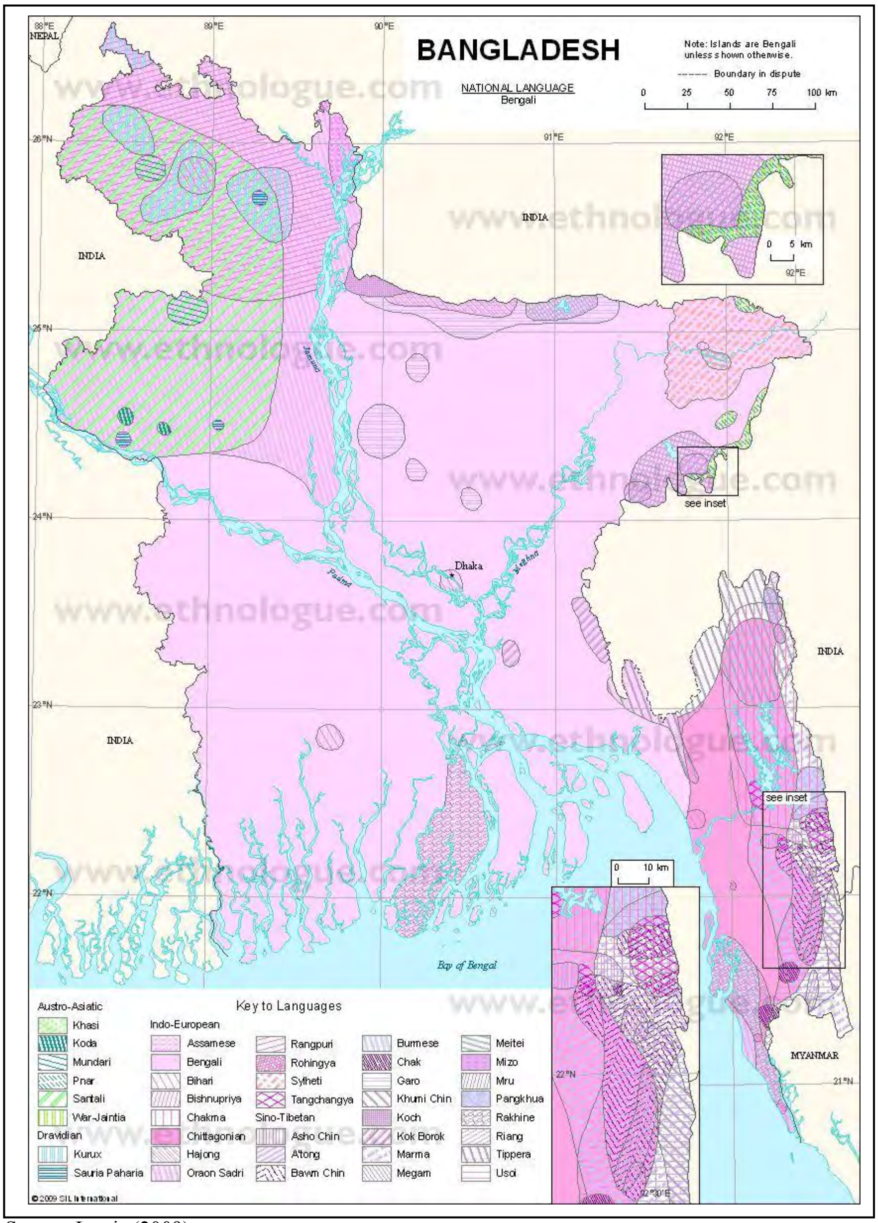
Figure 6.1-3 Poverty Map 2005

6.1.3. Language, Religion and Ethnic Groups

Although there are 38 different languages of Bangladesh, Bengali is by far the most widely spoken language in the country. 98 percent of the population is estimated to be able to speak the language.[95]

Muslims constitute 89.6 percent of the population followed by Hindus who constitute 9.3 percent. The rest includes Buddhists and Christians.[96] The tribal population in 2001 was 1.4 million, which was about 1.13 percent of the total population.[97]

[95] Lewis (2009)
[96] BBS (2010)
[97] BBS (2010)

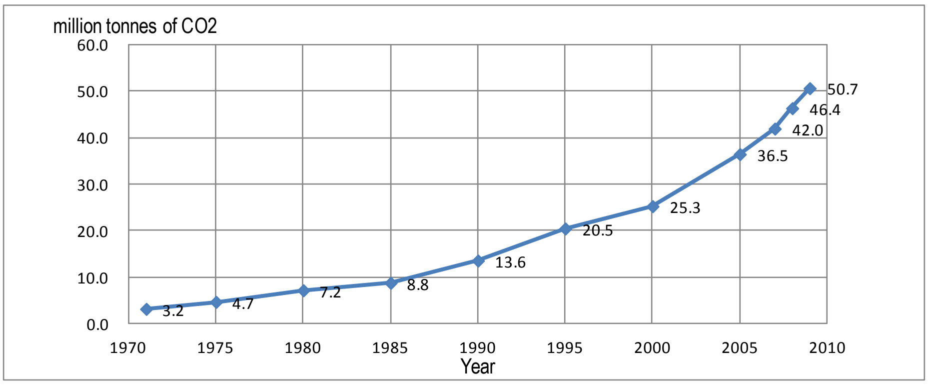


Source: Lewis (2009)

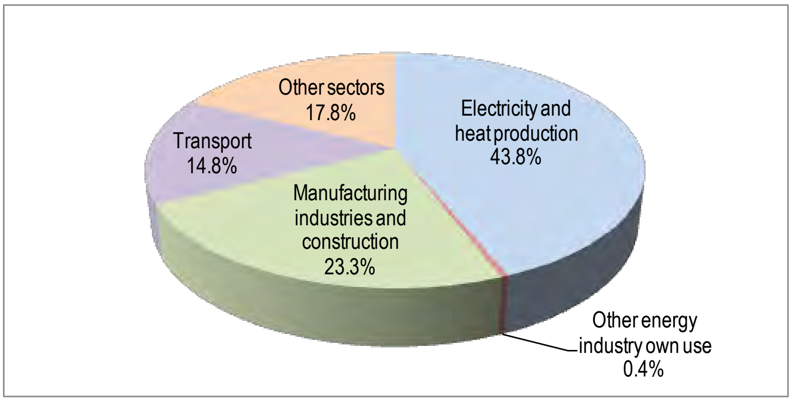
Figure 6.1-4 Languages of Bangladesh

6.1.4. CO2 Emission

The CO2 emission from fuel combustion in Bangladesh in 2009 was 50.7 million tons. This amount is 3.7 times more than the recorded amount in 1990, and had doubled for the past decade. The CO2 emission from electricity and heat production sector was 44 percent of the total emission in 2009.



Changes in CO2 emission



CO2 emissions by sector in 2009

Source: International Energy Agency, CO2 EMISSIONS FROM FUEL COMBUSTION 2011 EDITION

Table6.1-3 CO2 Emission from Fuel Combustion in Bangladesh

6.1.5. Basic Living Environment

In order to get the pictures of basic living environment of each division in Bangladesh, this section provides the survey data of distribution of households having electricity, distribution of households by sources of drinking water, and school enrolment in the age groups of 6-10 and 11-15 years.

The following table shows distribution of households with access to electricity by division in 2010. 55.26 percent of households reported to have access to electricity at the national level, 42.49 percent from rural, and 90.10 percent from urban households benefited from such facility. This figure reveals that the Dhaka division enjoyed the highest electricity access rate of 67.34 percent at the national level. This is followed by the Chittagong division with 60.34 percent and the Khulna division with 54.13 percent. Among all the divisions, Rangpur was ranked at the bottom with the lowest electricity access rate of 30.07 percent at the national, 68.68 percent at the urban, and 24.44 percent at the rural level.

Table 6.1-4 Percentage Distributions of Households Having Electricity

Electricity Access	Yes (%)		
Division	National	Urban	Rural
National	55.26	90.10	42.49
Barisal	40.12	82.33	31.62
Chittagong	60.34	92.31	48.84
Dhaka	67.34	96.15	47.36
Khulna	54.13	83.83	45.55
Rajshahi (Former)	41.73	72.85	36.17
Rajshahi (New)	51.88	75.53	46.94
Rangpur	30.07	68.68	24.44
Sylhet	47.22	88.94	39.09

Source: HIES Survey Report 2010

The following table provides distribution of households by sources of drinking water in 2010. At the national level, 85.37 percent used tube well water and 10.62 percent used supply water. The highest percentage of households using supply water belonged to the Dhaka division (21.30 percent) followed by the Chittagong division (13.71 percent), the Sylhet division (3.88 percent), and the Rajshahi division (2.66 percent). The highest percentage of households using tube-well water for drinking purposes belonged to the Rangpur division (98.07 percent) followed by the Rajshahi division (96.86 percent), the Barisal division (94.57 percent), the Sylhet division (91.17 percent), and the Khulna division (91.09 percent).

Table 6.1-5 Percentage Distributions of Households by Sources of Drinking Water

National (%)	Supply Water	Tube-well	Pond/River /Canal	Well/ Indra	Water falls	Other
National	10.62	85.37	0.94	0.99	0.08	2.00
Barisal	1.67	94.57	2.07	0.00	0.00	1.68
Chittagong	13.71	78.39	1.92	3.68	0.48	1.82
Dhaka	21.30	75.11	0.04	0.12	0.00	3.44
Khulna	2.55	91.09	3.20	0.07	0.00	3.09
Rajshahi (Former)	1.93	97.42	0.09	0.39	0.00	0.17
Rajshahi (New)	2.66	96.86	0.08	0.23	0.00	0.17
Rangpur	1.09	98.07	0.10	0.58	0.00	0.16
Sylhet	3.89	91.17	0.89	4.05	0.00	0.00

Source: HIES Survey Report 2010

Data on school enrolment in the age groups 6-10 and 11-15 years is presented on the following table. It shows that 84.75 percent of children belonging to the 6-10 age group and 77.82 percent of children belonging to the 11-15 age group are enrolled at the national level. Compared with the urban and the rural level, it is found that the school enrollment rate of the former was 4.09 percent higher than that of the latter in the age group 6-10, while the rate of the former was 0.44 percent higher than that of the latter. It is noteworthy that the Dhaka and Chittagong divisions were have lower school enrollment rates in both the 6-10 and 11-15 age groups than the other divisions such as Barisal, Khulna, Rajshahi, and even Rangpur.

Table 6.1-6 Percentage Children Enrolled in School

Both Sexes (%)	Children Aged 6-10 Years			Children Aged 11-15 years		
	National	Urban	Rural	National	Urban	Rural
National	84.75	87.88	83.79	77.82	77.49	77.93
Barisal	91.13	94.61	90.49	81.08	84.71	80.36
Chittagong	83.09	92.37	80.84	74.21	78.12	73.11
Dhaka	84.44	85.48	83.85	77.88	76.90	78.49
Khulna	89.01	90.24	88.65	82.86	76.17	84.80
Rajshahi (Former)	85.75	88.95	85.23	81.17	79.41	81.51
Rajshahi (New)	87.30	90.69	86.63	82.69	82.26	82.79
Rangpur	84.21	86.43	83.93	79.45	75.00	80.15
Sylhet	75.66	82.26	74.74	65.51	69.37	64.90

Source: HIES Survey Report 2010

The above survey data on electricity access, sources of drinking water and school enrolment revealed that rural areas and local divisions suffered a disadvantage in terms of infrastructure facilities such as electricity and water supply. The Barisal and Rangpur divisions experienced the worst conditions among the group. However, with regard to the school enrollment rate, the gap between the urban and rural area was hardly found. Even the Barisal and Rangpur divisions showed a better record than Dhaka and Chittagong divisions.

6.2. Rules and Institutions on Environmental and Social Considerations

6.2.1. The Bangladesh Environment Conservation Act

"The Bangladesh Environment Conservation Act, 1995", as amended in 2010, is the organic environmental law in Bangladesh. The provisions regulate conservation of the environment, improvement of environmental standards, control and mitigation of environmental pollution, establishment of the Department of Environment, and empowerment of its Director General. According to the Act, an Environmental Clearance Certificate from the Director General must be issued before initiating any industrial activity or development project with negative environmental impacts.

6.2.2. The Environment Conservation Rules

"The Environment Conservation Rules, 1997" were issued as enforcement regulations of "The Bangladesh Environment Conservation Act, 1995". The Rules provide for the following:

The national environmental quality standards for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise and vehicular exhaust;

Categorization of industries, development projects, and other activities on the basis of actual or anticipated pollution load and environmental impacts;

Procedure for obtaining Environmental Clearance Certificate (ECC);

Requirements for Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) as well as formulating Environmental Management Plan (EMP) according to categories of industries, development projects and other activities; and

Procedures for damage claim by persons affected or likely to be affected due to polluting activities or activities causing damage to normal civic life.

The Rules classify industrial units, development projects, and other activities into four categories in consideration of their type and scale for issuing the ECC. These categories are Green, Orange-A, Orange-B and Red. All existing industrial units and projects and proposed industrial units and projects that have positive environmental and social impacts or negligible negative impacts are categorized under "Green" and shall be granted ECC issued by the Department of Environment (DOE). For proposed industrial units and projects classified under the Orange-A, Orange-B and Red categories, needs to secure a Site Clearance Certificate (SCC) and thereafter an ECC will be issued. An IEE (Check list format) is required for a SCC to be issued by the DOE. Orange-B and Red category classified industrial units or projects are required to submit an IEE, EIA, and EMP to the DOE.

A detailed description of industrial unit and project types for those four categories is given in Schedule-1 of the Rules. However, there is no clear guidance about the application of renewable energy technologies or projects in the Schedule-1. An IEE or EIA study for SHS Programs and Solar Irrigation Pump Sub-projects has not been required up to the present.

With regard to Solar Mini-Grid Sub-projects, as the sub-project uses diesel generator as back-up generator, which generate SOx and noise, the DOE has categorized such mini-grid projects under the Orange–B category. For example, the mini-grid project of Sandwip financed by IDCOL has been categorized as Orange-B requiring an IEE and EIA.

The Biomass Gasification Sub-projects were classified under the Orange–B category by the DOE considering the issue of power generation and its associated risks. For example, the rice husk gasification project financed by IDCOL at Thakurgaon has been classified as an Orange-B category project. Large scale Biogas Power Generation Sub-projects (more than 100 kW) are also classified under the Orange-B category after considering the issue of electrical hazard and slurry management.

The following table shows provisional environmental category, main required documents, and clearance for the program and sub-projects in JICA-REDP. The actual category will be decided by a relevant DOE office depending on general information of JICA-REDP.

Table 6.2-1 Provisional Environmental Category and Clearance for Sub-project

Program Sub-project	Category	Required documents	Clearance
SHS Program	-	-	-
Solar Irrigation Pump	-	-	-
Solar Mini-Grid	Orange –B	General Information No Objection Certificate (NOC) form local authority Feasibility Study Report Initial Environmental Examination (IEE) Environmental Management Plan (EMP)	Site Clearance Certificate (SCC) Environmental Clearance Certificate (ECC)
Gasification of Biomass	Orange –B	General Information NOC Feasibility Study Report IEE EMP	SCC ECC

Program Sub-project	Category	Required documents	Clearance
Biogas Power Generation	Orange –A (Orange – B)	General Information NOC	SCC ECC

Source: Survey Team

The following table shows the categorization of industrial units and project types likely to be related in JICA-REDP.

Table 6.2-2 Categorization of Industrial Units and Components Related JICA-REDP

Industrial Unit or Project	Categorization in Schedule-1
Sodium silicate	Orange-B
Automatic rice mill	Orange-B
Engineering works (up to 10 hundred thousand Taka capital)	Orange-B
Grinding/husking wheat, rice, turmeric, chilly, pulses – machine above 20 Horse Power	Orange-B
Assembling batteries	Orange-B
Power plant	Red
Industrial gas (Oxygen, Nitrogen & Carbon-dioxide)	Red
Battery	Red
Engineering works (capital above 10 hundred thousand Taka	Red
Water, power and gas distribution line laying/relaying/extension	Red
Renewable Energy	(Not included in Schedule-1)

Source: The Environment Conservation Rules, 1997

The environmental standards for noise and water quality parameters likely to be related to JICA-REDP, effluent from industrial units or development activities, are shown in the following tables.

Table 6.2-3 Standards for Noise

Category of areas	Standards determined at dBA unit	
	Day	Night
Silent zone	45	35
Residential area	50	40
Mixed area (mainly residential area, and also simultaneously used for commercial and industrial purposes)	60	50
Commercial area	70	60
Industrial area	75	70

1. The time from 6 a.m. to 9 p.m. is counted as daytime.
2. The time from 9 p.m. to 6 a.m. is counted as night time.

Source: The Environment Conservation Rules, 1997

Table 6.2-4 Standards for Effluent

Parameter	Unit	Places for Determination of Standards		
		Inland Surface Water	Public Sewerage system connected to treatment at second stage	Irrigated Land
Ammonium Nitrogen	mg/L	50	75	75

Free Ammonia	mg/L	5	5	15
BOD5 at 20 Celsius	mg/L	50	250	100
Chloride	mg/L	600	600	600
COD	mg/L	200	400	400
Dissolved Oxygen	mg/L	4.5-8	4.5-8	4.5-8
Electro-Conductivity	micro mho/cm	1,200	1,200	1,200
Total Dissolved Solids	mg/L	2,100	2,100	2,100
Sulfide (as S)	mg/L	1	2	2
Lead (as Pb)	mg/L	0.1	1.0	0.1
Nitrate (as N)	mg/L	10	Not yet Fixed	10
Dissolved Phosphorus (as P)	mg/L	8	8	15
pH	-	6-9	6-9	6-9
Temperature (Summer) Temperature (Winter)	Centigrade	40 45	40 45	40 45
Suspended Solids	mg/L	150	500	200

Source: The Environment Conservation Rules, 1997

6.2.3. Legislation and Policy on Battery Recycling

(1) Current Condition

Use of lead acid battery has been on steep rise as vehicle use has been sharply increasing in the country with the growth of GDP. In a 2006 UNDP funded study by Waste Concern, a Bangladesh-based NGO, entitled “Lead Acid Battery Recycling in Bangladesh”, it was estimated that approximately 3,420 tons of lead that were 60 percent of the total lead requirement of the country were recovered from expired lead batteries per year. The recycle rate of the produced batteries in 2005 was estimated at 86 percent. According to another data, in 2006, the total number of produced batteries was 726,000 and the total number of recycled batteries was 626,376.[98] The recycling activities include lead, ash, plastic cover, and separators. The recovered lead has saved approximately USD five million per year in terms of foreign currency required for the imports.[99]

The collection and smelting activities of expired lead batteries are well dispersed throughout the country. Two chains are presently workable in battery recycling:
User- small buyer/dealer - broker - repairer/rebuilder – vangari (scrap) shop - smelter - lead user (for private users)
User - smelter (for institutional users such as army, navy or transport agency)

The collection activities, in which mostly the informal labor sector and enterprises are involved, take place in a very competitive market condition. The recycling activities have been providing income-earning opportunities to thousands of informal sector workers and their enterprises.

[98] BBS, Compendium of Environmental Statistics of Bangladesh 2009
[99] Waste Concern (2006)

Table6.2-5 Price of Used Lead Acid Battery at Different Actor and Component

(Unit: BDT)

Part	Small Buyer	Broker	Separator	Smelter/Rebuilder
Battery	100-400	200-600	400-800	400-800
Plastic Container (Good ones)				200-1,000/kg
Plastic Container (Bad ones)				15-20/kg
Plate (Good ones)				6-8/piece
Plate / Ash				20-28/kg

Source: Waste Concern, Lead Acid Battery Recycling in Bangladesh

With regard to environmental issues, soil and water pollutions are widespread in and around some smelting factories, especially in informal enterprises. Some persons dealing with battery recycling are not aware of environmental pollution or health hazards related to such recycling activities.

(2) Existing Rules and Regulations

"Lead Acid Battery Recycling and Management Rules (Statutory Regulatory Order No. 175-Act/2006)" on collection and recycling of used/non-functional batteries was enacted for the conservation of environment, improvement of environmental quality, and control and prevention of environmental pollution in 2006. According to the Rules, no battery recycling will be permitted without an environmental clearance from the DOE. The Rules also restricted the improper disposal of used batteries or any parts of its parts in open place, water bodies, and waste bins, among others. All used batteries must be sent to the battery recycling industry as approved by the DOE. Mutually agreed financial transactions on fixed costs are allowed for used/non-functional batteries.

Moreover, the "National 3R Strategy for Waste Management, 2010" and "The Solid Waste Management Rules, 2011' have been formulated.

6.2.4. JICA Guidelines

JICA has prepared "Guidelines for Environmental and Social Considerations, April 2010" (Thereafter referred to as JICA guidelines) as the referential guidelines for environmental and social considerations. According to the guidelines, JICA classifies development projects into four categories with regards to the extent of environmental and social impacts. It also takes into account outlines, scale, site, and other conditions. The four categories are as follows:
Category A: Proposed projects are likely to have significant adverse impacts on the environment and society.
Category B: Proposed projects are classified as Category B if their potential adverse impacts on the environment and society are less adverse than those of Category A projects.
Category C: Proposed projects are classified as Category C if they are likely to have minimal or little adverse impact on the environment and society.
Category FI: A proposed project is classified as Category FI if it satisfies all of the following:
JICA's funding of JICA-REDP is provided to a financial intermediary or executing agency;

- The selection and appraisal of the components is substantially undertaken by such an institution only after JICA's approval of the funding, so that the components cannot be specified prior to JICA's approval of funding (or project appraisal); and

- \- Those components are expected to have a potential impact on the environment.[100]

JICA-REDP to be implemented is classified as “Category FI”.

6.2.5. IDCOL Framework

IDCOL has formulated “Environmental and Social Management Framework (ESMF) June, 2011” and “Environmental and Social Safeguards Framework (ESSF), August 2011”. The ESMF was prepared for the Second Additional Financing for Rural Electrification and Renewable Energy Development (RERED) Project supported by the World Bank. It provides general policies, guidelines, codes of practice, and procedures to be integrated into the implementation of the RERED project. The ESMF includes “Policy Guidelines on Disposal of Warranty Expired Battery” and “Sample Agreement for Buy-Back of Warranty Expired Batteries”. The guidelines were formulated not only by IDCOL but in conjunction with several POs that has been operating the SHS Program. The outline of the guidelines is provided below:
The consumer will submit the battery to the POs and under no circumstances will it keep it with them or sell it to any third party.
PO representatives will make arrangements to collect the batteries from the consumer and store it in their local offices.
The batteries must be collected within 30 days after the consumers stop using it.
The PO representative will ensure that no component/part of the battery is left behind and the acid does not spill out of the battery during its transportation.
POs will send the warranty expired batteries within 30 days to any of the six central locations designated by battery manufacturers.
Battery manufacturers will be required to take environmental clearance from the Directorate of Environment for recycling.
Battery manufacturers will collect the batteries from the central locations and ensure safe transportation of the batteries to the site where the batteries will be recycled.

The ESSF provides policy and procedures on environmental management for all kinds of projects and programs supported by IDCOL. This framework also includes the safeguard management of expired batteries. IDCOL plays a role of supervision and technical support to the project implementing organizations (sponsors). Actual environmental studies, mitigation and management plans are conducted by the organizations.

In addition, IDCOL has prepared “Draft updated ESMF” for “Rural Electrification and Renewable Energy Development II (RERED II) Project” supported by the World Bank.

6.3. Components Screening Criteria from the Viewpoint of Environmental and Social Considerations

6.3.1. Potential Environmental and Social Impact and Mitigation Measures

(1) SHS Program Component

The locations of the SHS Programs are not yet fixed in this survey stage. The programs, however, will be implemented within Bangladesh. The potential environmental and social impacts were assessed on the basis of general conditions. The result of the impact assessment is

[100] JICA (2010)

shown in the following table. The SHS Program is classified as "Category B level of JICA Guidelines", because the expired batteries will cause environmental pollution, if the batteries remain in inappropriate sites or are treated improperly.

Table6.3-1 Result of Impact Assessment (SHS Program)

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
Pollution				
1	Air pollution	D	D	No considerable impact on air quality
2	Water pollution	D	D	No considerable impact on water quality
3	Waste	D	B-	**Construction Phase:** No generation of construction waste. **Operation Phase:** Old batteries will be collected and recycled. However, because the informal sector has been concerned in the collection, old batteries may remain in inappropriate sites.
4	Soil pollution	D	D	No considerable impact on soil quality
5	Noise and vibration	D	D	No considerable generation of noise and vibration
6	Ground subsidence	D	D	No considerable impact on ground subsidence
7	Offensive odors	D	D	No considerable generation of offensive odors
8	Bottom sediment	D	D	No considerable impact on bottom sediment
Natural Environment				
9	Protected areas	D	D	Program locations include protected area. However, no considerable impact on components in the protected area.
10	Ecosystem	D	D	No considerable impact on ecosystem
11	Hydrology	D	D	No considerable impact on hydrology
12	Geographical features	D	D	No considerable impact on geographical features
Social Environment				
13	Resettlement/ Land Acquisition	D	D	Resettlement or land acquisition will not be required.
14	Poor people	D	D	Because of voluntary basis to customers, no impact on poor people
15	Ethnic minorities and indigenous peoples	D	D	Because of voluntary basis to customers, no impact on indigenous people
16	Local economies, such as employment, livelihood, etc.	B+	B+	**Construction Phase:** Job creation related to SHS installing works **Operation Phase:** Job creation related to SHS maintenance works
17	Land use and utilization of local resources	D	D	No considerable impact on land use and utilization of local resources

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
18	Water usage	D	D	No considerable impact on water usage
19	Existing social infrastructures and services	D	B+	**Construction Phase:** No considerable impact on social infrastructure. **Operation Phase:** Improvement of electric condition
20	Social institutions such as social infrastructure and local decision-making institutions	D	D	Because of voluntary basis to customers, no considerable impact on social institutions
21	Misdistribution of benefits and damages	D	D	Because of voluntary basis to customers, no considerable impact on misdistribution
22	Local conflicts of interest	D	D	Because of voluntary basis to customers, no considerable impact on local conflict
23	Cultural heritage	D	D	No impact on cultural heritage
24	Landscape	D	D	No considerable impact on landscape
25	Gender	D	B+	**Construction Phase:** No considerable impact on gender **Operation Phase:** Improvement of women's household works
26	Children's rights	D	D	No considerable impact on children's rights
27	Infectious diseases such as HIV/AIDS	D	D	No considerable impact on infectious diseases
28	Working conditions (including occupational safety)	D	B+	**Construction Phase:** No considerable impact on working condition **Operation Phase:** Improvement of working condition
29	Accidents	D	B-	**Construction Phase:** No considerable impact on accidents **Operation Phase:** Risk of accidental electric shock
Other				
30	Trans-boundary impacts or climate change	D	D	No trans-boundary impacts such as climate change

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected
Source: Survey Team

1) Waste

Impact:

The batteries used SHS are mostly lead-acid type. If these batteries remain in inappropriate sites, these batteries may pollute water and soil. Lead has reproductive toxicity, acute inhalation toxicity, acute oral toxicity, specific target organ toxicity, acute aquatic toxicity, and chronic aquatic toxicity. Acid (Sulfuric acid) may cause skin corrosion. The expired batteries will be collected and recycled by the POs and registered battery manufacturers. However, since the informal sector has been concerned in the collection, old batteries may remain in inappropriate sites.

Mitigation:
IDOCL has prepared "Policy Guidelines on Disposal of Warranty Expired Battery". The customers, POs, and manufactures should observe the Policy fully. In order to identify battery collection conditions, periodic monitoring should be conducted.

2) Accident:

Impact:
Without knowledge on electricity, the customer may accidentally get an electrical shock.

Mitigation:
The POs should instruct basic knowledge on electricity to the customers.

(2) Solar Irrigation Pump Component

The locations of the Solar Irrigation Pump Sub-projects are not yet fixed in this survey stage. The programs, however, will be implemented within Bangladesh. The potential environmental and social impacts were assessed on the basis of general conditions. The result of the impact assessment is shown in the following table. The Solar Irrigation Pump Sub-project is classified as "Category C level of JICA Guidelines" in case of replacement of existing diesel pumps, which is the common case, since the sub-projects are likely to have minimal or little adverse impact. However, in case of a new installation of an irrigation system, impacts on the water usage and agricultural community may occur. Therefore, its operations and maintenance should be periodically monitored.

Table6.3-2 Result of Impact Assessment (Solar Irrigation Pump Sub-project)

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
Pollution				
1	Air pollution	D	D	No considerable impact on air quality
2	Water pollution	D	D	**Construction Phase:** Turbid water will be generated by construction works, but the pollution will be insignificant, in limited area and for a short time. **Operation Phase:** No considerable impact on water quality
3	Waste	D	D	No considerable generation of waste
4	Soil pollution	D	D	No considerable impact on soil quality
5	Noise and vibration	D	D	**Construction Phase:** No considerable generation of noise and vibration **Operation Phase:** Noise and vibration will be generated by pomp operation, but the levels will be lower than ones of diesel.
6	Ground subsidence	D	D	No considerable impact on ground subsidence

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
7	Offensive odors	D	D	No considerable generation of offensive odors
8	Bottom sediment	D	D	No considerable impact on bottom sediment
Natural Environment				
9	Protected areas	D	D	Sub-projects locations include protected area. However, no considerable impact on components in the protected area.
10	Ecosystem	C-	D	**Construction Phase:** Impact on ecosystem will not occur in ordinary circumstances. However, tree clearing may be required depending on project site. **Operation Phase:** No considerable impact on ecosystem
11	Hydrology	D	C-	**Construction Phase:** No considerable impact on hydrology **Operation Phase:** Excessive water use may cause impact on hydrology.
12	Geographical features	D	D	No considerable impact on geographical features
Social Environment				
13	Resettlement/ Land Acquisition	C-	D	Resettlement is unlikely to be required in ordinary circumstances. However, land acquisition may be required depending on project site.
14	Poor people	D	C-	**Construction Phase:** No impact on poor people **Operation Phase:** Impact on poor people may occur depending on water fee and project site.
15	Ethnic minorities and indigenous peoples	D	D	No considerable on indigenous people
16	Local economies, such as employment, livelihood, etc.	D	B+	**Construction Phase:** No impact on local economy. **Operation Phase:** Improvement of maintenance works and cost for irrigation system
17	Land use and utilization of local resources	C-	D	**Construction Phase:** Shift of land use from agricultural land to PV generation site may be required depending on project site. **Operation Phase:** No considerable impact on land use and utilization of local resources

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
18	Water usage	D	C-	**Construction Phase:** No considerable impact on water usage **Operation Phase:** Excessive water use may cause impact on existing water usage.
19	Existing social infrastructures and services	D	B+	**Construction Phase:** No considerable impact on social infrastructure. **Operation Phase:** Improvement of maintenance works and cost for irrigation system
20	Social institutions such as social infrastructure and local decision-making institutions	D	C-	**Construction Phase:** No considerable impact on social institutions. **Operation Phase:** Without a steady agricultural group, conflict among local decision-making institutions in maintenance works and cost for irrigation system may occur.
21	Misdistribution of benefits and damages	D	C-	**Construction Phase:** No considerable impact on misdistribution. **Operation Phase:** Without a proper water allocation and management plan, conflict among users may occur.
22	Local conflicts of interest	D	C-	**Construction Phase:** No considerable impact on local interest. **Operation Phase:** Without a proper water allocation and management plan, agreement of users, conflict among users may occur.
23	Cultural heritage	D	D	No impact on cultural heritage
24	Landscape	D	D	No considerable impact on landscape
25	Gender	D	B+	**Construction Phase:** No considerable impact on gender **Operation Phase:** Improvement of women's working condition
26	Children's rights	D	D	No considerable impact on children's rights
27	Infectious diseases such as HIV/AIDS	D	D	No considerable impact on infectious diseases
28	Working conditions (including occupational safety)	D	B+	**Construction Phase:** No considerable impact on working condition **Operation Phase:** Improvement of working condition
29	Accidents	D	D	No considerable impact on accidents

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
Other				
30	Trans-boundary impacts or climate change	D	D	CO_2 emission is less than diesel one. However, the reduction volume will be vanishingly small to global climate change.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected
Source: Survey Team

1) Ecosystem/ Resettlement/ Land use

Impact:
Procurement of land for the sub-project, such as PV generation site; tree clearing; land acquisition; and agricultural land may be required depending on the project site.

Mitigation:
Sub-projects requiring clearing of natural forest or involuntary resettlement should be rejected in the appraisal stage. Proper compensation for the lost land should be paid to the affected persons.

2) Hydrology/Water usage

Impact:
Excessive or uncontrolled water use may impact existing water usage and groundwater.

Mitigation:
The project proponent or agricultural group should prepare a proper water pump-up and use plan reference from experience in the surrounding areas and results of hydrological surveys.

3) Poor people

Impact:
If a proper water fee is not set, poor people can not afford to pay for it. This might widen the gap between the rich and poor people.

Mitigation:
The project proponent or agricultural group should set a proper payment method reference from experience in the surrounding areas. The payment method should be reviewed in the appraisal stage.

4) Social institutions/Misdistribution/Local conflicts

Impact:
If proper water allocation and management plans of irrigation system are not formulated, or a proper management group to maintain the irrigation system does not exist, especially in case of a new installation of an irrigation system, conflicts among local community in water use, maintenance works, and water fee may occur. In case of replacement of existing diesel pumps, without agreement among the existing users, conflicts in the replacement will also occur. Consequently, the irrigation system may not operate.

Mitigation:
The project proponent or agricultural group should formulate the water allocation and management plans reference from experience in the surrounding areas. The plans and capacity of the responsible group to maintain the irrigation system should be reviewed in the appraisal stage. In case of a new installation of an irrigation system, its operation and maintenance should be periodically monitored. In case of replacement of existing diesel pumps, the basic agreement among the existing users should be provided in the appraisal stage.

(3) Solar Mini-Grid Component

The locations of the Solar Mini-Grid Sub-projects are not yet fixed in this survey stage. The programs, however, will be implemented within Bangladesh. The potential environmental and social impacts were assessed on the basis of general conditions. The result of the impact assessment is shown in the following table. The Solar Mini-Grid Sub-projects are classified as “Category B level of JICA Guidelines”, because land acquisition for PV generation site will be required around marketplace or residential area.

Table6.3-3 Result of Impact Assessment (Solar Mini-Grid Sub-project)

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
Pollution				
1	Air pollution	D	D	**Construction Phase:** Dust and exhaust gas will be generated by construction works, but the pollution will be insignificant, in limited area and for a short time. **Operation Phase:** No considerable impact on air quality
2	Water pollution	D	D	**Construction Phase:** Turbid water will be generated by construction works, but the pollution will be insignificant, in limited area and for a short time. **Operation Phase:** No considerable impact on water quality
3	Waste	D	D	No considerable generation of waste
4	Soil pollution	D	D	No considerable impact on soil quality
5	Noise and vibration	D	D	**Construction Phase:** Noise and vibration will be generated by construction works, but the levels will be insignificant and the generation will be in limited area and for a short time. **Operation Phase:** No considerable generation of noise and vibration
6	Ground subsidence	D	D	No considerable impact on ground subsidence
7	Offensive odors	D	D	No considerable generation of offensive odors
8	Bottom sediment	D	D	No considerable impact on bottom sediment

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
Natural Environment				
9	Protected areas	D	D	Sub-project locations will not include protected area in ordinary circumstances.
10	Ecosystem	B- ~ C-	D	**Construction Phase:** Impact on ecosystem will not occur in ordinary circumstances. However, forest clearing may be required depending on project site. **Operation Phase:** No considerable impact on ecosystem
11	Hydrology	D	D	No considerable impact on hydrology
12	Geographical features	D	D	No considerable impact on geographical features
Social Environment				
13	Resettlement/ Land Acquisition	B- ~ C-	D	Land acquisition will be required around marketplace. Involuntary resettlement may be required depending on project site.
14	Poor people	D	D	Because of voluntary basis to customers, no impact on poor people
15	Ethnic minorities and indigenous peoples	D	D	Because of voluntary basis to customers, no impact on indigenous people
16	Local economies, such as employment, livelihood, etc.	D	B+	**Construction Phase:** No impact on local economy. **Operation Phase:** Activation of market
17	Land use and utilization of local resources	D	D	**Construction Phase:** Land acquisition will be required around marketplace. However, the impact will be insignificant and in limited area **Operation Phase:** No considerable impact on land use and utilization of local resources
18	Water usage	D	D	No considerable impact on water usage
19	Existing social infrastructures and services	D	B+	**Construction Phase:** No considerable impact on social infrastructure. **Operation Phase:** Improvement of electric condition
20	Social institutions such as social infrastructure and local decision-making institutions	D	D	Because of voluntary basis to customers, no considerable impact on social institutions
21	Misdistribution of benefits and damages	D	C-	**Construction Phase:** No considerable impact on misdistribution. **Operation Phase:** In case of low supply capacity to demand, misdistribution will occur.

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
22	Local conflicts of interest	D	C-	**Construction Phase:** No considerable impact on local interest. **Operation Phase:** In case of big difference between existing electric rate and solar mini-grid electric rate, conflict among users may occur.
23	Cultural heritage	D	D	No impact on cultural heritage
24	Landscape	D	D	No considerable impact on landscape
25	Gender	D	B+	**Construction Phase:** No considerable impact on gender **Operation Phase:** Improvement of women's working condition
26	Children's rights	D	D	No considerable impact on children's rights
27	Infectious diseases such as HIV/AIDS	D	D	No considerable impact on infectious diseases
28	Working conditions (including occupational safety)	D	B+	**Construction Phase:** No considerable impact on working condition **Operation Phase:** Improvement of working condition
29	Accidents	D	D	No considerable impact on accidents
Other				
30	Trans-boundary impacts or climate change	D	D	No trans-boundary impacts such as climate change

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected
Source: Survey Team

1) Ecosystem/ Resettlement

Impact:

- Procurement of land for the sub-project, such as PV generation site; forest clearing; or involuntary resettlement may be required depending on the project site.

Mitigation:

Sub-projects requiring clearing of natural forest or involuntary resettlement should be rejected in the appraisal stage.

2) Misdistribution/Local conflicts of interest

Impact:

If the electric supply capacity is short for the demand, or the electric power rate from the solar mini-grid is much higher than that from the existing supply grid, conflicts of interest among local market community in the connection to the solar mini-grid and rate may occur.

Mitigation:
The project proponent should install facilities with sufficient capacity and decide the proper rate. The capacity and rate should be reviewed in the appraisal stage. Its operation and maintenance should be periodically monitored.

(4) Gasification of Biomass Component

The locations of the Biomass Gasification Sub-projects are not yet fixed in this survey stage. The programs, however, will be implemented within Bangladesh. The potential environmental and social impacts were assessed on the basis of general conditions. The result of the impact assessment is shown in the following table. The Biomass Gasification Sub-projects are classified as "Category B level of JICA Guidelines", because air pollution and health disturbance by smoke, and impact on utilization of local resources may occur.

Table6.3-4 Result of Impact Assessment (Biomass Gasification Sub-project)

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
Pollution				
1	Air pollution	D	B-	**Construction Phase:** Dust and exhaust gas will be generated by construction works, but the pollution will be insignificant, in limited area and for a short time. **Operation Phase:** Smoke from biomass gasification plant may cause air pollution.
2	Water pollution	D	D	**Construction Phase:** Turbid water will be generated by construction works, but the pollution will be insignificant, in limited area and for a short time. **Operation Phase:** No considerable impact on water quality
3	Waste	D	D	No considerable generation of waste
4	Soil pollution	D	D	No considerable impact on soil quality
5	Noise and vibration	D	D	**Construction Phase:** Noise and vibration will be generated by construction works, but the levels will be insignificant and the generation will be in limited area and for a short time. **Operation Phase:** No considerable generation of noise and vibration
6	Ground subsidence	D	D	No considerable impact on ground subsidence
7	Offensive odors	D	D	No considerable generation of offensive odors
8	Bottom sediment	D	D	No considerable impact on bottom sediment
Natural Environment				
9	Protected areas	D	D	Sub-project locations will not include protected area in ordinary circumstances.

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
10	Ecosystem	C-	D	**Construction Phase:** Impact on ecosystem will not occur in ordinary circumstances. However, tree clearing may be required depending on project site. **Operation Phase:** No considerable impact on ecosystem
11	Hydrology	D	D	No considerable impact on hydrology
12	Geographical features	D	D	No considerable impact on geographical features
Social Environment				
13	Resettlement/ Land Acquisition	C-	D	Resettlement will not be required in ordinary circumstances. However, involuntary resettlement may be required depending on project site.
14	Poor people	D	D	No impact on poor people
15	Ethnic minorities and indigenous peoples	D	D	No impact on indigenous people
16	Local economies, such as employment, livelihood, etc.	D	B+	**Construction Phase:** No impact on local economy **Operation Phase:** Activation of local economy by selling silica
17	Land use and utilization of local resources	D	B-	**Construction Phase:** Land acquisition will be required. However, the impact will be insignificant and in limited area. **Operation Phase:** In case of rice husk gasification, because rice husk can be used as fuel of rice parboiling, impact on local resources may occur.
18	Water usage	D	D	No considerable impact on water usage
19	Existing social infrastructures and services	D	B+	**Construction Phase:** No considerable impact on social infrastructure **Operation Phase:** Improvement of electric condition
20	Social institutions such as social infrastructure and local decision-making institutions	D	D	No considerable impact on social institutions
21	Misdistribution of benefits and damages	D	D	No considerable impact on misdistribution.
22	Local conflicts of interest	D	C-	**Construction Phase:** No considerable impact on local interest **Operation Phase:** In case of rice husk gasification, because rice husk can be used as fuel of rice parboiling, conflict among rice husk users may occur.

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
23	Cultural heritage	D	D	No impact on cultural heritage
24	Landscape	D	D	No considerable impact on landscape
25	Gender	D	D	No considerable impact on gender
26	Children's rights	D	D	No considerable impact on children's rights
27	Infectious diseases such as HIV/AIDS	D	D	No considerable impact on infectious diseases
28	Working conditions (including occupational safety)	D	B-	**Construction Phase:** No considerable impact on working condition **Operation Phase:** Smoke and dust from biomass gasification plant may include hazardous substances and cause health disturbance to the workers.
29	Accidents	D	D	No considerable impact on accidents
Other				
30	Trans-boundary impacts or climate change	D	D	No trans-boundary impacts such as climate change

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected
Source: Survey Team

1) Air pollution/ Working conditions

Impact:
Smoke emitted from a biomass gasification plant may include hazardous tar. In the case of rice husk gasification, the smoke includes silica. Silica may become a cause for irritation of the eyes and the respiratory system. Moreover, some crystalline silica particles may cause cancer. It may cause health disturbance to the workers and local people without proper smoke treatment systems and operation.

Mitigation:
The project proponent should install highly efficient precipitation (smoke treatment) equipment and/or filter system. The capacity and specification should be reviewed in the appraisal stage. The smoke and dust levels, precipitation equipment, filter system, and health condition of the workers and local people should be monitored periodically.

2) Ecosystem/ Resettlement

Impact:
The procurement of land for the gasification plant, tree clearing, or involuntary resettlement may be required.

Mitigation:
Sub-projects requiring clearing of natural forest or involuntary resettlement should be rejected in the appraisal stage.

3) Utilization of local resources/ Local conflicts

Impact:

Since the rice husk can be used as fuel, compost, cattle feed, or bedding materials in poultry farms, impact on the existing use and conflict among rice husk users may occur.

Mitigation:

The project proponent should prepare a proper procurement plan of the rice husk without impact on the existing use. The procurement plan should be reviewed in the appraisal stage.

(5) Biogas Power Generation Component

The locations of the Biogas Power Generation Sub-projects are not yet fixed in this survey stage. The programs, however, will be implemented within Bangladesh. The potential environmental and social impacts were assessed on the basis of general conditions. The result of the impact assessment is shown in the following table. The Biogas Power Generation Sub-projects are classified "Category C level of JICA Guidelines", because the estimated power generation is 20 kW and the projects are likely to have minimal or little adverse impact. However, the biogas leakage during normal operation conditions should be monitored periodically.

Table6.3-5 Result of Impact Assessment (Biogas Power Generation Sub-project)

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
Pollution				
1	Air pollution	D	D	**Construction Phase:** Dust and exhaust gas will be generated by construction works, but the pollution will be insignificant, in limited area and for a short time. **Operation Phase:** Exhaust gas will be generated by generator operation, but the pollution will be insignificant and in limited area.
2	Water pollution	D	B+ C-	**Construction Phase:** Turbid water will be generated by construction works, but the pollution will be insignificant, in limited area and for a short time. **Operation Phase:** Because waste water will be digested in the system, the environmental load will be reduced. However, improper slurry management may cause water pollution.
3	Waste	D	B+	**Construction Phase:** No considerable generation of waste **Operation Phase:** Because waste will be digested in the system, the environmental load will be reduced.
4	Soil pollution	D	D	No considerable impact on soil quality

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
5	Noise and vibration	D	D	**Construction Phase:** Noise and vibration will be generated by construction works, but the levels will be insignificant and the generation will be in limited area and for a short time. **Operation Phase:** Noise and vibration will be generated by generator operation, but the levels will be insignificant.
6	Ground subsidence	D	D	No considerable impact on ground subsidence
7	Offensive odors	D	D	No considerable generation of offensive odors
8	Bottom sediment	D	D	No considerable impact on bottom sediment
Natural Environment				
9	Protected areas	D	D	Sub-project locations will not include protected area in ordinary circumstances.
10	Ecosystem	D	D	No considerable impact on ecosystem
11	Hydrology	D	D	No considerable impact on hydrology
12	Geographical features	D	D	No considerable impact on geographical features
Social Environment				
13	Resettlement/ Land Acquisition	D	D	Because project site will be located in premises owned by the proponent, resettlement will not be required in ordinary circumstances.
14	Poor people	D	D	No impact on poor people
15	Ethnic minorities and indigenous peoples	D	D	No impact on indigenous people
16	Local economies, such as employment, livelihood, etc.	D	D	No impact on local economy.
17	Land use and utilization of local resources	D	D	Because project site will be located in premises owned by the proponent, impact on land use and utilization of local resources will not occur in ordinary circumstances.
18	Water usage	D	D	No considerable impact on water usage
19	Existing social infrastructures and services	D	B+	**Construction Phase:** No considerable impact on social infrastructure. **Operation Phase:** Improvement of electric condition
20	Social institutions such as social infrastructure and local decision-making institutions	D	D	No considerable impact on social institutions

No.	Impact Item	Assessment		Reason / Remarks
		Pre-Construction Phase Construction Phase	Operation Phase	
21	Misdistribution of benefits and damages	D	D	No considerable impact on misdistribution.
22	Local conflicts of interest	D	D	No considerable impact on local interest.
23	Cultural heritage	D	D	No impact on cultural heritage
24	Landscape	D	D	No considerable impact on landscape
25	Gender	D	D	No considerable impact on gender
26	Children's rights	D	D	No considerable impact on children's rights
27	Infectious diseases such as HIV/AIDS	D	D	No considerable impact on infectious diseases
28	Working conditions (including occupational safety)	D	D	No considerable impact on working condition
29	Accidents	D	C-	**Construction Phase:** No considerable impact on accidents **Operation Phase:** Accidental gas explosion by insufficient facilities or inadequate operation
Other				
30	Trans-boundary impacts or climate change	D	D	CO2 emission is less than diesel one. However, the reduction volume will be vanishingly small to global climate change.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected
Source: Survey Team

1) Water Pollution

Impact:
Improper and irregular slurry management may cause water pollution and public nuisance.

Mitigation:
The project proponent should install sufficient facilities and conduct the proper maintenance.

2) Accidents

Impact:
The insufficient facilities or inadequate operation may cause an accidental gas explosion

Mitigation:
The project proponent should install sufficient facilities. The management staff should give the operators training on the safety measures. The design of the facilities should be reviewed in the appraisal stage.

6.3.2. Screening Criteria for the Selection of Appropriate Sub-Projects

The JICA-REDP components are unlikely to include sub-projects having significant adverse impacts on the environment and society (projects of Category A level in JICA Guidelines). Nevertheless, to select appropriate sub-projects in the components from a viewpoint of environmental and social considerations, the environmental and social screening criteria was prepared by the Survey Team. The screening criteria is shown below:

- The sub-project shall observe related environmental laws and regulations including "The Bangladesh Environment Conservation Act, 1995", "The Environment Conservation Rules, 1997" and "Lead Acid Battery Recycling and Management Rules (Statutory Regulatory Order No. 175-Act/2006)".
- The sub-project categorized as "Category A" in "JICA Guidelines" will be rejected in JICA-REDP.
- The sub-project requiring EIA in obedience to the "Environment Conservation Rules, 1997", including Red category projects, will be rejected in JICA-REDP.
- The sub-project shall not require physical relocation.
- The sub-project shall not require clearing of natural forest.
- The biomass gasification sub-project shall take proper countermeasures to prevent health disturbance through the production of smoke, dust, ash and tar.

Role of IDCOL:

- IDCOL conducts the environmental screening on the basis of the environmental screening form (Attached in Appendices Ch 6. S 6.2) prepared by the PO or sponsor and field surveys to examine the potential positive and negative environmental and social impacts and identify whether the sub-project is categorized as "Category A" in "JICA Guidelines" in the appraisal stage.
- IDCOL submits the screening form and a series of the reports on the results of the screening and scoping including the categorization in the appraisal stage, and the environmental monitoring in the operation phase to JICA.
- IDCOL supervises and supports the legal environmental procedure of the PO or sponsor.

Obligation of PO or sponsor:

- The PO or sponsor prepares the environmental screening form (Attached in Appendix 1 Ch 6. S 6.3) and submit the form to IDCOL.
- The PO or sponsor conducts the environmental procedure regulated in relevant laws and reports the progress and results to IDCOL.
- The PO or sponsor conducts the environmental monitoring and submit the results to IDCOL.

6.3.3. Environmental Monitoring Plan

IDCOL will be responsible for the supervision of the environmental monitoring in compliance with the JICA Guidelines and will report the monitoring result to JICA regularly. The environmental monitoring items are shown in the following table. Based on the monitoring outcomes and operating conditions, these items will be revised or updated appropriately.

Table 6.3-6 Environmental Monitoring Item

Component	Category level of JICA Guidelines	Monitoring Item
SHS Program	B	Collection of expired battery Distribution of new battery Battery recycling plants
Solar Irrigation Pump	B	Operation and maintenance condition of solar irrigation pump
Solar Mini-Grid	C	Operation and maintenance condition of solar mini-grid
Gasification of Biomass	B	Visual condition of smoke and dust from gasification Condition of precipitation equipment and filtering system Health condition of worker and local people Smoke quality (as needed)
Biogas Power Generation	C	Biogas leakage during normal operation conditions

Source: Survey Team

6.4. Capacity Development Requirements for the Implementing Organization on Environmental and Social Considerations

6.4.1. Environmental Management Capacity

(1) IDCOL

IDCOL has financed not only the renewable energy sector but power generation, transportation, water supply and gas infrastructure sectors that require the implementation of IEE or EIA and the obtaining of an Environmental Clearance Certificate in compliance with "the Environment Conservation Rules". IDCOL developed an "Environmental and Social Appraisal Manual (ESAM)" as the first environmental and social management framework in 2000 and has recently updated the framework according to needs in the activities. Through the technical support of the Asian Development Bank, the ESAM has been revised in 2011 and was renamed as the Environmental and Social Safeguards Framework (ESSF). As IDCOL is working with the World Bank, ADB, IFC and other organization, this ESSF has been prepared in a way that would cover the safeguards requirement of all reputed development partners. In addition, for renewable energy projects, IDCOL is also practicing an Environmental and Social Management Framework (ESMF) that was prepared for the “Rural Electrification and Renewable Energy Development (RERED) Project”, which is supported by the World Bank.

IDCOL has conducted preliminary surveys on environmental and social impact for many kinds of projects in the appraisal stage and guided project proponents in IEE, EIA and environmental management. IDCOL has considerable experience in environmental management. However, as IDCOL expands their activities, a supporting hand can be useful to assist its Environmental Consultant in the future.

(2) POs

Most of the POs that operate the SHS program are NGOs or CSR (Corporate Social Responsibility) bodies in major companies to provide an improvement of life environment in rural areas. Therefore, the POs have a strong environmental awareness and they make good efforts to collect old batteries. Since some POs belong to major companies owing the battery production sector, they collect old batteries on a commercial basis. However, due to many informal buyers also aggressively collecting old batteries, the POs cannot perfectly control their battery collection.

6.4.2.Recommendation on Capacity Development

(1) Expired Old Battery Survey

IDCOL has prepared the "Policy Guidelines on Disposal of Warranty Expired Battery" in "Environmental and Social Management Framework June, 2011". The POs make good efforts to collect old batteries. However, due to the aggressive collection of expired batteries by many informal buyers, the actual condition of the battery collection is not known well. IDCOL intends to employ a consultant and conduct a survey on collection and recycling of expired batteries used in the SHS program. In addition, the Consultant needs to determine ways to ensure the satisfactory collection of expired battery from customers and reduce the influence of unauthorized battery smelters to prevent environmental pollution. The result should be utilized among IDCOL, POs, and battery manufacturers. IDCOL will revise its "Policy Guidelines on Disposal of Warranty Expired Battery" on the basis of the results of the survey and according to need.

(2) Development of Database

At present IDCOL is using a database based on MS excel. However, in order to utilize the environmental and social screening, assembly of project information, and preparation of documents, it is recommendable that IDCOL introduce a Geographic Information System (GIS) to supplement the existing database. A series of training on the GIS software should be required in parallel. The information input into GIS should include the following information:
Climate data, such as amount of insulation;
Hydrological data, such as groundwater level;
Land use, such as protected area and forest cover;
Electrified area;
Project information and monitoring result; and
Related study result.

(3) Other Capacity Development Candidates

IDCOL needs to have sufficient capacity to ensure environmental, social, and occupational safeguards. In this regard, it requires training on the following aspects:

a. Orientation on Industrial Environmental Management System (IEMS):
Industrial Environmental Management System (IEMS) and Occupational Health Safety (OHS) are not well practiced in Bangladesh. This is due to the requirement of significant knowledge and experience about industrial operation process and behavior, and control and treatment of pollutants. .IDCOL is trying to make sure of the proper implementation of the IEMS and OHS in battery manufacturing plants and recycling plants. It is also trying to raise awareness among customers by giving training to POs about environmental and other relevant safeguards. IDCOL should have adequately trained staffs, who will train battery manufacturers, recyclers and all other relevant stakeholders about the proper implementation of IEMS and OHS at an internationally accepted level.
b. Training on expired solar PV panel management and disposal:
IDCOL also needs sufficient training about managing expired solar PV panels to its staff, since IDCOL should have sufficient orientation about proper disposal of expired solar panel to be able

to train POs. Thereafter, POs will take the responsibility to train and raise awareness among customers.

c. Training about managing electrical and fire hazards:
IDCOL is financing the SHS, mini-grid, and biomass gasification projects with moderate capacity. It is also financing a large power plant with a significantly high capacity. IDCOL has financed the largest power plant (Meghnaghat 450 MW power plant) in Bangladesh. Since most of the POs and sponsors do not have sufficient knowledge about proper electrical and fire hazard management, IDCOL needs to conduct a comprehensive training program about these topics to its safeguard staffs. Thereafter, they will train the POs and sponsors, whom they would be managing.

(4) Consulting Service for Environmental and Social Considerations

In order to ensure the health and safety of suppliers, users, and disposers of RE equipment it is recommended that IDCOL apply consulting services and conduct awareness raising activities on proper management of batteries and other equipment,. It is recommended that consultants:
Prepare training manuals and brochures for awareness raising activities on electrical and fire hazards, and waste management for the POs, sponsors, and end-users;
Conduct a series of trainings on electrical and fire hazards, and waste management to the POs, sponsors, and end-users;
Conduct awareness raising activities on proper disposal of old batteries and electric waste to the POs, sponsors, and end-users;;
Monitor the occupational environment of operating biomass gasification and biogas power generation facilities; and
Report the monitoring results and recommendations to improve the occupational environment according to needs.

6.4.3. Reinforcing IDCOL's Environmental Unit and ESMF

IDCOL's current environmental and social consideration unit belongs to the Legal Branch. An in-house consultant is employed as an environmental and social management specialist. IDCOL is planning to set up the Environmental and Social Safeguards Management Unit (ESSMU) to ensure and implement environmental and social management in all projects as an external unit (see section 3.1.1. Organization). An in-house consultant will be employed with the status quo in the early stage.

IDCOL has prepared "Draft updated ESMF" so as to be adaptable to "Rural Electrification and Renewable Energy Development II (RERED II) Project" supported by the World Bank. Major differences between the present "ESMF (June, 2011)" and "Draft updated ESMF" are as follows:

Table6.4-1 Differences between "ESMF (June, 2011)" and "Draft updated ESMF"

Item	ESMF (June, 2011)	Draft updated ESMF
Table of Contents	1. Objectives 2. Brief Project Description 3. Relevant National Policy, Act and Rule 4. World Bank's Environmental Safeguards 5. World Bank's Social Safeguards 6. General Principles for Environmental and Social Safeguard Management 7. Environmental Assessment and Mitigation Measures	Executive Summary 1. Introduction 2. Brief Project Description 3. Relevant Policy, Act and Rule (JICA Guidelines newly added) 4. Environmental and Social Management 5. Environmental Assessment and Mitigation Measures 6. Capacity-Building and Monitoring of ESMF

	8. Capacity Building and Monitoring Safeguard Framework Implementation 9. Consultation and Disclosure Annex-1: Policy Guidelines on Disposal of Warranty Expired Battery Annex-2: A Sample Agreement for Buy-Back of Warranty Expired Batteries Annex-3: Health Impact of Lead Exposure Annex-4: Environmental Clearance Process for Commercial Renewable Energy projects Annex-5: Structure of Environment Assessment Report Annex-6: Health Impact of Mercury Exposure Annex-7: Information of Warranty Expired Battery Annex- 8: Questionnaire for Social Compliance Annex-9: Proposed Organogram of IDCOL	Implementation 7. Consultation and Disclosure Annex-1: Assessment Report of Implementation of Existing ESMF Annex-2: Screening for Social Compliance Annex-3: Guidelines for Selecting New Battery Supplier Annex-4: Agreement for Buying Back Expired Batteries Annex-5: Information of Expired Batteries Annex-6: Safeguard Screening Format for Remote Area Power Supply Systems (RAPSS) Annex-7: Environmental Clearance Process Annex-8: Structure of Environment Assessment Report Annex 9: Field Level Assessment Findings Annex-10: Overview of JICA-REDP
Target Components	- Solar Home System - Compact Fluorescent Light - Other Renewable Energy Technologies (brief descriptions)	- Solar Home System - Remote Area Power Supply Systems (including Solar Irrigation Pump, Solar Mini-Grid, Gasification of Biomass, Biogas Power Generation and Mini-hydro Power) - Household Energy - Compact Fluorescent Light
Environmental Impact	- General environmental impacts were presented.	- Specific environmental impacts are presented.
Old Battery Recycling	- Outlines of monitoring plan and policy guidelines were presented.	- Monitoring plan is strengthened more practically. - “Agreement for Buying Back Expired Batteries” is updated on buy back price (from 28% of market battery price to 24%) - “Guidelines for Selecting New Battery Supplier” is newly added.
Organization of IDCOL	Establishment of ESSMU was mentioned.	Concrete functions of ESSMU are presented.

Source: Survey Team

7. Project Implementation Plan

7.1. JICA-REDP Scheme

Implementation plan for JICA-REDP is explained, clarified, and elaborated in this chapter. Scope, finance, structure, indicators and timetable for JICA-REDP are also explained. Although much of the activities of IDCOL's RE activities under the World Bank RERED (Rural Electrification and Renewable Energy Development) project are commonly shared with JICA-REDP as its components, JICA-REDP can be defined as an independently operational project.

IDCOL, the Executing Agency for JICA-REDP implements the Project in harmony with the World Bank RERED, under coordination with the World Bank, ADB, IDB, KfW, GIZ, and other Development Partners that are contributing to the World Bank Project. IDCOL receives loan from JICA via the Ministry of Finance of Bangladesh in the form of a two-step loan. The loan is utilized in a harmonized manner with the RERED for five components, which are: (i) the SHS Program Component, (ii) the Solar Pump Irrigation Component, (iii) the Solar Mini-Grid Component, (iv) the Gasification of Biomass Component, and (v) the Biogas Power Generation Component. These components are mostly based on the existing RE programs and projects (RERED Project) supported by the World Bank and executed by IDCOL.

In each of the components, IDCOL identifies the sponsors and sub-projects to which the two-step loan is extended. Financial and technical due diligence are conducted by IDCOL for the sub-project candidates. Due diligence is conducted only in selection of the sponsors in case of SHS Program Component. New branch exclusively designated to RE Components is planned to be established within IDCOL. This new branch is expected to execute the most operations of the JICA-REDP.

While each component will have to be implemented mostly under an existing institutional structure, there is also a need to set up a new arrangement to oversee the whole picture of the project. A JICA expert will be dispatched to pursue this function to oversee the whole JICA-REDP. The expert will also support the capacity development of IDCOL by supporting the drafting of appraisal manuals and operational guidelines for the RE components. This task, after the initial period, will be handed over to IDCOL, who will hire professional consultants that will continue to furnish the IDCOL staff with updated knowledge and skills on RE technology and business.

7.2. Project Scope through JICA-REDP

Certain portions of IDCOL's five RE Program and RE Projects are considered as the subject of assistance through JICA-REDP. Portion among the total RE Program and RE Projects is suggested by the Survey Team, based on the latest fund requirement, availability of funds, and implementation timetable.

7.2.1. SHS Program Component

A total required cost for 2,680,000 SHS sets to be added by 2015 is USD 788 million. The loan will cover USD 458 million, from which USD 233 million is yet to be procured. The Survey Team recommends to the Government of Japan that it offer a loan accounting for 21.8 percent of the total requested amount, i.e., USD 100 million (21.8 percent of USD 458 million). This portion for JICA-REDP is set based on assumption that the remainder of the loan is expectedly available from additional support from other development partners including ADB and IDB.

JICA-REDP's fund will contribute to installing 585,094 SHS sets (21.8 percent of 2,679,732 sets), that will electrify 1.82 percent of the households in Bangladesh. As a consequence, the loan offer by Japan will increase Bangladesh's SHS electrification rate up to 12.5 percent.

Table 7.2-1 Subject for Assistance through JICA-REDP: SHS Program

	SHS Program Total	(JICA Portion)
Targets	Additional **2,679,732 sets (100%)** From 2013 to 2015 Average size: 42 W	**585,094 sets (22%)** From 2013 to 2015.
Total required cost (USD million)	788 (USD 294 per set)	172
Equity portion (USD million)	302 (38% of the total cost) (Down payment + finance by POs)	65.9
Grant (USD million)	28 (4% of the total cost) (Buy down grant)	6.1
Loan (USD million)	458 (58% of the total cost)	**100 (JICA ODA Loan)**

Source: Survey Team based on IDCOL Funding Requirement and analyses

7.2.2. Solar Irrigation Pump Component

The installation of 1550 Solar Irrigation Pumps requires a total cost of USD 62 million. The grant is expected to cover USD 25 million, while loan of USD 19 million will be required. USD five million is already available to IDCOL while the remaining USD 14 million is yet to be sought.

The Survey Team, with reference to the availability of the grant that will match the financial support to the sub-projects, recommends that the Japanese ODA loan cover the total remaining USD 14.4 million. This will result in Japan contributing to the installation of 1,200 sets of solar irrigation pumps.

Table 7.2-2 Subject for Assistance through JICA-REDP: Solar Irrigation Pump Component

	Solar Pumps for Irrigation Total	(JICA Portion)
Targets	Additional **1,550 locations (100%)** From 2013 to 2016. Minimum pump capacity of 400 m3/day	**1,200 locations (77%)** From 2013 to 2016.
Total required cost (USD million)	62.0	48.0

	Solar Pumps for Irrigation Total	(JICA Portion)
Equity portion (USD million)	18.6 (30% of the total cost)	14.4
Grant (USD million)	24.8 (40% of the total cost)	19.2
Loan (USD million)	18.6 (30% of the total cost)	**<u>14.4 (JICA ODA Loan)</u>**

Source: Survey Team based on IDCOL Funding Requirement and analyses

7.2.3. Solar Mini-Grid Component

As for the Solar Mini-Grid, 50 installations are being targeted. A total loan of USD 9 million and a total grant of USD 15 million are requested. The total grant of USD 15 million is expected to be offered from KfW and USAID, among other development partners. Grant requirement is therefore expected to be fully met.

The Survey Team recommends having the Japanese loan directed to solar mini-grid installation in all remaining 29 locations, also considering Japan's technical strength in this field. The loan to be allocated from JICA for the Solar Mini-Grid Component will be USD 5.2 million. The amount can also be deemed appropriate when compared with the availability of grant to match the loan.

Table 7.2-3 Subject for Assistance through JICA-REDP: Solar Mini-Grid Component

	Mini-Grid Total	(JICA Portion)
Targets	Additional **<u>50 locations (100%)</u>** From 2013 to 2016 Average capacity of 150 kW at marketplaces	**<u>29 locations (58%)</u>** From 2013 to 2016
Total required cost (USD million)	30.0	17.4
Equity portion (USD million)	6.0 (20% of the total cost)	3.5
Grant (USD million)	15.0 (50% of the total cost)	8.7
Loan (USD million)	9.0 (30% of the total cost)	**<u>5.2 (JICA ODA Loan)</u>**

Source: Survey Team based on IDCOL Funding Requirement and analyses

7.2.4. Gasification of Biomass Component

The construction of gasification facilities is expected to be approximately one year. Under the constraint that the disbursement for JICA-REDP sub-projects should be completed by the end of 2016, the sub-projects for which the loan will be disbursed will have to be approved by the end of 2015. This is applicable for JICA-REDP sub-projects.

Out of 28 facilities planned to be funded by IDCOL, 20 of them are expected to be approved by early 2015 and constructed by the end of 2016. JICA-REDP will therefore be applicable to these 20 facilities. Loan extended to IDCOL in this component will be USD 3.4 million.

	Gasification of Biomass	(JICA Portion)
Targets	Additional **28 facilities (100%)** From 2013 to 2016 Average size of 200 kW.	**20 facilities (71%)** From 2013 to 2016
Total required cost (USD million)	8.0	5.7
Equity portion (USD million)	1.6 (20% of the total cost)	1.15
Grant (USD million)	1.6 (20% of the total cost)	1.15
Loan (USD million)	4.8 (60 % of the total cost)	**3.4 (JICA ODA Loan)**

Source: Survey Team based on IDCOL Funding Requirement and analyses

7.2.5. Biogas Power Generation

Furthermore, 450 facilities are planned to be installed under the funding support from IDCOL by 2016. These are of relatively small sized equipments of average 20 kW capacity, which are suitable for poultry farms with approximately 5,000 heads or more.

The Survey Team, from the viewpoint of technical and financial viability, and after discussions with GIZ experts, recommends that priority for support should be the relatively larger scale facilities for poultry farms with the size of at least 10,000 heads, as agreed with IDCOL. Narrowing the original denominator of approximately 12,000 poultry farms down to 1,600, eligible poultry farms for support can be calculated as 60 (3.8% of the denominator).

	Biogas Power Generation	(JICA Portion)
Targets	Additional installation of **450 facilities (100%)** From 2013 to 2016 Average facility size 20kW	**60 facilities (13%)** From 2013 to 2016
Total required cost (USD million)	14.4	2.0
Equity portion (USD million)	4.3 (30% of the total cost)	0.6
Grant (USD million)	2.9 (20% of the total cost)	0.4
Loan (USD million)	7.2 (50 % of the total cost)	**1.0 (JICA ODA Loan)**

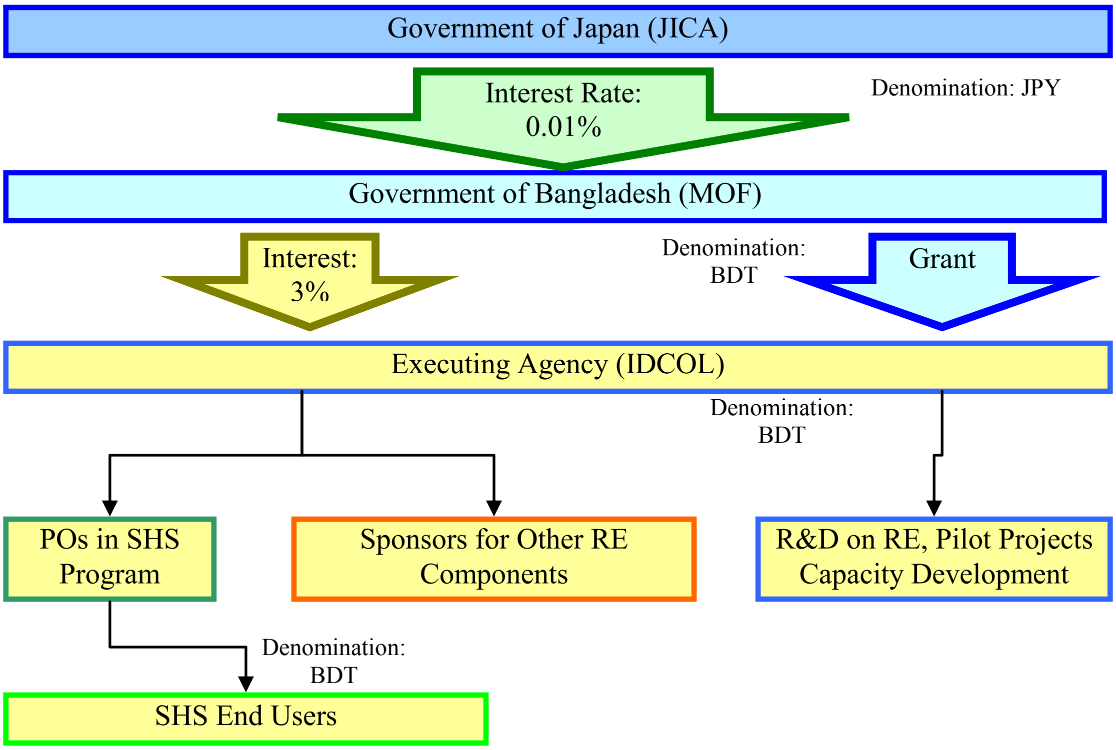
Note (*): Total installations will become 451 with the already existing one biogas power generation project as of end 2011.

7.3. Financing Plan

7.3.1. Arrangements for the Two-Step Loan

The fund disbursed from the Government of Japan will be first received by the Ministry of Finance (MOF) of Bangladesh. The MOF will be directed to IDCOL as the "Subsidiary Loan". The terms and conditions of the subsidiary loan are yet to be negotiated and decided. With regards to the low loan interest rate from JICA to MOF (expected to be at 0.01 percent), a part of the fund to be extended to IDCOL is expected to be more concessional, e.g. in the form of grant, as with the case with the World Bank (IDA).

The JICA ODA loan can be utilized under two different conditions for three different purposes. First, a portion under the same concessionality with loan from other development partners can be introduced. This portion will be used for the SHS Program and other RE components that are required to harmonize the lending terms with the other development partners. Second, a grant portion in return to setting the first condition, can be set by the MOF. The grant is expected to be allocated to technical cooperation elements including the capacity development of IDCOL, sponsors, and other stakeholders.



Source: Survey Team

Figure 7.3-1 JICA ODA Loan to be Extended to IDCOL in the form of Loan and Grant

Apart from the loan mentioned above, the Survey Team recommends that a part of the funding should be extended to IDCOL in the form of a grant. This will enable the fund to be utilized for pilot projects for further research and development, as well as for capacity development of IDCOL and the sponsors.

7.3.2.Lending Terms for Two-Step Loan

(1) Terms and Conditions of the Refinance Loan of SHS Program

Terms and conditions of the refinance loan in the SHS Program will be in line with the existing SHS program funded by other development partners. IDCOL will review the eligibility of POs every year. The following are the basic stipulations of the lending terms:

1) Eligibility Criteria for Participating Organizations (POs)

The current criteria will be applied to the JICA-REDP SHS Program Component. Stipulation of eligibility will therefore be as follows:

1) For All Participating Organizations:
a) General Criteria
Satisfactory business plan approved by the PO's Board of Directors;.
Particulars of the operational and financial results of the PO for at least the previous two (2) years;
The PO should furnish proof to IDCOL that the financial performance of the PO concerned is in conformity with the applicable financial criteria outlined below;
After fulfilling the eligibility criteria by PO for program entry, the PO shall continue to meet the aforementioned eligibility criteria, to the satisfaction of IDCOL;
PO has established and maintained sound and transparent accounting, MIS, and internal audit system; and
Accounts are audited by a reputable external auditor on an annual basis.

b) Financial Criteria
Minimum Tk. 10,000,000/- of equity;
Debt to equity ratio of the MFI not in excess of 3.0;
Minimum total cash collection ratio of principal and interest on current loan portfolio calculated on a rolling twelve month basis of 95 percent;
Minimum after tax profit equivalent to four percent p.a. on revolving loan fund (RLF);
In cases where prospective business profitability is considered to be positive, the PO should be at least breaking even after meeting operational expenses and debt service. However, in such cases, continued eligibility will be conditional on being able to meet the four percent p.a. after tax profit criterion the following year; and
Minimum debt service cover ratio of 1.25 times.

2) Specific Eligibility Criteria for NGO/MFI (Supplier and Lender POs)
Registered with appropriate registration authority to conduct microfinance services;
Currently conducting microfinance services with soft loan funds from:
PKSF (Palli Karma Shahayak Foundation) as a participating organization (PO),
Bank of Small Industries and Commerce (BASIC) Limited, and/or
Any other similar national or international funding source;
Have microfinance operations in project areas identified by PO for the promotion of solar energy;
Number of beneficiaries is not less than 10,000; and
Capable of managing rural renewable energy program.

3) Selection Criteria for Private Entity (Supplier POs)
A lawful private business entity organized under the laws of Bangladesh, complying with pertinent laws and regulations regarding capital adequacy, classification of assets, non-accrual of interest and provisioning, exposure limits, etc.;
A verification that PE meets satisfactory financial criteria, ratio requirements and exposure limits; and
Capable of managing rural renewable energy program.

4) Conversion of Supplier PO into Supplier and Lender PO

A Supplier PO may be converted into a Supplier and Lender PO following fulfillment of the following major criteria:

The Supplier PO shall have signed a Participation Agreement with IDCOL.

The Supplier PO has installed a minimum of 1,000 SHS under IDCOL SHS program.

The loan recovery rate for those SHS shall not be less than 95 percent.

Satisfactory report from the Auditors engaged by IDCOL.

Repetition of "Eligibility Criteria for Participating Organizations (POs)" as presented in 3.1.7 IDCOL's Component Management Structure (SHS Program).

POs will be assessed annually under their obligations to submit an audited financial report to IDCOL. Required criteria for the POs to remain accredited as POs by IDCOL currently do not exist. IDCOL sees that such criteria may be introduced as necessary.

2) Eligible Items to be Financed by the Refinance Loan

The IDCOL refinance loan does not include any recurrent cost at the operation and maintenance stage but covers construction cost and consulting service fee. Land acquisition cost will not be included in the loan portion as IDCOL requires such costs to be borne by the sponsors within their equity portion.

3) Currency

The currency denomination will be in Bangladesh Taka (BDT).

4) Financing Structure

The SHS Program is financed from three major sources: down payment by the end-users (mostly households and shops), by the Participating Organizations (POs), and grant and loans provided by the development partners through IDCOL.

5) Interest Rate, Loan Tenure and Grace Period

The interest rate, loan tenure, and grace period applicable to each refinance loan to POs will be determined by POs' cumulative refinance amount from IDCOL.

Table7.3-1 Lending terms Refinance Loan in SHS Program Component

Cumulative Refinance Amount (BDT)	Interest Rate (on outstanding balance)	Loan Tenure including grace period	Grace Period
Up to 250 million	6% per annum	Up to 7 Years	1 year
From 250 million up to 500 million	7% per annum	Up to 6 Years	1 year
From 500 million up to 1 billion	8% per annum	Up to 6 Years	1 year
From 1 billion	9% per annum	Up to 5 Years	0.5 year

Source: Set by the Survey Team based on current stipulation by IDCOL

8) Size Limit of the Loan

Refinancing loan is structurally limiting the IDCOL portion to up to 80 percent of the total loan extended by the POs. Apart from this threshold IDCOL does not stipulate any upper limit to the size of the loan. IDCOL can still retain control of the size of the fund by requiring the POs to submit their annual business plans for the SHS Program, to be approved by IDCOL.

7) Credit Risk and Security for Loan

IDCOL shall bear the credit risk of POs. IDCOL SHS Program requires approximately 40 percent of the refinance amount as security, which comprises a reserve of four quarterly repayment installments in the debt service reserve account (DSRA); and either a legal mortgage of land or a bank guarantee for 20 percent of the outstanding refinance amount. In case of defaults, security will be in favor of IDCOL.

8) Refinance Loan Agreement

A refinance loan agreement shall be signed between IDCOL and a PO that requires the PO to:
Diligently maintain and operate the subproject in a safe, efficient, and business-like manner;
Provide after sale maintenance support to end-users for at least five years ;
Furnish reports to IDCOL regarding the recycling of batteries; and
Furnish to IDCOL its audited project account and monthly and half yearly statements.

(2) Terms and Conditions of the Loans from IDCOL to Sponsors in Other Components

Major points of terms and conditions of the loan provided by IDCOL to the accredited sponsors in Solar Irrigation Pump, Solar Mini-Grid, Gasification of Biomass, and Biogas Power Generation Components are stipulated as follows:

1) Eligibility Criteria for Sub-Projects

IDCOL Financial officer will analyze the information, documentation submitted by the Project Sponsor, and prepare a project appraisal for review by the CEO of IDCOL prior to its presentation to the IDCOL Board of Directors. In conducting its project appraisal, the IDCOL staff will focus on the analysis of the materials provided by the Project Sponsors for the purpose of judging regarding the following:

- Compliance with GoB, World Bank and IDA environmental guidelines and procedures. If a recent EIA has not been prepared, IDCOL will request that study to be conducted and planned for addressing any issues identified in the EIA be included. The Sponsor should provide a resettlement plan that is consistent with the GoB, World Bank, IDA social, and resettlement policies, and guidelines as appropriate.
- Procurement of goods, services, and equipment must be in compliance with ICB guidelines and procedures established by the World Bank and IDA. If the project is unsolicited, IDCOL should satisfy itself that either the goods/services needed for the project or up to 40 percent of the total cost of the project, can be procured through ICB procedures.
- Evidence that projects financing plan can be achieved.
- Ability of the Sponsor to meet the milestones established in the financing plan for equity infusions into the project. This could be through standby letters of credit from a commercial bank backing up these infusions.
- Sponsors must have a proven track record of operating similar projects in Southeast Asia or other emerging countries under conditions similar to those that exist in Bangladesh. IDCOL should seek descriptions of the progress made on these projects.
- The project can meet an EIRR requirement of 12.0 percent.[101]
- Technology proposed by the project has a track record of being successfully implemented and used in other emerging countries under conditions similar to those that exist in Bangladesh or Southeast Asia.
- The cash flows are predictable, reliable, and sufficiently robust to support the financial feasibility of the project and ensure that the IDCOL loan will be repaid.
- At the conclusion of the review, the financial officer will prepare a preliminary project appraisal report based on the above checklist.

[101] "EIRR" is as expressed in the original document. It is thought to signify project internal rate of return in terms of finance (FIRR).

- Once the financial officer has completed the preliminary appraisal report, it will be reviewed by the CEO and submitted to the IDCOL Board of Directors for approval or rejection. In the event that IDCOL decides to reject an application, the CEO will inform the Sponsor of the rejection.
- The sub-project categorized as "Category A" in "JICA Guidelines" will be rejected in JICA-REDP.

Repetition of "Eligibility Criteria for RE Projects" as presented in. 3.1.8IDCOL's Component Management Structure (RE Projects).

2) Currency and Eligible Portion of the Loan

The currency denomination will be in Bangladesh Taka (BDT), and will be utilized to finance the loan portion among the three major sources for sub-projects: equity portions by the sponsors, and grant and loans provided by the development partners through IDCOL.

3) Size Limit of the Loan

Although IDCOL may extend loan to the entire portion of the sub-projects, the portion of loan for sub-projects will be limited to 80 percent of the project cost in any case. The interest rate, loan tenure, and grace period applicable to each loan to Sponsors are as follows:

Table7.3-2 Lending terms for the five components

Components	Denomination	Interest	Tenure	Grace Period
SHS (reference)	BDT	6 – 9%	5 – 7 years	0.5 – 1 year
Solar Pump	BDT	6%	10 years	1 year
Mini-Grid	BDT	6%	10 years	2 years
Gasification	BDT	6-10%*	7 years	1 year
Biogas	BDT	6-9%**	5 Years	1 year

Note: (*) Model case calculation was conducted on 200 kW plant which resulted in optimum interest rate of 4%, while existing example of larger scale plant (SEAL 400 kW) shoed financial viability at the interest rate of 10%

Note: (**) Model case calculation was conducted for 20 kW plant which resulted in optimum interest rate of 4% while existing example of larger scale plant (Phoenix 400 kW) showed viability at the interest rate of 9%.

Source: Set by the Survey Team based on current stipulation by IDCOL

4) Credit Risk and Security

IDCOL shall bear the credit risk of Sponsors. IDCOL requires full recourse security, which is the combination of the following means of guarantee up to full recourse of funding: 1) mortgage of land, 2) a letter of hypothecation, 3) personal guarantee of the directors, 4) corporate guarantee by affiliated companies, and 5) lien on project accounts. In case of defaults, the security will be in favor of IDCOL.

5) Loan Agreement

A loan agreement shall be signed between IDCOL and a Sponsor that requires the Sponsor to:
Implement the subproject under the supervision of IDCOL
Be responsible for the operation and maintenance of the equipment;
Furnish its quarterly financial statements and audited accounts for its financial year;
Deliver certain portion of the subproject cost as base equity to the subproject;
Provide sub-project securities; and
Be responsible to meet the project cost overrun, if any, from its own resources.

6) Suspension of Disbursement from the Two Step Loan Scheme

JICA reserves the right to disallow IDCOL to disburse loans to Sponsors and POs in any component and loans to end-users in SHS program under the Two Step Loan scheme, in the case such loans to Sponsors and POs are deemed to be in inconformity with the above terms and conditions, including but not limited to the eligibility of Sponsors and POs, and investment activities and items.

7.3.3.Bank Account and Withdrawal Arrangements

JICA-REDP, as will the case with many of the Two-Step Loan projects, will be executed by utilizing the JICA "Special Account" arrangement as a platform for the money transaction between JICA, MOF, IDCOL and the Sponsors (including the POs in the SHS Program). JICA Special Account arrangement is a mechanism in which small but numerous transactions will be conveniently conducted.[102]

(1) Special Account Arrangement at the Bangladesh Bank

The Special Account for JICA-REDP will be opened at the Bangladesh Bank in the form of "Convertible Taka Special Account" (CONTASA), which accommodates JPY and BDT denominations. The ownership of the account will be with the MOF while the actual operation of the account will be commissioned to the Executing Agency of the Project, i.e. IDCOL.[103]

(2) Disbursement and Replenishment Procedures

In response to the initial disbursement request from IDCOL, JICA will disburse a certain amount of money in JPY denomination into the account as the initial disbursement. The money will be converted from JPY into BDT within the CONTASA by the MOF, as necessary so as to enable IDCOL to utilize the money in the local currency. IDCOL, before using the money, will withdraw the required amount from CONTASA to IDCOL's own BDT account. It will be from this IDCOL account that the money will be transferred to the sponsors' and POs' account for their RE sub-projects as well as for the refinancing loans.

IDCOL will then request for replenishment of the money utilized from the CONTASA, so that the remaining balance of the account will be returning back to the initially disbursement amount prior to the utilization of the money (replenishment request). The balance of CONTASA will, therefore remain constant, back to the initial disbursement amount, after a cycle of disbursement and replenishment procedures are completed.

While IDCOL will manage the account solely in BDT, the MOF undertakes the responsibility of currency exchange between JPY and BDT. Nevertheless, both initial disbursement request and replenishment request, to be made by IDCOL, will have to be in JPY denomination, based on the amount handled by IDCOL in BDT converted to JPY utilizing an exchange rate set by the MOF.

(3) Direct Disbursement

In a limited case of disbursement of the money from JICA for the Project, an alternative arrangement, i.e., "Direct Disbursement" may also be used. This is an arrangement where the

[102] Other international development partners supporting IDCOL's RE programs and projects also employ similar bank accound and withdrawal arrangements whereby designated special accounts are opened in the Bangladesh Bank for each of the development partners. ADB uses an "Imprest Account" arrangement which is broadly identical to the JICA-REDP arrangement except for that direct disbursement is commonly used for transactions over approximately USD 2 million. The World Bank (IDA) uses a "Dollar Special Account" (DOSA) which differs from the JICA-REDP in that disbursement from the account is made directly from DOSA to the end recipient, and not via IDCOL account. IDB employs DOSA as their special account as with the World Bank except for that direct disbursement arrangemen is not utilized. Both Imprest Account and DOSA are dual currency convertible account at the Bangladesh Bank.

[103] Arrangement of a Convertible Taka Special Account (CONTASA) for the purpose of the MOF receiving a loan fund from the international development partners thereby being extended to a project executing agency is as stipulated in the MOF-ERD handbook 2008.

money will be disbursed directly from an account under the possession of JICA in Japan to the end recipient of the money. In the case of JICA-REDP, the anticipated grant portion of the project money will be disbursed under this arrangement. The direct disbursement will be made in response to the request from IDCOL to JICA and subject to approval by JICA.

7.3.4. Required Amount for JICA-REDP

Having defined the contribution amount for each of the components, the total loan assistance amount of JICA-REDP is calculated as USD124 million. The loan is expected to contribute to 22 percent of the SHS Program target, 77 percent of the Solar Irrigation Pump Component, 58 percent of the Solar Mini-Grid, 71 percent of the Gasification of Biomass Component, and 13 percent of the Biogas Power Generation Component targets.

Table 7.3-3 Subject of Japanese ODA loan Assistance

	SHS Program	Solar Irrigation Pump	Solar Mini-Grid	Gasification of Biomass	Biogas Power Generation
Installation numbers (sets)					
Total installation target	2,680,000	1,550	50	28	450
Allotment for JICA-REDP	585,094	1,200	29	20	60
Share among the total target	22%	77%	58%	71%	13%
Loan amount (USD million)					
Total loan requirement	458	18.6	9.0	4.8	7.2
Allotment for JICA-REDP	100	14.4	5.2	3.4	1.0
Share among the total requirement	22%	77%	58%	71%	13%

Source: Survey Team

(1) Loan

The loan allotted for the JICA-REDP will contribute to the following components:

SHS Program Component: USD 100 million
(22 percent of the total requested loan) for the SHS Program Component;
Solar Irrigation Pump Component: USD 14.4 million
(77 percent of the total requested loan) for the Solar Irrigation Pump Component;
Solar Mini-Grid Component: USD 5.2 million
(58 percent of total requested loan amount) for the Solar Mini-Grid Component;
Gasification of Biomass Component: USD 3.4 million
(71 percent of the total requested loan) for the Gasification of Biomass Component; and,
Biogas Power Generation Component: USD One million
(13 percent of the total requested loan) for the Biogas Power Generation Component.

(2) Grant to Match the JICA-REDP Loan

Most of the sub-projects to be conducted under the JICA-REDP require grant funds to match a certain portion of initial investment cost. Grant supports for IDCOL's RE Programs and RE Projects are funded by other development partners.

Comparing the grant demand to match the sub-projects to be financed by JICA-REDP with the current availability of grant for IDCOL, it can be deemed that the grant to match the JICA-REDP loans is readily available for all of the components.

Table 7.3-4 Grant Requirement to Match JICA REDP

(USD million)

	SHS Program	Solar Irrigation Pump	Solar Mini-Grid	Gasification of Biomass	Biogas Generation
Grant to Match JICA-REDP	6.1	19	8.7	1.1	0.4

Source: Compilation by the Survey Team based on information from IDCOL

Table 7.3-5 Current Grant Status

(USD million)

Donors	SHS Program	Solar Irrigation Pump	Solar Mini-Grid	Gasification of Biomass	Biogas Generation
KfW		0.3	0.6		
IDA (5013)	7.0	0.2			
GPOBA (DFID)		0.5	0.6		
GPOBA (SIDA)	4.4				
ADB Grant	2.0	0.2	0.3	0.1	0.1
BCCRF (Proposed)		23.0			
USAID (Proposed)	2.4	0.3	3.0	0.6	0.4
KfW (Proposed)		0.3	10.5	0.9	1.3
GIZ (Proposed)	1.6				
TOTAL	17.4	25	15	1.6	1.8*

Note (*): Biogas Power Generation Component still requires further USD 1.1 million to attain the target of USD 2.9 million

Source: IDCOL, Additional Fund Requirement, July 2012

IDCOL explained that the actual availability of grants marked "proposed" in IDCOL's fund requirement sheet can be estimated as follows:

Table 7.3-6 Status and Outlook for Proposed Grants to IDCOL

Provider of Grant	Status of negotiation	Expected approval	Expected disbursement
KfW	Already approved between GoB and the government of Germany by memorandum in June 2012.	February 2013	July 2013
BCCRF	Approved by Technical Committee. Awaits final approval from the Board.	December 2012	January 2013
USAID (managed by The World Bank)	The World Bank has already obtained clearance from USAID.	November 2012	January 2013

Source: Compilation by the Survey Team based on information from IDCOL

(3) JICA-REDP Loan within the Total Required Funding Amount

JICA-REDP amounts to USD 124 million. This fund will have to be matched not only by grant but also with the sub-project sponsors' own funding, i.e., the equity portion (in the case of SHS the matching fund will be the end-users' down payment and POs' loan). The total required funding amount, including these matching funds, as well as USD 124 million from JICA-REDP, is USD 245 million.

Table 7.3-7 Total Cost and Fund Requirement for JICA-REDP by Components

	SHS Program	Solar Irrigation Pump	Solar Mini-Grid	Gasification of Biomass	Biogas Power Generation	Total
Target under the Project (sets)	585,094	1,200	29	20	60	-
Total Project Cost (USD million)	172	48	17.4	5.7	2.0	245.1
JICA-REDP Amount (USD million)	100	14.4	5.2	3.4	1.0	124

Source: Survey Team

7.4. Executing Agency

7.4.1. IDCOL as the Executing Agency

The executing agency of the Project is IDCOL which was established in 1997 as a government-owned non-banking financial institution. IDCOL was established, pursuant to the Development Credit Agreement executed between the GoB and IDA and the Project Agreement executed between IDA and IDCOL, and was registered as a public limited company under the Companies Act 1994. IDCOL is the largest local financier in private sector infrastructure and renewable energy financing. IDCOL is funded by the Government and international development partners, i.e. the World Bank (WB), Asian Development Bank (ADB), KfW, Gesellschaftfür Internationale Zusammenarbeit (GIZ), Islamic Development Bank (IDB), SNV, and others. IDCOL and its activities are under the supervision of the Economic Relations Department (ERD) of the MOF.

7.4.2. Justifications of Financing the Components through IDCOL

Instead of funding individual components and sub-projects, the Renewable Energy Development Project extends loan to these activities through IDCOL in the form of a two-step loan. Major reasons for employing this structure of funding are as follows:

(1) Small scaled sub-projects are better managed under a bundled structure

The smallest of the sub-project can be the size of USD 100, as with the small scale SHS. Even the largest of the sub-projects in terms of capital cost is that of the biomass gasification which cost no more than a few hundred thousand US dollars. From the viewpoint of efficiency in promoting these small scale sub-projects, the procedure to extend loans should be standardized and conducted under a bundled structure as opposed to an individually tailored manner. IDCOL, having the experience of conducting the SHS Program and NDBMP through POs, is an appropriate organization that can function to manage and conduct a structured and standardized loan extension procedure.

(2) Need for comprehensive management entity for promotion of RE technologies.

Due to its versatility, the solar PV technology offers various benefits. Users can avail of the generated electricity for lighting, for powering communications equipment, for traction of motor and pumps, as well as various other functions. As the consequence, components listed up in the Project somehow share common factors among each other. SHS, the solar irrigation pump, and the solar mini-grids can have functional overlaps. Moreover, a potential user can have the choice of either the solar PV or the biomass utilization.

To avoid duplication of promotional structures for each of these RE technologies, the establishment of an integrated managerial function is desired. IDCOL, who has track record of promoting diverse RE technologies, including solar PV and biomass, is an ideal agency, which can play a managerial role in the promotion of the components. IDCOL will be setting a comprehensive target for the promotion of RE sub-projects, and will be extending loans to the various requirements with the flexibility and interchangeability among the components.

(3) Ownership promotion policy of IDCOL realizes sustainable RE deployment

IDCOL has a policy to encourage ownership on their borrowers by imposing own funding (equity portion) on every project.[104] This is based on IDCOL's belief that sponsors' ownership of the project is essential for making the projects sustainable. As the consequence, SHS financed by IDCOL fund are found to be well-maintained when compared with the SHS installed under other organizations such as the LGED and REB (LGED offered SHS on donation basis, while REB offered SHS under fee payment scheme). Promotion of RE technologies under IDCOL's components will enable the sub-project to be operationally sustainable.

(4) IDCOL policy to promote social development

IDCOL is a government-affiliated financial institution that conducts its activities under the policy of Government of Bangladesh. Further, IDCOL's policy on extending its fund is principally aimed to encourage social service and development. Financing through IDCOL will ensure that the resources will be utilized in line with government policy, and will promote social development.

7.4.3. Stakeholders and Their Roles

Stakeholders common to all of the sub projects are listed below. There will also be more indirect stakeholders such as those who will benefit from the activities of the end-users:
End-Users (of electricity, water or any other products and by-products);
Sponsors who implement components (includes POs who implement SHS Program);
Equipment suppliers and other service providers;
Executing Agency;
Monitoring and advisory functions;
Funding organizations (JICA and other development partners); and
The Government of Bangladesh.

Roles and relations of the stakeholders in the Project can be broadly categorized into two patterns: one is the SHS Program type and the other is the project component type of structure. The major feature of SHS Program is that the owner / user of the equipment will be end-users while that for other components will be the sponsors.

If these are arranged into one Renewable Energy Development Program, the roles and the relations of the stakeholders can be illustrated in the following figure. The Overall Project will be supported and monitored by an expert appointed by JICA. The expert will be responsible in reporting to JICA about the status of the Project and in facilitating IDCOL and other stakeholders to promote the Project.[105] Further, JICA may request IDCOL to conduct capacity development for the stakeholders who are in need of better skills and knowledge. Sponsors,

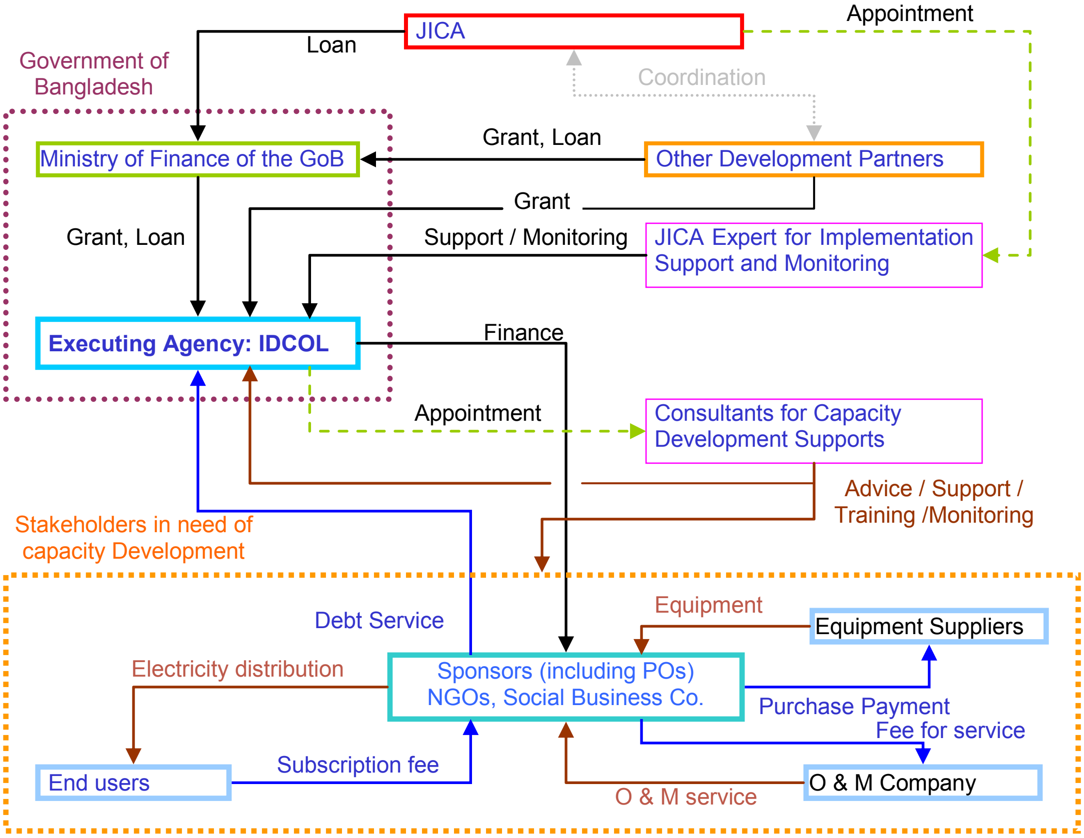
[104] According to an interview with the Directors of IDCOL.
[105] Consultants for monitoring and implementation support are similarly appointed by KfW. These consultants report not only to KfW but also to other development partners involved in IDCOL's RE activities (information from interviews with IDCOL and KfW).

especially those of small scale, equipment suppliers, O&M company and the end-users are the possible subjects for these capacity development activities.[106]

7.4.4. Structuring the Relationship among the Stakeholders

IDCOL's SHS Program is an example of developing a structure where major stakeholders are fitted in. POs are systematically given their functions to execute their roles. A similar structure can be sought for JICA-REDP's other components. Mechanisms to attract sponsors, to have them function proactively, and to have the business model developed by the sponsors will be required for the Solar Irrigation Pump, the Solar Mini-Grid, the Gasification of Biomass, and the Biogas Power Generation Components.

The incentive scheme that is applied in SHS Programs is an ideal mechanism for encouraging POs to implement their tasks and to formulate an appropriate business model for each of the sub-projects. Another element that can help in structuring the key stakeholders firmly into the component is the training opportunities. IDCOL may offer training opportunities to the sponsors, suppliers, and service providers on improving their capacity to further implement their sub-projects. As can be seen from the example of the SHS Program, training opportunities function as a strong incentive to the sponsors, suppliers, service providers, and even the customers.



Source: Survey Team

Figure 7.4-1 Roles and Relations among the Stakeholders to the Project

[106] The World Bank similarly requires IDCOL to conduct trainings for the POs in conjunction with the Execution of Loan. Funding for these activities (technical assistance) are funded as grant to IDCOL (information from interview with IDCOL).

7.4.5. IDCOL's Operational Arrangement for JICA-REDP

(1) Project Director

The Project will be conducted by IDCOL under the responsibility of the Project Director, who is also in charge of other projects and programs funded by other development partners. Such projects and programs include part of the SHS program and NDBMP. The Deputy CEO will be nominated as the Project Director. The Deputy Project Director will be the Director of the RE branch.

Although the Project Director is fully accountable for every matter on the JICA-REDP, all decision making on IDCOL's organizational matters remain under the function of the IDCOL Board. All executive decision makings will also remain with the CEO. All reporting from IDCOL to JICA on JICA-REDP will therefore be issued by the CEO. Nevertheless, the Project Director will function as the interface with JICA for all matters. In the cases of absence of the CEO, the Project Director or her / his Deputy will be authorizing the communication documents on behalf of the CEO.

(2) Utilization of Existing Structure

Five components that will comprise the JICA-REDP are all IDCOL's existing RE Program and RE Projects. Among these five components, the SHS Program Component has an already well-established structure as the World Bank RERED Project. Other international development partners (ADB, IDB, KfW, GPOBA and others) are contributing to the intervention making use of the RERED Project structure. JICA-REDP, through its SHS Program Component, should similarly contribute to IDCOL's existing SHS Program, in line with, and making use of the existing RERED Project structure.

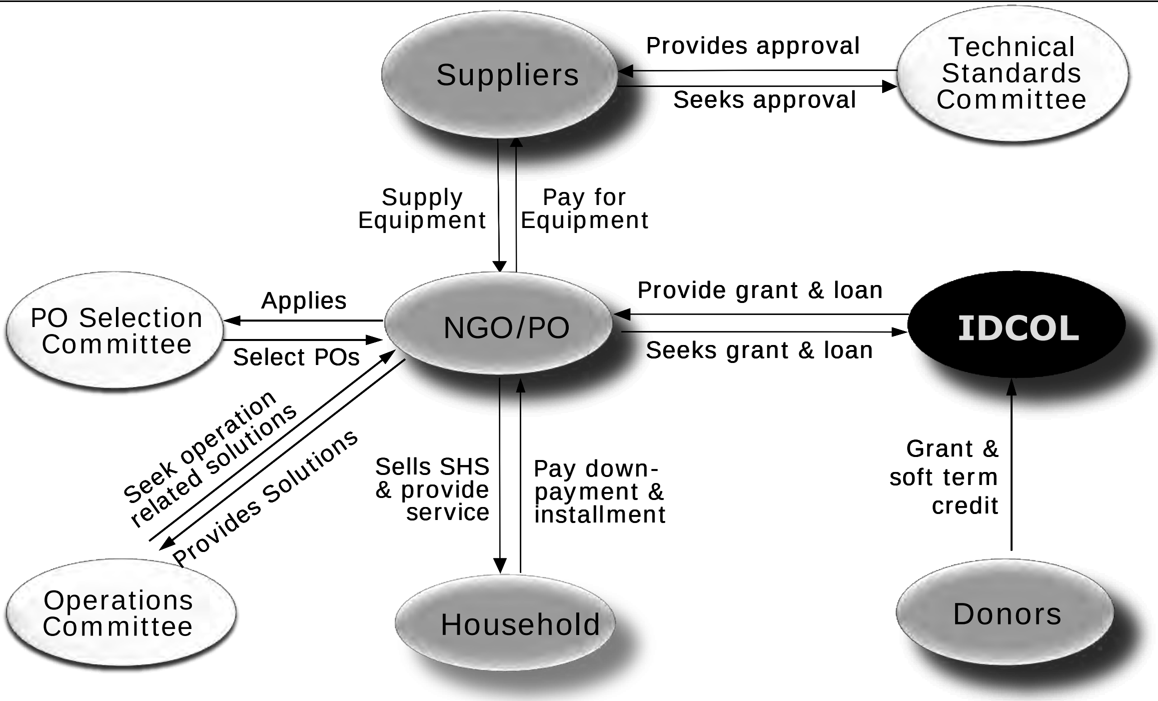
JICA-REDP is a Project that is in line with the World Bank RERED Project. The Project implementation arrangement at IDCOL, except for the new arrangements, is described in sub-section 7.4.6 of this report. The operational arrangements described in sub-sections 3.1.7 of this report apply to the arrangements for the operation of the SHS Program Component, as well as the sub-section 3.1.8, to the arrangement for Solar Irrigation Pump Component, Solar Mini-Grid Component, Gasification of Biomass Component, and Biogas Power Generation Component. The essence of the arrangements already introduced in these previous sections is summarized as follows:

1) Arrangement for Operation of SHS Program Component

Existing operational structure for the SHS will be applied to the execution of JICA-REDP's SHS Program Component. Applicable structure will be as follows:

(i) Program Structure and Overseeing

IDCOL is the provider of funds for the SHS Program, backed by funding from development partners. The sponsors, in principle, are NGOs who are accredited as participating organizations (POs). The Technical Standard Committee approves the specification of the technologies and products that are applied to the SHS. This specification approval scheme plays an essential role to maintain certain quality standards of SHS to be deployed. Apart from the approval scheme, there is also an inspection mechanism to assure the quality of goods and services provided in the program. IDCOL comes up with an inspection team comprised of six persons that conduct the inspection of solar PV instruments. If a defect is found, responsible POs will be contacted to have repairs arranged.



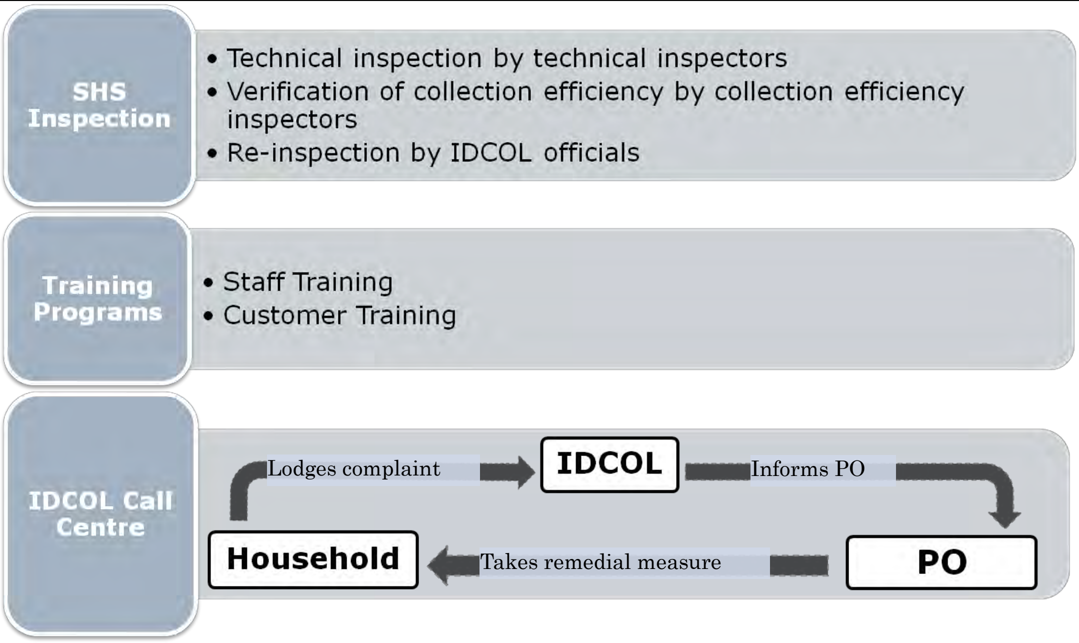
Repetition of Figure 2.2-2

In the SHS Program, there are three designated committees for managing the operation. These are Technical Standards Committee, the PO Selection Committee, and the Operations Committee. Among these three committees, the Technical standard Committee and the PO Selection Committee are independent committees, while the Operations Committee functions under IDCOL's management. Composition, functions, and authority of the committees for SHS Programs are stipulated in IDCOL's SHS Operational Guidelines.

(ii) IDCOL's Task in Operation and Maintenance of the Program

The payment of the maintenance fee is not required for end-users during the loan period (one to three years) except for the cost of repairing or exchanging parts. Maintenance will be conducted by the POs for BDT 300 per year after the loan period and IDCOL does not have to bear any maintenance duties. Replacement costs of parts are not included in loans and grants from POs to end-users but end-users can enjoy warranty periods for 20 years for solar PV panels and five years for batteries.

As for the Operation and Maintenance structure for RE Programs run by IDCOL, the Program Officer will be in charge with the inspection, training, and call center service as the major tasks. IDCOL's function to give trainings plays a major role to keep the service quality at a certain level. Quality control mechanisms are shown as follows:



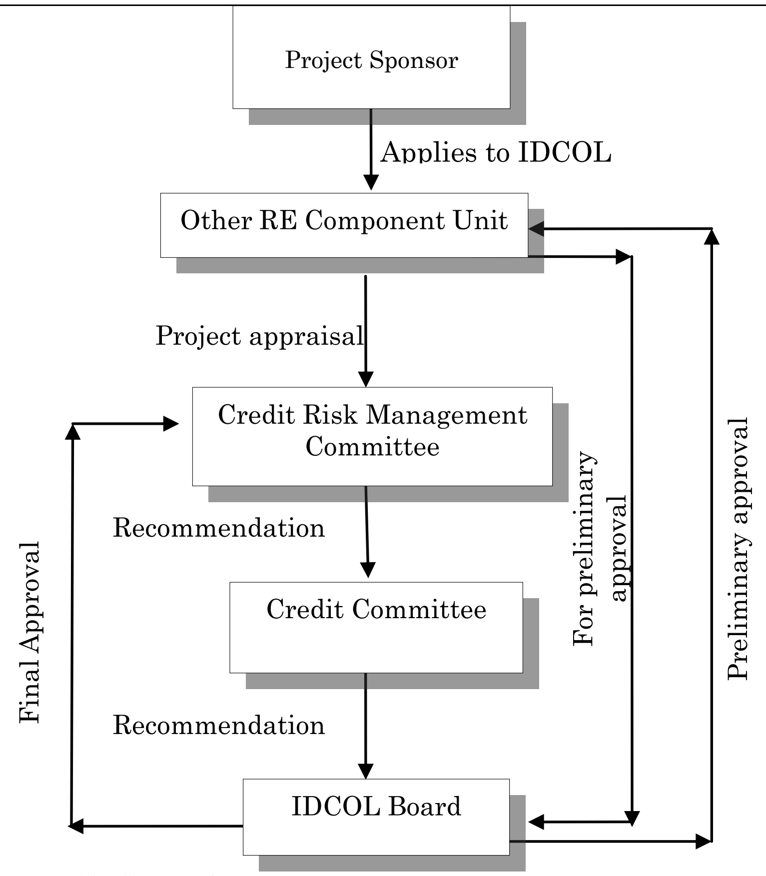
Repetition of Figure 3.1-4

(iii) Communications with the Development Partners
The concerned development partners are informed about IDCOL's current achievement of annual targets, fund requirements, repayment status, and other topics through monthly SHS Operations Committee meetings. During such meetings, development partners will be invited. IDCOL requests the development partners for authorization to utilize the money through the withdrawal applications.

2) Arrangement for Operation of Other RE Components (Appraisal Procedure)

The Solar Irrigation Pump Component, the Solar Mini-Grid Component, the Gasification of Biomass Component, and the Biogas Power Generation Components are the JICA-REDP components that will be structured based on IDCOL's existing RE Projects frameworks. IDCOL's existing RE frameworks have been designed and conducted as the "other RE Projects" portion of the WB's RERED Project, and is different from that of the SHS Program. Existing implementation arrangement focusing on the appraisal procedure is as follows:

IDCOL's Other RE Component Unit, on receipt of application for sub-projects, will conduct an appraisal of the proposed sub-project. On the basis of the results of the project appraisal, the Credit Risk Management Committee will review the report and send recommendations to the Credit Committee. The Credit Committee conducts further review of both project appraisals and recommendations as to approve fund allocation for these sub-projects. Further recommendations will then be sent to the IDCOL Board. Based on all of the appraisal results and recommendations, the IDCOL Board makes the final decision.



Repetition of Figure 3.1-5 with adjustment for JICA-REDP

3) Risk Mitigation

JICA-REDP's risk identification and mitigation measures will be broadly based on the existing arrangements at IDCOL. The Credit Risk Management Committee will continue to play an essential role in managing the risk. Security, as the practical means to mitigate the risk, will also be identical to the current arrangement at IDCOL. The following explains the outline of the risk management structure:

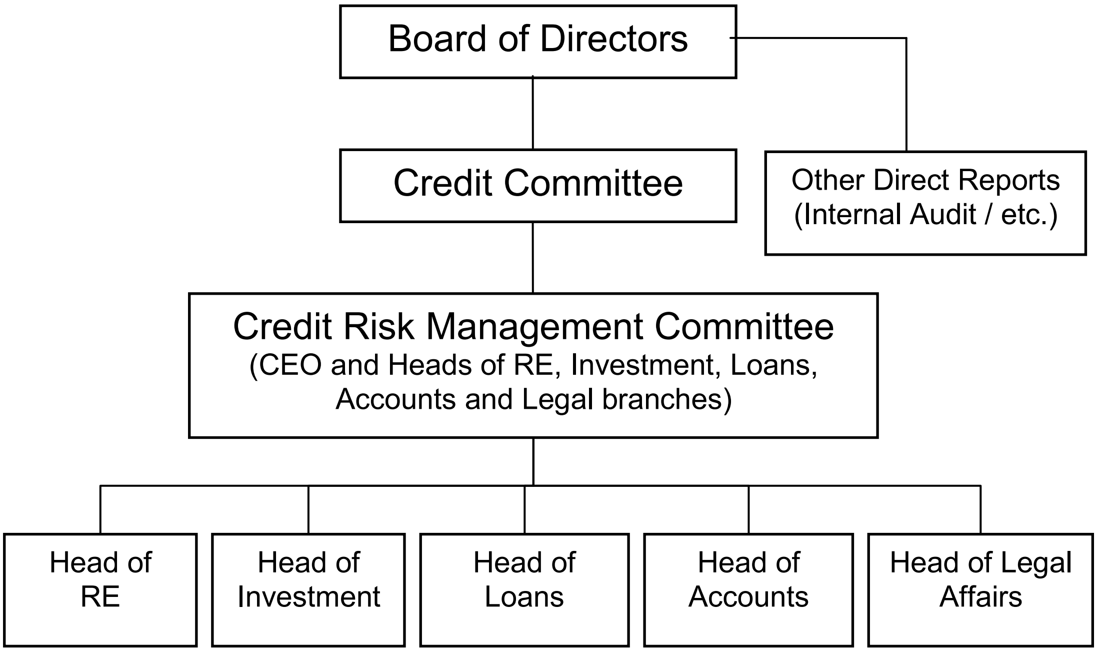
The risks including credit risk, economic risk, and Force Majeure, in general, are shouldered by the borrowers in terms of the interest rate associated with the risk premium. Two interest rate options are available for IDCOL loans, as determined from time to time by the Board of Directors:

- Variable rates, based on 6 month US$ LIBOR, plus a risk premium; and
- Fixed rates, based on the term of the loan and the appropriate US dollar swap rate, plus a risk premium.

The risk premium is decided by the Credit Committee of the IDCOL Board and is determined based on the following:

- The specific risks associated with each individual project;
- Risks associated with the industry or sector, in which the project is being implemented, such as the strength of the regulatory structure;
- Country or political risk associated with doing business in Bangladesh; and
- Risks associated with length of loan maturity.

The credit management structure is as follows:



Source: IDCOL

Figure 7.4-2 IDCOL Credit Risk Management Structure

IDCOL "Board of Directors" will have the overall responsibility for management of risks. The Board will decide the risk management policy of IDCOL and set limits for liquidity, interest rate, foreign exchange and equity price risks.

The "Credit Committee" will be a subcommittee, which includes the CEO and members of the Board of Directors. In general, all credit proposals shall be originated from the investment department of IDCOL. The Credit Risk Management Committee shall conduct a thorough credit and risk assessment prior to forwarding any proposal to the Credit Committee. Nevertheless, the credit proposal should clearly state that all instructions and guidelines of the credit policy have been complied with.

The Credit Committee shall analyze the credit proposal to see whether the proposal is consistent with IDCOL's credit polices and credit norms, guidelines/regulations of the Bangladesh Bank, and relevant laws, among others and has been presented observing all the required formalities. The Committee, in the light of its analysis shall consider the positive and negative sides of the proposal and shall give its opinions/recommendations. It should be noted here that the Credit Committee shall only give opinions/recommendations about a proposal. Credits will be finally approved by the IDCOL Board.

The "Credit Risk Management Committee" will be headed by the CEO and comprise heads of investment, loans, accounts, and legal affairs. The functions of the Credit Risk Management Committee are as follows:

- Implementation of the credit risk policy/ strategy approved by the Board;
- Monitor credit risk and ensure compliance with limits approved by the Board;
- Recommend to the Board, for its approval, clear policies on standards for presentation of credit proposals, financial covenants, rating standards and benchmarks;
- Decide in terms of capital allocation and defining limits in line with the risk strategy;
- Decide delegation of credit approving powers, prudential limits on large credit exposures,

standards for facility collateral, portfolio management, facility review mechanism, risk concentrations, risk monitoring and evaluation, pricing of facilities, provisioning, and regulatory/legal compliance, among others.;

- Lay down risk assessment systems, develop MIS, monitor quality of facility/investment portfolio, identify problems, correct deficiencies and undertake facility review/audit; and
- Undertake portfolio evaluations and conduct comprehensive studies on the environment to test the resilience of the facility portfolio.

The SHS Program requires the POs to reserve approximately 40 percent of the refinance amount as security. The security is partly kept as cash in bank accounts and partly in the form of a guarantee.

RE Projects, on the other hand, are funded under full recourse finance scheme. A mixture of various instruments is utilized for IDCOL to secure the value equal to the loan that will be extended from IDCOL to the sponsors. Instruments include land mortgage, letter of hypothecation issued by banks, personal guarantee of the directors, and others.

Table 7.4-1 Security for the SHS Program and RE Projects

	SHS Program	Other RE Projects
Security	• A Reserve of four quarterly repayment installments in the Debt Service Reserve Account (DSRA) • Either a legal mortgage of land or a bank guarantee for 20% of the outstanding refinance amount	Combination of the following means of guarantee up to full recourse of funding: - Mortgage of land - A letter of hypothecation - Personal guarantee of the directors - Corporate guarantee by affiliated companies - Lien on project accounts.
In case of defaults	Security will be in favor of IDCOL	Security will be in favor of IDCOL

Repetition of Table 3.3-1

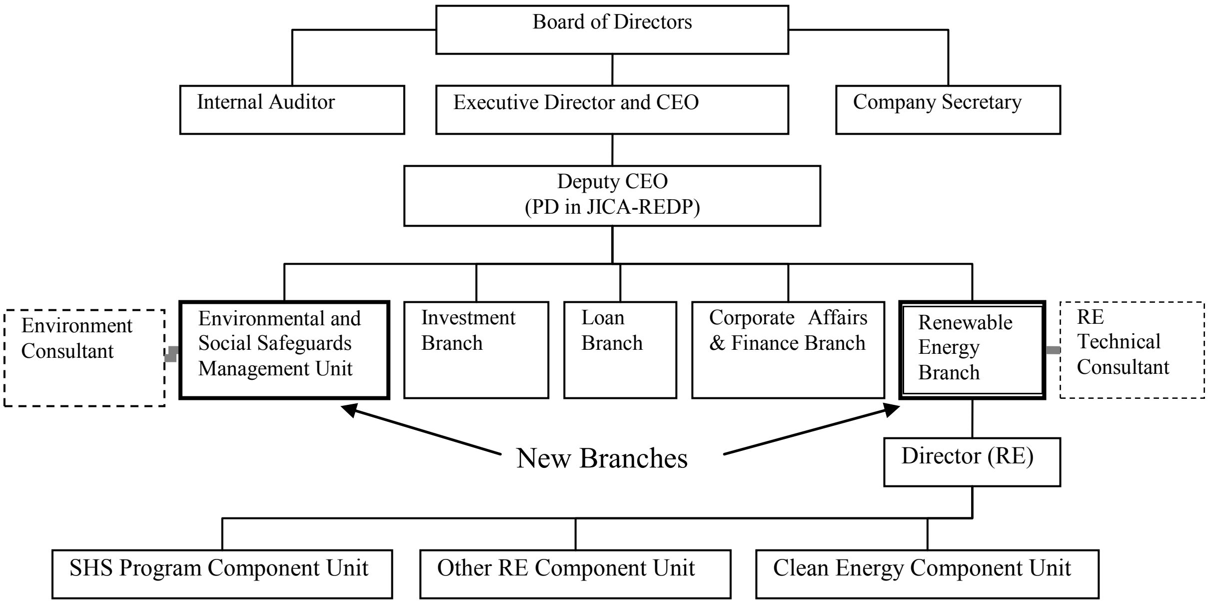
4) Future Plan for Programming Solar Pumps for Irrigation Project

IDCOL indicated that Solar Irrigation Pump Component and Solar Mini-Grid Component may be reformed to have them structured as a program in 2014 or later.

(3) New Structure of the Executing Agency for JICA-REDP

Management structure of IDCOL takes the form of executive director governance. The Board is represented by six members, three from public and three from private sectors. IDCOL confirmed that current structure with four branches namely, the Corporate Affairs & Finance Branch, the Legal Branch, the Loan Branch, and the Investment Branch. This structure will be expanded to add two more branches which are the Renewable Energy Branch and Environment & Social Safeguards Management Unit.

The Renewable Energy Branch will be a dedicated branch for implementation of the SHS Program, the NDBMP, and other RE sub-projects (= RE components within the context of the Project). Under the Renewable Energy Branch, three units will be established, which are the SHS Unit, the NDBMP Unit and Other RE Component Unit. The JICA-REDP will be conducted by the first and the third Units. The RE technical consultant will function to support the Renewable Energy Branch. The environmental consultant will collaborate with the Environmental and Social Safeguard Management Unit. IDCOL aims to obtain its Board approval for its new structure by December 2012.



Source: Prepared by the Survey Team based on discussions with IDCOL

Figure 7.4-3 Organizational Structure of IDCOL Incorporating Newly Established Branches

(4) New Component Units for JICA-REDP

In view of the necessity to reinforce current existing implementation structure for IDCOL's RE Programs and RE Projects, IDCOL needs to establish new component units for JICA-REDP. The current structure in which RE Projects are conducted under the Senior Investment Officers should be reinforced to become the "Component Units" (Separated between solar PV and biomass technologies as required), that will report directly to the management. This will enable JICA-REDP to be conducted in a larger scale compared with the current pilot scale operation. IDCOL is planning to establish three component units under the RE Branch. These are: (i) the SHS Program Component Unit, (ii) the Other RE Component Unit and (iii) the Clean Energy Component Unit. The JICA-REDP will be executed in the SHS Program Component Unit and the other RE Component Unit.

Each component unit will be headed by Unit Managers (to which Assistant Directors will be posted), and will be supported by Assistant Unit Managers (Senior Officers will be posted).

(5) Capacity of the Component Units

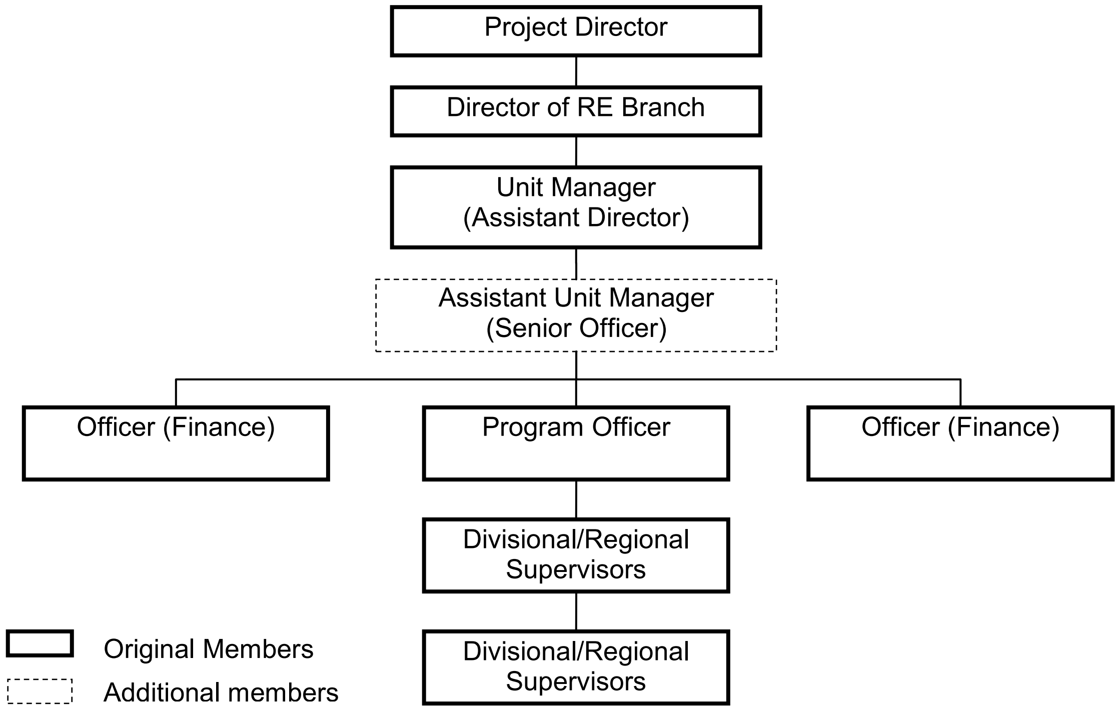
The function of the Component Unit will be to implement the JICA-REDP components in conjunction with the WB RERED Project by:

i) Project formulation and calling for offer,
ii) Appraisal of potential sub-projects,
iii) Arranging for funding support,
iv) Advising and monitoring the implementation of sub-projects,
v) Reporting to the IDCOL Board and JICA,
vi) Monitoring; and,
vii) Continuously improving its own capacity to implement the components.

The Component Units to be established will not only have the existing knowledge transferred from the existing functions of the existing Senior Investment Officers, but will also have its competence strengthened. The new units are required to have stronger functions to attract more potential sponsors with sub-projects. The units will also have to be capable of assessing the sub-projects' technical viability and business models.

1) SHS Program Component Unit

The SHS Component Unit will be responsible for operation of the SHS Program including hosting of the Operational Committee Meetings, communications with the Technical Standards Committee, and monitoring. Approval of the annual budget for the Program will be made by the Credit Risk Management Committee, Credit Committee and the Board of IDCOL. Any rules will be recommended by the Units for approval by the Board.



Source: Prepared by the Survey Team based on discussions with IDCOL

Figure 7.4-4 Structure of the SHS Program Components to be Established

The SHS Program Component Unit will be formulated by transferring the staffs involved in the existing SHS Program. The number of staff to be positioned in the Component Unit is set with consideration for the estimated number of POs under SHS Program. As consequence, the number of staffs will increase in 2013, but will be kept constant up to 2016. To enable a boost in SHS Program operation, IDCOL is currently seeking for more POs to be accredited for the Program. Further, the recruitment of additional staffs are expected in its earliest timing, i.e., during the first quarter in each of the years.

Table7.4-2 Number of Staffs in SHS Program Component Units

	2012	2013	2014	2015	2016
Unit Manager / Senior Officer / Officer	5	6	6	6	6
Divisional Supervisor	2	5	5	5	5
Regional Supervisor	20	15	15	15	15
Technical Inspector	74	100	100	100	100
Collection Efficiency Inspector	7	10	10	10	10
Training Coordinator / Inspector	2	3	3	3	3

Source: Prepared by the Survey Team based on discussions with IDCOL

Execution of the SHS Program Component requires a country-wide network coverage structure. Currently, two Divisional Supervisors are looking after nine Divisions, while 20 Regional Supervisors take care of ten Regions. The coverage is planned to be adjusted to five Divisional Supervisors looking after nine Divisions with 15 Regional Supervisors take care of ten Regions. The distribution and function of the Divisional and Regional Supervisors are as shown in the next table: It should be noted that the number of supervisors and regional officers do not match the above table due to existence of double assignments.

Table7.4-3 Distribution and Coverage of Supervisors and Technical Inspectors in SHS Program Component Units

Regional Supervisors	District Covered	IDCOL Regional Offices	Number of Technical Inspectors
Dhaka Regional Supervisor	Mymensingh Tangail Jamalpur Gazipur Manikganj Sherpur Munshiganj Dhaka	147, 1/1, Monipuri Para, Old Airport Road, Dhaka	9
Faridpur Regional Supervisor	Faridpur Madaripur Gopalganj Narail Jhenaidah Jessore Magura Chuadanga Meherpur Rajbari Kushtia	Heritage Beg Lodge, Charkamalapur, Faridpur Shadar, Faridpur	5
Bogra Regional Supervisor	Bogra Naogaon Gaibandha Natore Rajshahi Pabna Chapi nawabganj Joypurhat Serajganj	Janeseba Housing Complex, Road No: 8, Block-D, Plot No: 10, Jamilnagar, Bogra	6
Rangpur Regional Supervisor	Kurigram Lalmonirhat Dinajpur Rangpur Panchagarh Thakurgaon Nilphamari	Bardhan Kuti, Cantonment Road, Dhap, Rangpur Shadar, Rangpur	5
B.Baria Regional Supervisor	Chandpur Netrokona Kishoreganj Comilla B.baria Narsingdi Narayanganj	Zahangir Bahaban, Poniuaut Road, B.Baria Shadar, B.Baria	9
Sylhet Regional Supervisor	Sunamganj Hobiganj M.bazar Sylhet	Angura Villa, Daudpur, Bypass Road, Sylhet	8

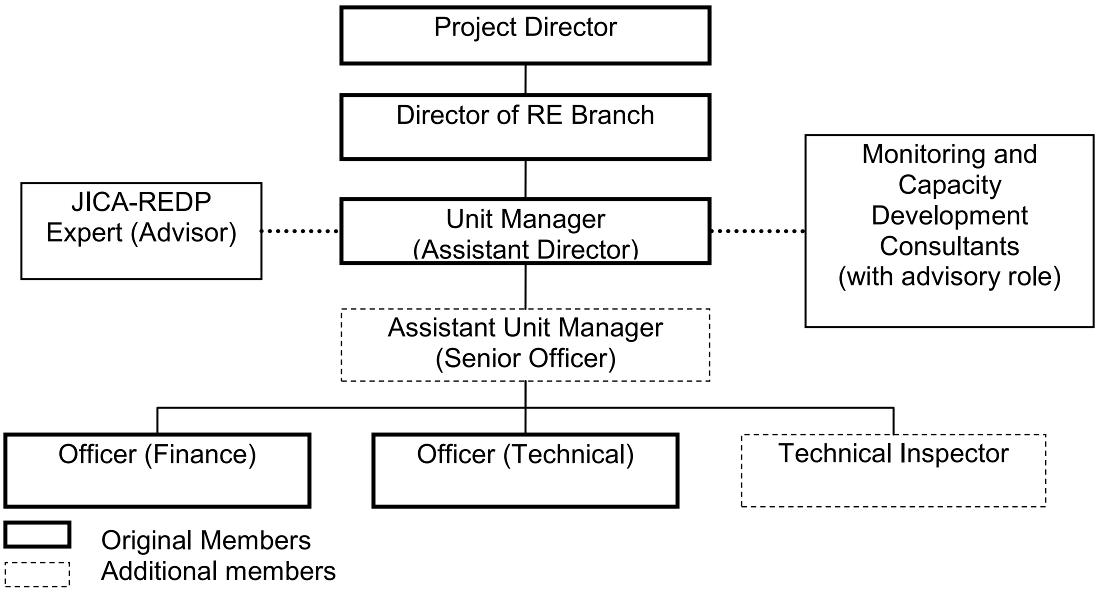
Regional Supervisors	District Covered	IDCOL Regional Offices	Number of Technical Inspectors
Chittagong Regional Supervisor	Chittagong Noakhali Laxmipur Rangamati Coxs Bazar Khagrachari Bandarban Feni	Kuheli, House No: 30 (3rd Floor), Road No: 1, Shugandha Residential Area, Panchlish, Chittagong	9
Barisal Regional Supervisor	Barisal Shariatpur Bhola Jhalakathi	Darul Goni Bhaban, 2nd Floor, New Gorosthan Road, Barisal-8200.	8
Khulna Regional Supervisor	Satkhira Khulna Bagerhat	Jothi Villa, 88/3, Moddhopara Moshjid Road, Boira, Khalishpur, Khulna	7
Barguna Regional Supervisor	Patuakhali Barguna Perojpur	Poli Monjil, College Branch Road (Botthala), Barguna Shadar, Barguna	8

Source: Compiled by the Survey Team based on IDCOL documents

2) Other RE Component Unit

The Other RE Component Unit will be responsible for the operation of the components including the project formulation support, appraisal, technical assessment, and monitoring. Approval of the sub-projects will be made by the Credit Risk Management Committee, Credit Committee, and the Board of IDCOL. Any procedural and technical standard rules will be recommended by the Units for approval by the Board.

Structure of the Other RE Component Unit is expected to be headed by the Unit Manager (Assistant Director). A JICA-REDP expert will support the Unit Manager as an advisor for appraisal manual development, monitoring, and other functions. A Monitoring and Capacity development consultant will be hired to also to support the Unit Manager. Staffs are expected to be posted exclusively for the component unit, without concurrent posting. The following figure is the tentative image of the component unit.



Source: Prepared by the Survey Team based on discussions with IDCOL

Figure 7.4-5 Structure of the Other RE Component Unit to be Established

The "Other RE Component Unit" will be set up to look after four components, namely the Solar Irrigation Pump, the Solar Mini-Grid, Gasification of Biomass, and Biogas Power Generation Components. Later, if necessary, the solar irrigation pump component may be established as a separate Unit considering its volume.

A Component Unit Manager will be responsible for management of the component. However, any decision on investment and procurement will be made by the Project Director, regardless of the amount.

The number of staff will be three. The Unit will be headed by the Unit Manager and supported by two Officers (initial stage), - one technical and one financial. The Technical Officer will be responsible for operation and maintenance of the component. The Unit Manager and Assistant Manager posts will be occupied by well-experienced staff while Financial Officers can be newly-recruited. Technical inspectors will be recruited and posted in each regional office of IDCOL to collect information related to irrigation, verification of proper installation, and operation of irrigation pumps as well to inspect other RE projects, once these sub-projects are up and running.

Table7.4-4 Number of Staffs in the Other RE Component Unit

	2012	2013	2014	2015	2016
Unit Manager	1	1	1	1	1
Assistant Unit Manager	0	1	1	1	1
Officer (Finance)	1	2	2 (+2)	2+2	2 (+2)
Officer (Technical)	1	1	1 (+1)	1 (+1)	1 (+1)
Technical inspectors	0	10	10	10	10
TOTAL	3	15	18	18	18

Note: Numbers in brackets are additional staffs designated for biomass derived RE components
Source: Prepared by the Survey Team based on discussions with IDCOL

The number of staff to be positioned in the Component Unit is set with consideration for the estimated number of sub-projects to be executed under each of the components. The number of sub-projects is expected to increase significantly through 2013 to 2015. As to enable a smooth start of JICA-REDP, IDCOL is planning to recruit additional staffs at its earliest timing, i.e., during the first quarter in each of the years.

Table7.4-5 Estimated Number of Sub-Projects

	2012	2013	2014	2015	2016
Solar PV RE sub-projects	55	208	310	513	516
Solar Irrigation Pump	50	200	300	500	500
Solar Mini-Grid	3	8	10	13	16
Biomass derived RE sub-projects	21	35	105	157	160
Gasification of Biomass	1	5	5	7	10
Biogas Power Generation	20	30	100	150	150

Source: IDCOL, Additional Fund Requirement, July 2012

The organizational structure that will be applied to operate JICA-REDP will be fully consistent and common with the structure of RERED Project Operation, in which the WB, ADB, IDB, KfW, GIZ, and other development partners are involved.

(6) Monitoring of JICA-REDP

Monitoring of JICA-REDP is also included as an essential function of the Component Units. IDCOL, as the executing agency will be responsible for monitoring and reporting of the Project to JICA. The RE Branch will be conducting the monitoring with the components, compiling the results and preparing the periodical monitoring reports. The monitoring should include, but not limited to, the following perspectives.

- Identifying any bottlenecks for the implementation of the Project and the components under the Project;
- Ensuring that the technology, equipment and mechanism offered under the components are appropriately addressing to the need of the sponsors and the other stakeholders;
- Confirming and reassessing, if required, the proportion of resources allocated to each of the components.
- Carefully observing any effect in terms of environmental and social considerations.

Based on the findings from the monitoring reports, IDCOL should consult with JICA on any possible improvements of the Project, by adjustment of resource allocation, introduction of new equipment, considerations for additional mechanisms, and by other measures.

(7) Guidelines and Manuals for JICA-REDP Operation

The SHS Program Component currently has a set of well-developed operational structure and guidelines. This is due to the arrangement for the RERED Project. Other components have been conducted with considerations to individual cases, by applying the existing project appraisal manual with flexibility. This project appraisal manual is a document developed for infrastructural projects such as power, transport, and other large scale development projects. Stipulations in the manual, therefore, are not always applicable to RE Components.

In preparation for the operation of JICA-REDP, IDCOL will develop a comprehensive set of guidelines and manuals that will not only support the efficient conduct of the Project but that would also enable the lessons learned to be accumulated in a systematic manner in the form of guidelines and manuals. The following three guidelines and manuals are proposed by the Survey Team to be developed. The Operational Guidelines are already being prepared by IDCOL and its initial draft is expected to be completed in due course. These guidelines and manuals are expected to be developed under accord of the stakeholders of the World Bank RERED Project, and therefore applicable not only to JICA-REDP but also to sub-projects under the RERED Project.

1) Operational Guidelines

IDCOL is currently preparing the Operational Guidelines, which describe the procedures and appraisal points for both SHS Program Component and other RE components. Administrative procedures should also be incorporated into the Operational Guidelines so as to enable IDCOL's RE Branch to accumulate its experience and skills as its institutional memory. A PDCA management cycle should be introduced in the administrative procedure for JICA-REDP operation.

2) Appraisal Manual for RE Sub-projects in Other RE Components

IDCOL does not possess an organized appraisal manual for other RE components. IDCOL has an appraisal manual made mainly for IDCOL's infrastructure projects and the manual is applied to other RE Projects with flexibility. The manual may also include due diligence procedure for RE sub-project sponsors.

The Survey Team has recommended to IDCOL to develop a designated RE sub-project appraisal manual, with support from a JICA expert. IDCOL welcomed the recommendation and the manual is planned to be prepared by April 2013.

In response to the recommendation, IDCOL is now planning to develop an appraisal manual for other RE components by April 2013. The manual is expected to cover comprehensive items including i) technical specification for equipment, ii) technical specification for entire system performance, notably their required operation rate, and iii) adequate installation condition with reference to the operational guidelines.

3) Technical Specifications

Standardized Technical specification for SHS is set by the TSC, which is an organization independent from IDCOL. For the other RE components, the technical specifications are yet to be standardized. Technical feasibility of each subproject is examined through IDCOL's appraisal for each of the applications. The Appraisal manual to be developed by IDCOL for implementation of JICA-REDP is expected to contribute to effective and efficient appraisal of the sub-project applications.

Some of the proposals for the technical specifications for solar PV equipment are: (i) system operation rate, (ii) dust proof standards, (iii) precautions for wiring, (iv) data logging functions. Proposals for the technical specifications for biomass derived RE equipment are: (i) operation rate requirement; (ii) pre-treatment options, (iii) environmental and safety requirements; and (iv) data logging functions.

7.4.6. New Implementation Arrangement at IDCOL for JICA-REDP

IDCOL's organizational capacity to implement JICA-REDP is readily existent as far as the implementation of the ongoing RE Programs and RE Projects is concerned. With JICA-REDP, a new approach to encourage the execution of sub-projects under each of the components will be required. First, a new designated branch to implement RE Programs and RE Projects is planned to be established. The introduction of this RE branch, under which the RE component units will be placed, is expected to reinforce the capacity for execution of RE sub-projects. The branch will be operated by staffs exclusively dedicated to RE component activities that will be able to concentrate on RE topics. Second, support from the JICA expert and component management consultants are expected to strengthen IDCOL's ability to evaluate applications for sub-projects from technical and business environment aspects. Third, the establishment of exclusive unit for social and environmental considerations will be an essential function to ensure that JICA-REDP will be implemented by IDCOL under sufficient considerations for the social and environmental aspects.

Table7.4-6 Comparison of the New Implementation Arrangement with the Current Arrangement

	Current Arrangement	JICA-REDP	Background
Implementation Structure	SHS Program and RE Projects are conducted under the Investment and Loans Branches. RE Programs and RE Projects do not have a designated implementing branch within IDCOL. Nearly all IDCOL staffs	A new designated branch for RE will be established in IDCOL. There will be three groups in the Unit, namely the SHS, the NDBMP and Other RE Projects.	The Survey Team observed that lending for the RE Projects are not conducted in a functional manner, with knowledge being accumulated by a limited number of people.

	are involved in RE Programs and Projects.		
Consulting services	Technical consultants are hired for each RE project. IDCOL usually asks KfW and GIZ for technical advice.	Consultants will be hired by IDCOL to support the capacity development of through the conduct of the Project.	Even though IDCOL, as a financial institution does not require technical expertise, the Survey Team found that proposals for sub-projects cannot be pursued without basic understanding on RE technologies and business models.
Guidelines and Manuals	RE Projects are conducted on experimental basis by applying the project appraisal manual with flexibility.	New technical specifications and appraisal manual dedicated to RE Components (other than SHS Program Component) will be prepared and applied. A management system document that will enable IDCOL to sustainable improve IDCOL's capacity to execute JICA-REDP on its own capacity will be developed. JICA will extend advisory service through its long-term technical expert.	Lessons learned from current experimental trials should be systematically accumulated and shared among the stakeholders in the form of guidelines and manuals.
Environment and Social consideration	IDCOL relies on an in-house consultant for its Environment and Social Consideration tasks.	An exclusive unit for environmental and social consideration will be established. The unit will be able to oversee the whole picture of the Project.	Current social and environmental consideration function is pursued by one in-house consultant who is not in a position to give advice unless required.

Source: Survey Team

7.5. Expected Effect of the Project and Reporting

RE components that comprise the JICA-REDP, and suggested in this report are commonly significant in their effect to reduce the greenhouse gas emissions by offsetting the use of fossil fuels. Further, the SHS Program has more significance in bringing electricity to non-electrified rural areas.

There are also other indirect effects to contribute to the development of economies and societies in Bangladesh by implementing the JICA-REDP. These indirect effects include promotion of local economic activities by relieving burden of diesel / kerosene procurement, improving working environment by eliminating exhaust gas from fuel usage, and also by reducing the risk of fire and other accidents. In the case of the SHS Program, which brings about electricity to the rural households, there are also benefits to the users by offering power source for television sets and mobile phones that brings about more information and communication tools. Working hours can be extended resulting in more income, and children would also able to study for longer hours after dark.

Some of these expected effects can be simply calculated while others cannot be quantified without the structuring of quantifying methodology. Direct effects that can be quantitatively evaluated are calculated. Expected indirect effects which are mostly described qualitatively are also analyzed.

7.5.1. Quantitative Direct Effects and Reporting

Major quantitative direct expected effects by implementing the five RE components as identified in Chapter 4 are: power to be generated, effect of reduction in fuel usage, and also reduction of greenhouse gas emissions. These effects are calculated and are aggregated as in the following table:

Table 7.5-1 Effect of JICA-REDP by Baseline and Target

Effect	Indicator	Baseline and target	Effect of JICA-REDP
Power Generation Capacity from Renewable Energy Sources	Installed Generation Capacity (MW)	Baseline	0
		Target: [Two years after the Project Completion]	41
Energy saved through utilization of RE equipment	Yearly Power Generation Volume (MWh/year)	Baseline	0
		Target: [Two years after the Project Completion]	62,879
	Electricity Available for Use (MWh/year)	Baseline	0
		Target: [Two years after the Project Completion]	56,290
Emissions offset by utilization of RE equipment	Effect of the Reduction of CO2 (t-CO2/year)	Baseline	0
		Target: [Two years after the Project Completion]	34,516
Beneficiaries (*)	Number of units deployed times average number of users	Baseline	0
		Target: [Two years after the Project Completion]	2,949,600

* Beneficiaries are counted by multiplying the number of facilities by average users (SHS = 5, Solar irrigation pump = 15, Solar mini-grid = 400. Beneficiaries for Gasification and Biogas facilities could not be quantified as number of users for each facility is unable to be defined.

Source: Compiled by the Survey Team based on IDCOL Funding Requirement and analyses

IDCOL, as a financial institution is also expected to perform in line with the expectation in prudence and credibility. Indicators for IDCOL to be reporting annually to JICA on the execution status of JICA-REDP will include the followings. IDCOL will be expected to continue reporting until 9 years after the completion of lending transactions.

Table 7.5-2 Reporting Format for IDCOL's Performance Indicators

Indicators	2013	2014	2015	2016	2017	2018	-----	-----	2024	2025
Number of sub-projects for which loan has been provided (number of cases)										
Cumulative amount of sub-loans disbursed under the Component (BDT million)										
Collection ratio of the Two Step Loan (%)										

Source: Compiled by the Survey Team

Reporting from IDCOL to JICA will be on quarterly basis. The report will be called the Project Status Report (PSR), and will not only entail the measured performance but will also include the condition and observation of the execution status of the JICA-REDP.

7.5.2. Qualitative Effects

The qualitative effects of each component are summarized as shown in Table 7.5-2. It is expected that each component has various positive impacts on households, farmers, shoppers, and industry, such as social and life (or working) environment improvement, income generation and job creation.

(1) SHS Program

SHS program components are expected to generate not only quantitative effects mentioned above, but also a lot of qualitative effects for households installing SHS and SHS related industry. Qualitative effects of SHS installation are mainly associated with the indirect effects of rural electrification, which are categorized into "social and life environment improvement effects" and "income generation effects". In addition to these effects, SHS installation creates job opportunities for manufacturing and maintenance of SHS.

1) Social and life environment improvement effects

Related to social and life environment improvement effects, SHS installation brings good impact on household's education, health and safety, time spent on household workload, and information and entertainment access.

Various literatures mention that one of the most important incentives for households to introduce SHS is the expectation of increased study hours for children.[107] Some research demonstrates that this expectation has been met by the SHS installation. For example, the report published by Bangladesh Institute of Development Studies (BIDS)[108] illustrated that the time spent on studying by a student living in an electrified house at night was 1.32 hours at an average and it is longer than that by a student in a non-electrified house which was 0.96 hours at an average.

Regarding health improvement for households, improved indoor air quality is brought by the replacement of a kerosene lantern which produces "soot" causing health hazard. In 2010, UNDP and SANYO Electric Co, Ltd. conducted a research to verify the effectiveness of avoidance of kerosene lantern to health improvement. The report also mentioned that the kerosene lantern

[107] For example, ESMAP (2008)
[108] BIDS (2004)

replacement can reduce the risk of house fire, which relieves the concerns of households. It is noteworthy that lantern replacement decrease the time spent on purchasing kerosene in the market.

The Welfare Impact of Rural Electrification; a Reassessment of the Cost and Benefits[109]" discusses that the house electrification facilitates media access (radio and TV), which has positive indirect benefits on health and nutrition, and fertility through improved health knowledge. Television also provides entertainment not only to the households, but to the whole community, since villagers are likely to gather to watch TV in the households having the facility.

2) Income generation effects

Income generation effects are brought by prolonged working hours and better equipment. A good example is that small stores in communities can extend its opening hours into night time by introducing SHS. Another example of this positive effect is that home workers can continue their work in the night under the lighting provided by brought about by the SHS. Regarding better equipment, it is reported that more households possess mobile phones after the house electrification by the SHS, since it becomes much easier for them to do mobile charging. The possession of mobile phone creates more business opportunities by improving business communications. Both cases definitely lead income increases for workers.

3) Job creation effects

In addition to the positive effects on households, SHS contributes to job creation for manufacturing and maintenance of SHS, and money collection from households. As SHS has become a big industry, POs and IDCOL are required to hire a large number of workers for inspection and money collection. Moreover, some companies, such as Radiant Alliance Limited, have started to assemble solar panels used for SHS in Bangladesh, which contributes to local employment.

(2) Solar Irrigation Pump

1) Working environment improvement effects

Although not enough researches have been carried out regarding the indirect effects of solar irrigation pump component, a lot of indirect effects are expected by its installation. Regarding the work environment, the replacement of diesel irrigation pumps to solar irrigation pumps reduces significant workload for maintenance, which is needed for the diesel pump operations. The replacement of diesel pumps also reduces the noise made by the diesel pump operations, which contributes to better work environment for farmers.

2) Income generation effects

Improved productivity is expected by the installment of irrigation pumps, which enables farmers to conduct three crops. This leads to income generation of farmers.

3) Job creation effects

The workforce is needed for manufacturing solar irrigation pumps and its protection against theft.

[109] World Bank Independent Evaluation Group (2008)

(3) Solar Mini-Grid

1) Social and life environment improvement effects

The solar mini-grid component is expected to bring the same qualitative effects regarding social and life environment improvement as discussed above in the SHS component. In addition, households and communities can enjoy improved security and safety, if community lighting (such as street lighting) is provided through mini-grid facilities.

2) Income generation effects

Since solar mini-grid provides lighting to marketplaces during the night time, shoppers in marketplaces can extend business hours. Shoppers might also enjoy better facilities such as refrigerators and fans which can attract more customers to come. These will lead to more business chances and income increase for shoppers.

3) Job creation effects

The workforce is needed for manufacturing and maintenance of the solar mini-grid.

(4) Gasification of Biomass

The gasification of biomass component mainly contributes to job creation and local industry promotion. The workforce is needed for maintenance of the plant operations and silica production sales.

(5) Biogas Power Generation

Biogas power generation component mainly contributes to job creation and local industry promotion. The workforce is needed for maintenance of the plant operations.

Table 7.5-2 Qualitative effects of each component in the JICA-REDP

Component	Beneficiaries	Indirect Effects	Direct effects
SHS Program	Households	Social and life environment improvement	(1) Longer study hours (2) Improved indoor air quality (3) Reduced household workload (4) Better media access and entertainment
		Income generation	(1) Longer business hours (2) Better equipment
	Industry	Job creation	(1) The workforce is needed for installation and maintenance of SHS, as well as for money collection.
Solar Irrigation Pump	Farmers	Work environment improvement	(1) Reduced time spent on maintenance (2) Reduction of noise made by diesel pumps
		Income generation	(1) Improved productivity
	Industry	Job creation	(1) Workforce will be required for installation of solar irrigation pumps and also, for protection against theft.
Solar Mini-Grid	Households and communities	Social and life environment improvement	(1)-(4) The same as SHS (5) Better community lighting (Improved security and safety)

	Shoppers	Income generation	(1) Longer business hours (2) Better equipment
	Industry	Job creation	(1) More workforces will be required in relation to the assembling of the equipment, resulting in more income opportunities.
Gasification of Biomass	Industry	Job creation	(1) More workforces will be required in relation to the operation of the plant, resulting in more income opportunities.
Biogas Power Generation	Industry	Job creation	(1) More workforces will be required in relation to the operation of the plant, resulting in more income opportunities.

Source: Survey Team

7.5.3.Project Implementation Timetable

Implementation of JICA-REDP is expected to start in 2013. Current assumption for the conclusion of the Loan Agreement (L/A) between JICA and IDCOL is February - March 2013, which is the last timing before the end of Japanese fiscal year 2012/13. First disbursement of the loan is expected to be in July 2013. Plans for execution of the sub-projects by components are set according to IDCOL assumptions.

Table 7.5-3 JICA-REDP Implementation Timetable

Calendar Year	2012	2013				2014				2015				2016				2017		Total
Bangladesh Fiscal Year				BFY 2013/14				BFY 2014/15				BFY 2015/16				BFY 2016/17				
Japan Fiscal Year			JFY 2013/14				JFY 2014/15				JFY 2015/16				JFY 2016/17					
	10-12	01-03	04-06	07-09	10-12	01-03	04-06	07-09	10-12	01-03	04-06	07-09	10-12	01-03	04-06	07-09	10-12	01-03	04-06	
Preparation																				
Prior Notification																				
Signing of Loan Agreement(L/A)																				
Component Management Support Consultants																				
Procurement of Consultants																				
Service Rendering and Trainings																				
JICA Disbursement for RE Conponents																				
SHS Program Component (1,000)				180 K				195 K				210 K								585K
Solar Irrigation Pump Component				160				240				400				400				1200
Solar Mini Grid Component				5				6				8				10				29
Gasification of Biomass Component				4				4				5				7				20
Biogas Power Generation Component				4				14				21				21				60
Project Completion																				

Notes:
Final application for SHS Program Component Refinancing: September 2015
Final appraisal for Solar Irrigation Pump Component: December 2015
Final appraisal for Solar Mini Grid Component: December 2015
Final appraisal for Gasification of Biomass Component: December 2015
Final appraisal for Biogas Power Generation Component: June 2016
BFY: Bangladesh Fiscal Year (July - June)
JFY: Japanese Fiscal Year (Apr - Mar)

Source: Compiled by the Survey Team

Disbursement of the loan for the components will start from Bangladeshi Fiscal Year 2013/14, until December 2016. The Project Completion date is set at the end of December 2016.

Component activities will commence after the signing of the Loan Agreement. Some of the activities, such as the preparation of the selection of the consultants, may be started prior to the agreement.

The Survey Team considers that review by JICA and / or experts hired under JICA's technical cooperation may be required for some activities prior to the commencement of component activities as well as the individual sub-projects (before decision on IDCOL's loan approval to sponsors).

8. Conclusion

The preparatory survey revealed that JICA-REDP can be implemented with the two-step loan of USD 124 million together with approximately USD 5 million for consulting services. The portion for consulting services is expected to be extended to IDCOL in the form of a grant, as with the case of the World Bank Technical Assistance fund. Disbursement of the two step loan is expected to commence in 2013, lasting until the end of 2016. JICA-REDP will be conducted in harmony with the World Bank RERED Project, under which interventions from the other international development partners and funds (ADB, IDB, KfW, GIZ, GPOBA, and BCCRF, among others) will be coordinated.

1) Emphasis on Capacity Development

The main feature of JICA-REDP is that the Project aims not only to promote RE and EE&C measures in Bangladesh, but also to contribute to further develop the capacity of the executing agency, IDCOL. For this purpose, the Project will include the dispatch of a JICA expert that will support the structuring of the component operation and management system, as well as the consulting service for continuous capacity development through furnishing of updated global trends in RE and EE&C technology. These technical cooperation measures are welcomed by IDCOL, whose plan is to enhance its technological expertise, including its research and development functions. JICA-REDP technical cooperation is expected to contribute to be consistent with IDCOL's orientation to strengthen its R&D and human resourced development capacities that will serve not only IDCOL but also be available to persons and organizations outside IDCOL.

Challenges against the execution of JICA-REDP were also identified in this preparatory survey. The survey showed that the SHS Program, to which majority of the fund will be allocated, is operated under a well established structure. The SHS Program Component of the JICA-REDP is therefore suggested to be executed by making full use of this existing mechanism. The component, therefore, will be operated under the arrangement of the World Bank RERED Project. On the other hand, the implementation structure for other RE components (solar irrigation pump, solar mini-grid, gasification of biomass and biogas power generation components) will have to be improved from procedures for current RE Projects at pilot characteristics, with more standardization and systematization.

The first step is to develop replicable model sub-projects that are suitable for being deployed to various candidate sites. Technologies, equipment and business model standardization will also be required. Development and continuous improvement of appraisal manuals and operational guidelines are expected to comprise the core of technical cooperation under JICA-REDP, especially during the initial years of execution.

The procedure of RE Projects execution at IDCOL was assessed to be fairly conducted, based on their existing guidelines and manuals. Nevertheless, RE Projects, still with trial factors require skills and experience. Technical Assistance in JICA-REDP is expected to address the requirement to accumulate such experiences in the form of institutional knowledge. Introduction of an element of spiral improvement through PDCA cyclic project management is suggested in this survey. This should be integrated into the RE Component operational guidelines with appropriate reporting, disseminating, and reviewing of the key information among the members of the organization.

The survey also suggests that further and continuous exposure to the updated global trend of RE and EE&C technologies and businesses should be furnished to IDCOL staffs. IDCOL is expected not only to pursue its own projects but also lead Bangladesh with RE and EE&C

promotion. To this end, IDCOL staffs are required to be further acquainted with various technologies, ideas, and its applications in other countries. IDCOL, itself may reinforce its research and development functions to become capable of disseminating its knowledge on RE and EE&C technologies. JICA-REDP, through its technical cooperation may contribute to IDCOL's R&D function reinforcement by means of continuous training on the latest global trends on relevant technologies.

Table 7.5-1 Findings and Suggestions on JICA-REDP Operation

Findings:	Suggestions:
SHS Program is well structured and established;	JICA-REDP should be conducted in harmony and under good coordination with the on-going RERED Project;
Technical specifications and business environment will have to be assessed in more systematic manner;	JICA-REDP may contribute to the development / improvement of RE component appraisal manuals;
Experiences, skills obtained through RE activities should be accumulated and utilized as institutional memory;	JICA-REDP may contribute to the improvement of operational guidelines by incorporating operation management system procedures;
IDCOL officers should be furnished with the up-to-date trend on RE technologies and businesses.	JICA-REDP may provide technological capacity development trainings to IDCOL and other stakeholders.

Source: Compiled by the Survey Team

2) Need for a Platform for EE&C Measures Promotion

All five components to be implemented under JICA-REDP are RE components. The survey found that currently IDCOL is not situated in an environment to promote funding for EE&C measures, except for brick kiln improvement activities. Proper measures to be encouraged on residential and commercial demand sides could not be identified due to the lack of effective regulatory framework in Bangladesh today.

Financial support for the promotion of EE&C in residential, commercial, and industrial (notably for small and medium size enterprises) areas can be found in some of the developing and emerging economies. Regulations and instruments that encourage the energy end-users to apply EE&C measures are required to be introduced. To this end, the development of EE&C rules and regulations will have to be supported. The function of SREDA, which is expected to become the competent authority for both RE and EE&C, will be stipulated within the SREDA Act. Among various proposed authorities of SREDA, the current version of the bill states that incorporation of EE&C measures into building code, labeling and accreditation, appointment of energy auditors are included. Furthermore, SREDA is expected to support the MoPEMR to establish rules and regulations that should stipulate incentives or restrictions that will promote EE&C measures. Drafting of such rules is urged, so as to enable financial institutions such as IDCOL to introduce EE&C promotion components in parallel with RE promotion activities.

3) Direction for Future

Once the execution of the JICA-REDP commences, the SHS Program Component will contribute to improving the living conditions of households in non-electrified rural areas, while other RE Components will contribute to offsetting the use of diesel generated power. Gasification of Biomass Component and Biogas Power Generation Components will, simultaneously contribute to the promotion of agricultural, poultry, husbandry and dairy businesses in rural Bangladesh, leading to income generation and activation of rural economy.

Activities conducted by financial support from IDCOL are hence intermediate outcomes of JICA-REDP projects. These outcomes will contribute to the sustainable development of Bangladesh. Under the assumption that similar replications would be possible in other developing countries, the skills and experiences of IDCOL would become invaluable to be extended to them. By further developing IDCOL’s capacity to deploy RE and EE&C equipment and measures to contribute to the rural economy, IDCOL may become an appropriate organization for conducting similar activities in another country, with the support from international development partners in the form of triangular cooperation. The next step for IDCOL may then be to expand its development contribution activities, not only within Bangladesh, but also to other developing countries.

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