Document of
The World Bank

Report No: ICR2609

IMPLEMENTATION COMPLETION AND RESULTS REPORT
(IDA-36790 IDA-46430 IDA-50130 TF-51301)

ON A

CREDIT
IN THE AMOUNT OF SDR 150 MILLION, 83.8 MILLION and 107.6 MILLION
(US$ 492.98 MILLION EQUIVALENT)

AND A

GLOBAL ENVIRONMENTAL FACILITY GRANT
IN THE AMOUNT OF SDR 6.6 MILLION
(US$ 8.2 MILLION EQUIVALENT)

TO THE

THE PEOPLE'S REPUBLIC OF BANGLADESH

FOR A

RURAL ELECTRIFICATION AND RENEWABLE ENERGY DEVELOPMENT

PROJECT

June 26, 2013

Sustainable Development Department
Energy Unit
Bangladesh Country Management Unit
South Asia Region

CURRENCY EQUIVALENTS
(Exchange Rate Effective April 2013)

Currency Unit = Bangladeshi Taka (BDT)
BDT 1.00 = US$ 0.0128
US$ 1.00 = BDT 78

FISCAL YEAR
July 1 – June 30

ABBREVIATIONS AND ACRONYMS

ACRE	Area Coverage Rural Electrification
ADB	Asian Development Bank
BDT	Bangladeshi Taka
BPDB	Bangladesh Power Development Board
BST	Bulk supply tariff
BSTI	Bangladesh Standards and Testing Institute
CAS	Country Assistance Strategy
CDM	Clean Development Mechanism
CER	Certified emissions reduction
CFL	Compact Fluorescent Lamps
DESA	Dhaka Electricity Supply Authority
DSM	Demand side management
EIA	Environmental Impact Assessment
EIRR	Economic rate of return
ELIB	Efficient Lighting Initiative of Bangladesh
EMP	Environmental Management Plan
ESMAP	Energy Sector Management Assistance Program
FIRR	Financial rate of return
GDP	Gross domestic product
GEF	Global Environment Facility
GEO	Global Environment Objective
GHG	Greenhouse Gas
GoB	Government of Bangladesh
ICR	Implementation Completion and Results Report
IDA	International Development Association
IDCOL	Infrastructure Development Company Limited
IL	Incandescent Light
ISR	Implementation Status and Results
kWh	Kilowatt-hour
LSI	Load Shedding Information
M&E	Monitoring and Evaluation
MFI	Microfinance Institution
MW	Megawatt
NGO	Non-Governmental Organization
NPV	Net present value
NSC	National Steering Committee
OHSAS	Occupational Health & Safety Management System

PAD	Project Appraisal Document
PBS	Palli Bidyut Samity
PDO	Project Development Objective
PO	Partner Organization
PSDTA	Power Sector Development Technical Assistance Project
PV	Photovoltaic
QAG	Quality Assurance Group
REB	Rural Electrification Board
RERED	Rural Electrification and Renewable Energy Development Project
SHS	Solar Home System
SDR	Special Drawing Rights
TA	Technical Assistance
TSC	Technical Standards Committee
UOLT	Uniform On Lending Term
VOLT	Variable On Lending Term
Wp	Watts peak

Vice President:	Isabel M. Guerrero
Country Director:	Johannes Zutt
Sector Manager:	Jyoti Shukla (Acting)
Project Team Leader:	Zubair K.M. Sadeque
ICR Team Leader:	Mani Khurana
ICR Team Member:	Katie Kennedy Freeman

COUNTRY: BANGLASDESH
RURAL ELECTRIFICATION AND RENEWABLE ENERGY DEVELOPMENT

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A. Basic Information

Country:	Bangladesh	Project Name:	Rural Electrification and Renewable Energy Development
Project ID:	P071794, P074040	L/C/TF Number(s):	IDA-36790, IDA-46430, IDA-50130, TF-51301
ICR Date:	06/24/2013	ICR Type:	Core ICR
Lending Instrument:	SIL, SIL	Borrower:	PEOPLE'S REPUBLIC OF BANGLADESH
Original Total Commitment:	XDR 153.00M,USD 8.20M	Disbursed Amount:	XDR 304.67M,USD 8.20M
Environmental Category: B, C		**Focal Area**: C	

Implementing Agencies:
Rural Electrification Board
Infrastructure Development Company Limited (IDCOL)

Cofinanciers and Other External Partners:
Global Environment Facility

B. Key Dates

Rural Electrification and Renewable Energy Development - P071794

Process	Date	Process	Original Date	Revised / Actual Date(s)
Concept Review:	04/06/2001	Effectiveness:	12/31/2002	12/31/2002
Appraisal:	02/26/2002	Restructuring(s):		07/06/2009 08/28/2011 12/20/2012
Approval:	06/25/2002	Mid-term Review:	07/10/2006	07/09/2006
		Closing:	06/30/2008	12/31/2012

Renewable Energy Development - P074040

Process	Date	Process	Original Date	Revised / Actual Date(s)
Concept Review:	04/06/2001	Effectiveness:	01/15/2003	12/31/2002
Appraisal:	06/06/2001	Restructuring(s):		
Approval:	06/05/2002	Mid-term Review:	07/10/2006	07/09/2006
		Closing:	12/31/2007	12/31/2009

C. Ratings Summary	
C.1 Performance Rating by ICR	
Outcomes	Satisfactory
GEO Outcomes	Satisfactory
Risk to Development Outcome	Moderate
Risk to GEO Outcome	Moderate
Bank Performance	Satisfactory
Borrower Performance	Satisfactory

C.2 Detailed Ratings of Bank and Borrower Performance (by ICR)			
Bank	**Ratings**	**Borrower**	**Ratings**
Quality at Entry	Satisfactory	Government:	Satisfactory
Quality of Supervision:	Satisfactory	Implementing Agency/Agencies:	Satisfactory
Overall Bank Performance	Satisfactory	Overall Borrower Performance	Satisfactory

C.3 Quality at Entry and Implementation Performance Indicators			
Rural Electrification and Renewable Energy Development - P071794			
Implementation Performance	**Indicators**	**QAG Assessments (if any)**	**Rating:**
Potential Problem Project at any time (Yes/No):	No	Quality at Entry (QEA)	2002 Highly Satisfactory 2010 Moderately Satisfactory
Problem Project at any time (Yes/No):	No	Quality of Supervision (QSA)	2010 Moderately Satisfactory
DO rating before Closing/Inactive status	Satisfactory		

Renewable Energy Development - P074040			
Implementation Performance	**Indicators**	**QAG Assessments (if any)**	**Rating:**
Potential Problem Project at any time (Yes/No):	No	Quality at Entry (QEA)	2002 Highly Satisfactory 2010 Moderately Satisfactory
Problem Project at any time (Yes/No):	No	Quality of Supervision (QSA)	2010 Moderately Satisfactory
GEO rating before Closing/Inactive Status	Satisfactory		

D. Sector and Theme Codes

Rural Electrification and Renewable Energy Development - P071794		
	Original	Actual
Sector Code (as % of total Bank financing)		
Energy efficiency in Heat and Power		3
Other Renewable Energy	9	56
Transmission and Distribution of Electricity	91	41
Theme Code (as % of total Bank financing)		
Climate change	29	60
Infrastructure services for private sector development	14	
Participation and civic engagement	29	
Rural services and infrastructure	28	40

Renewable Energy Development - P074040		
	Original	Actual
Sector Code (as % of total Bank financing)		
Renewable energy	100	100
Theme Code (as % of total Bank financing)		
Climate change	29	60
Infrastructure services for private sector development	14	
Participation and civic engagement	28	
Rural services and infrastructure	29	40

E. Bank Staff

Rural Electrification and Renewable Energy Development - P071794		
Positions	At ICR	At Approval
Vice President:	Isabel M. Guerrero	Mieko Nishimizu
Country Director:	Johannes C.M. Zutt	Frederick Thomas Temple
Sector Manager:	Jyoti Shukla	Penelope J. Brook
Project Team Leader:	Zubair K.M. Sadeque	Subramaniam V. Iyer
ICR Team Leader:	Mani Khurana	
ICR Primary Author:	Katie Kennedy Freeman	

Renewable Energy Development - P074040		
Positions	**At ICR**	**At Approval**
Vice President:	Isabel M. Guerrero	Mieko Nishimizu
Country Director:	Johannes C.M. Zutt	Frederick Thomas Temple
Sector Manager:	Jyoti Shukla	Penelope J. Brook
Project Team Leader:	Zubair K.M. Sadeque	Subramaniam V. Iyer
ICR Team Leader:	Mani Khurana	
ICR Primary Author:	Katie Kennedy Freeman	

F. Results Framework Analysis

Project Development Objectives (from Project Appraisal Document)
The Project's aim is to support Bangladesh's efforts to raise levels of social development and economic growth by increasing access to electricity in rural areas.

Revised Project Development Objectives (as approved by original approving authority)
Increase access to electricity in rural areas of Bangladesh and help promote more efficiency energy consumption

Global Environment Objectives (from Project Appraisal Document)
The global objective of the Project is to reduce atmospheric carbon emissions by overcoming market barriers for renewable energy development, including high implementation costs.

Revised Global Environment Objectives (as approved by original approving authority)
Not applicable

(a) PDO Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1 :	Expand access to rural households through financing of solar home systems			
Value (quantitative or Qualitative)	0 Solar home systems	64000	994000	1231720
Date achieved	05/31/2002	06/30/2008	08/28/2011	12/31/2012
Comments (incl. % achievement)	Exceeded AF 2011 Target by 24% .Investment in this component was scaled in the two additional financings that further scaled up the solar home systems component of the project.			
Indicator 2 :	Expand renewable energy options for off-grid energy supply in rural areas			
Value (quantitative or Qualitative)	0 Mini Grids	3	4	3
Date achieved	05/31/2002	06/30/2008	08/28/2011	12/31/2011

Comments (incl. % achievement)	3 mini- grids were set up instead of 4.Two of the plants are operational at present. The third plant had to be shut down as its operation was no longer financially viable.			
Indicator 3 :	More efficient energy consumption through installation of compact fluorescent lamps			
Value (quantitative or Qualitative)	0 Number of bulbs	10 million	27.5 million	10.5 million
Date achieved	07/06/2009	12/31/2012	08/28/2011	01/01/2011
Comments (incl. % achievement)	The target was revised to 10 million with the 2012 project restructuring, as the second phase of the CFL component was dropped.			
Indicator 4 :	Grid Based connections for access to electricity			
Value (quantitative or Qualitative)	0	700000		656802
Date achieved	05/31/2002	06/30/2008		12/31/2009
Comments (incl. % achievement)	Shortfall of 6%. The 2007 GoB moratorium on new grid connections caused the actual number of connections made under the project to fall short of the target.			

(b) GEO Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1 :	Promote adoption of renewable energy by removing market barriers and reducing implementation cost			
Value (quantitative or Qualitative)	See PDO Indicator 1&2			
Date achieved	05/31/2003			
Comments (incl. % achievement)	This indicator was linked to PDO Indicators 1 & 2, to the degree that the achievement of those was due to GEF support to promote adoption of renewable energy by removing market barriers and reducing implementation costs.			
Indicator 2 :	Reduction of Atmospheric carbon emissions/ Greenhouse Gas Emissions			
Value (quantitative or Qualitative)	0	250,000		4.14 million
Date achieved	05/31/2002	06/30/2002		12/31/2012
Comments (incl. % achievement)	Ton of avoided carbon emissions as a result of project Interventions. Exceeded the target by more than 15 times			

(c) Intermediate Outcome Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1 :	Number of solar home systems installed.			
Value (quantitative or Qualitative)	See PDO Indicator 1			
Date achieved	05/31/2002			
Comments (incl. % achievement)	See PDO Indicator 1			
Indicator 2 :	Number of renewable energy based mini-grid systems			
Value (quantitative or Qualitative)	See PDO Indicator 2			
Date achieved	05/31/2002			
Comments (incl. % achievement)	See PDO Indicator 2			
Indicator 3 :	Number of households connected to the grid			
Value (quantitative or Qualitative)	See PDO Indicator 4			
Date achieved	05/31/2002			
Comments (incl. % achievement)	See PDO Indicator 4			
Indicator 4 :	Three packages of lines transferred to REB			
Value (quantitative or Qualitative)	0 km	9400	12000	11295
Date achieved	05/31/2002	06/30/2008	07/06/2009	06/30/2011
Comments (incl. % achievement)	For line handover, there were resistance/issues on the ground. These included: a) resistance by the vested interest groups within BPDB and b) resistance of some consumers who had fallen into a non-payment pattern.			
Indicator 5 :	Number of incandescent bulbs replaced with energy efficient compact fluorescent lamps			
Value (quantitative or Qualitative)	See PDO Indicator 3			
Date achieved	07/06/2009			
Comments (incl. % achievement)	See PDO Indicator 3			
Indicator 6 :	Reduce system loss of distribution lines taken over from BPDB			
Value	More than 40% system loss	System loss reduced		13.7%

(quantitative or Qualitative)		to less than 20%		
Date achieved	05/31/2002	06/30/2008		08/31/2009
Comments (incl. % achievement)	This was not a part of 2012 restructuring paper but was an intermediate outcome earlier			

G. Ratings of Project Performance in ISRs

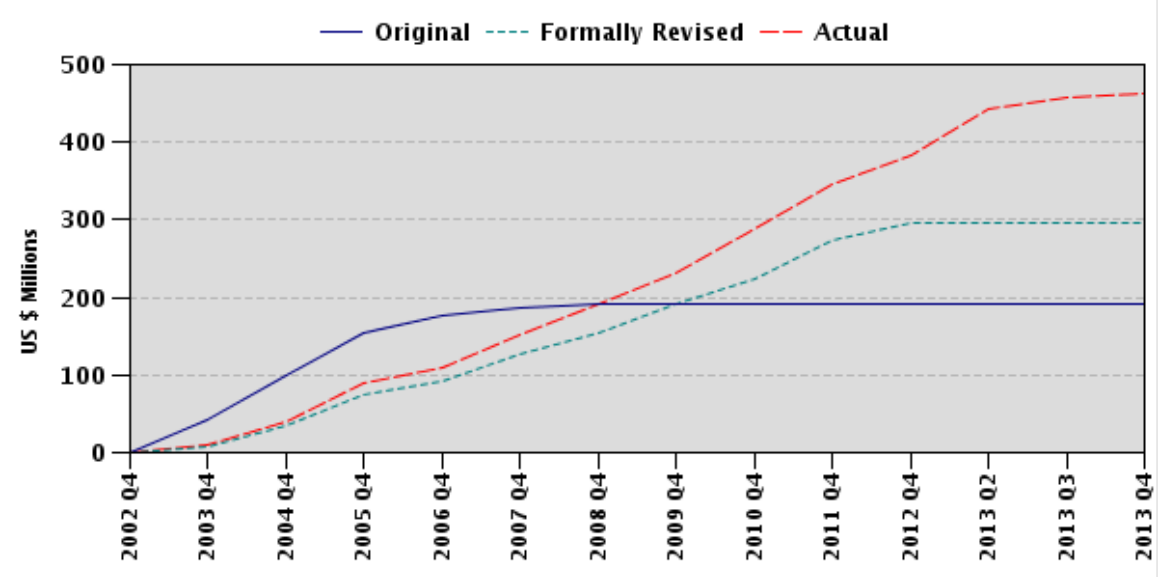
-						
No.	Date ISR Archived	DO	GEO	IP	Actual Disbursements (USD millions)	
					Project 1	Project 2
1	10/23/2002	S		S	0.00	0.00
2	12/18/2002	S		S	0.00	0.00
3	06/25/2003	S	S	S	9.04	0.33
4	12/23/2003	S	S	S	13.58	1.17
5	06/25/2004	S	S	S	38.50	2.02
6	06/30/2004	S	S	S	40.37	2.11
7	12/23/2004	S	S	S	64.03	3.00
8	06/02/2005	S	S	S	80.51	3.81
9	12/05/2005	S	S	S	98.82	4.82
10	06/22/2006	S	S	S	106.42	5.61
11	12/20/2006	S	S	S	120.60	6.04
12	06/25/2007	S	HS	S	147.69	6.29
13	12/14/2007	S	HS	S	167.48	6.71
14	06/17/2008	S	HS	S	184.19	6.84
15	12/24/2008	S	HS	S	229.39	8.00
16	05/28/2009	S	S	S	230.69	8.11
17	11/29/2009	S	S	S	230.69	8.17
18	05/26/2010	S	S	S	276.74	8.20
19	12/11/2010	S	S	S	322.90	8.20
20	06/07/2011	S	S	S	344.84	8.20
21	12/27/2011	S	S	S	346.25	8.20
22	06/27/2012	S	S	S	384.22	8.20
23	12/23/2012	S	S	S	443.99	8.20

H. Restructuring (if any)

Restructuring Date(s)	Board Approved		ISR Ratings at Restructuring			Amount Disbursed at Restructuring in USD millions		Reason for Restructuring & Key Changes Made
	PDO Change	GEO Change	DO	GEO	IP	Project1	Project 2	
07/06/2009	N		S		S	230.69		Additional financing for scaling up support to the fast-growing SHS component and adding a new component on CFLs
08/28/2011	Y		S		S	346.25		Additional financing for existing components, PDO restructured to better reflect project objectives
12/20/2012			S		S	443.99		Cancellation of funds due to savings in solar home systems and scaling down of the CFL component

I. Disbursement Profile

P071794



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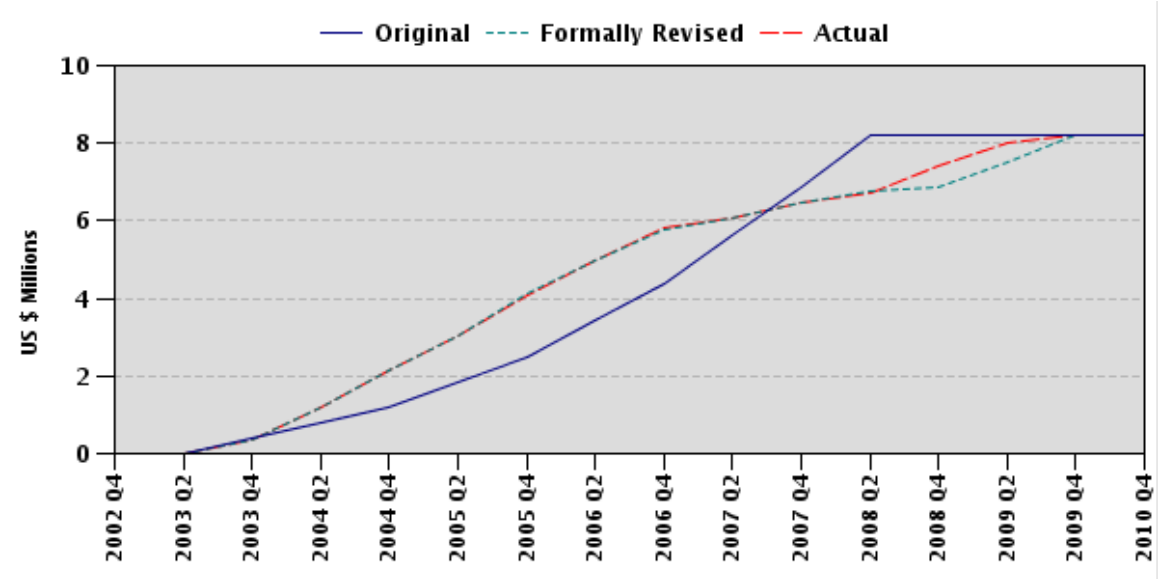
Original
Formally Revised
Actual
US $ Millions
10
8
6
4
2
0
2002 Q4
2003 Q2
2003 Q4
2004 Q2
2004 Q4
2005 Q2
2005 Q4
2006 Q2
2006 Q4
2007 Q2
2007 Q4
2008 Q2
2008 Q4
2009 Q2
2009 Q4
2010 Q4

1. Project Context, Development and Global Environment Objectives Design

1.1 Context at Appraisal

1.1.1 Country Background

At project appraisal in 2001, the population of Bangladesh was 129 million, with nearly 77% of people living in rural areas. About 49% of the population was living below the poverty line, 85% of which lived in the rural areas. Though access to electricity was a right included in the constitution (clause 16), less than 25% of the rural population had access to electricity (the national access rate was 30% in 2002). At the same time, consistent GDP growth above 5% caused increasing demand from those connected to the grid. Significant generation capacity was added in early 2000, giving impetus to increasing access to electricity[1]. The 2000 Country Assistance Strategy (CAS) emphasized the importance of rapidly increasing access, improving efficiency, and undertaking reforms in the electricity sector. The country also had a vast network of community-based non-governmental organizations providing micro-finance solutions to the rural population. During the latter part of the 2000s, when the two additional financing were processed in quick successions, the country was facing acute infrastructure deficits, particularly power generation constraints, against a backdrop of a continued GDP growth of above 6%.

1.1.2 Sector Background

At the time of appraisal, the rural power distribution network was owned and managed by consumer-owned cooperatives called *Palli Bidyut Samity* (PBSs), functioning under the umbrella of an apex organization, the Rural Electrification Board (REB). REB and the PBSs had proven effective in delivering reliable services at high levels of operational and financial performance and had benefited from previously successful World Bank projects. Their performance efficiency was in sharp contrast to that of the other two utilities operating in the country, Bangladesh Power Development Board (BPDB) and the Dhaka Electricity Supply Authority (DESA), which together comprised 75% of total electricity sales.

At the time of appraisal, the PBSs were connecting roughly 350,000-400,000 households a year to the grid. At that rate of expansion - and even without accounting for population growth - Bangladesh would have needed nearly 30 years to make electricity universally available. Furthermore, the dispersed nature of rural settlements and the difficulty of accessing some communities often made grid electrification difficult and expensive. Even in areas with grid electrification, electricity consumption was low: a large number of households used less than 40 kilo-watt hours (kWh) a month, mainly for lighting purposes.

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[1] The first-ever Independent Power Producer (IPP) with a capacity of 360 MW was introduced in early 2001 with Bank support (through a Partial Risk Guarantee) and another one was in the horizon. The second IPP of 450 MW came into operation in late 2002, which was also supported by the Bank (through a Government-owned financial intermediary – Infrastructure Development Company Limited, IDCOL). Together, these two IPPs added 27% of installed capacity by 2002.

There was an urgent need to accelerate the pace of electricity access expansion to meet the goals set in the Government of Bangladesh's (GoB) 2002 Vision and Policy Statement on Power Sector Reforms, which aimed to provide the entire country with access to electricity by 2020 (later revised to 2021). Since the goal of universal access to electricity could not be reached by grid expansion alone, the project adopted a two-pronged approach to increase electrification rates: (a) Improve and expand REB's rural grid network, and (2) Provide renewable energy alternatives through the provision of Solar Home Systems (SHSs) to homes rural areas where grid extension was not viable.

At the time of the first additional financing (AF 2009) in 2009, the Bangladesh power sector was characterized by growing demand (8%- 10% per annum), persistent low rural access rates, and one of the lowest average per-capita electricity consumptions in the world (165 kWh per year). Peak electricity demand was around 5,200 mega-watts (MW), and the virtually stagnant generation capacity of 3,600 - 4,300 MW was insufficient to satisfy the national demand. The supply shortages forced the GoB to stop or slow down new grid connections by 2007. The generation capacity deficits resulted in frequent and increasingly longer power outages that prompted industries, shops and households to install their own generators, pushing up the cost of living. Against this background, the off-grid SHS program was growing quickly, having already installed 236,000 systems (against the original target of 50,000). Every month an average of 12,000 systems were being installed and additional IDA support was required to meet the growing demand. Taking into account the persistent power generation shortages, as a demand side management (DSM) measure, the GoB embarked upon the Efficient Lighting Initiatives of Bangladesh (ELIB) program, which aimed to deploy energy efficient Compact Fluorescent Lamps (CFLs) to replace incandescent lamps.

At the time of the second additional financing (AF 2011) in 2011, peak electricity demand in the country had risen to 6,000 MW, and the available generation capacity of 4,600 - 5,000 MW was still insufficient to satisfy current demand. Off-grid renewable energy proved to be the short-to-medium-term solution and the least-cost option available for millions of people in the remote areas of the country to gain access to electricity services. Thus, the project undertook further expansion of renewable energy-powered solutions.

1.1.3 Rationale for Bank Assistance

At the time of the appraisal of the Rural Electrification and Renewable Energy Development Project (RERED) project, the Bank and REB engagement had a successful track record of implementing three rural electrification projects[2].
They had Successful, Satisfactory, and Highly Satisfactory outcome ratings. Following the last "Highly Satisfactory"-rated IDA project (the Third Rural Electrification Project, which closed on

[2] a) Rural Electrification Project (Cr. 1262 BD and a supplemental Cr. 1504 BD), b) Rural Electrification II (Cr. 1633 BD), c) Rural Electrification III (Cr. 2129 BD)

December 31, 1999), REB and the PBSs were well poised for an additional IDA credit. Both REB, acting as a quasi-regulator and financial manager, and the PBSs acting as service operators, had good track records of operational and financial management.

The Bank's comparative advantage was largely in playing a catalytic role by assisting the GoB in establishing an appropriate policy framework to guide the rural electrification program. The Bank's involvement enabled the establishment of appropriate standards for the selection of grid and off-grid options and the transfer of lines in rural areas from BPDB to REB, thereby contributing to the sustainability of the rural electrification program. In addition, the Bank and the GEF's global knowledge and experience in the field of renewable energy, based on related projects in progress in Asia, Africa and Latin America, enabled the transfer of established international best practice and valuable emerging concepts to Bangladesh. The project team brought together professionals with a range of country and sector expertise in rural electrification and renewable energy projects in the Philippines, Zimbabwe, Vietnam, South Africa, Thailand, Laos, Cambodia, Indonesia, Pakistan, India and Sri Lanka.

1.2 Project Development Objectives (PDO) and Key Indicators (as approved)

The project's aim is to support Bangladesh's efforts to raise levels of social development and economic growth by increasing access to electricity in rural areas.

The original PDOs and Key Performance Indicators (KPIs) were as follows:

RERED Project Development Objectives	Key Performance Indicators
Increase access to electricity in rural areas by grid and off-grid options.	Number of rural consumers provided access from the grid: At midterm: 400,000, and at Close: 700,000 Number of rural consumers serviced from renewable energy sources: At midterm: 24,000 and at Close: 64,000
Enhance socioeconomic impact of electricity provision in rural areas.	
Education: enhanced through improved lighting.	Increase in number of hours school aged children in the household study at night
Quality of Life: improved from higher safety, comfort and convenience; such as improved lighting inside and outside, replacing kerosene and use of appliances (TV, radio, fan, refrigerator).	Higher percentage of households in the electrified areas feel secure and more comfortable; increase number of lumen-hour for lighting inside home; and number of households use space cooling (fan) cold food storage (refrigerator) and TV/radio (for information and leisure.)
Women Empowerment: Improved education among girls and easier access to news and information specifically on women developmental issues through TV and radio	Number of hours school aged girls in the household study at night; percentage of women getting access to news and information; and number of women knowledgeable about reproductive health, HIV/AIDs and other women issues
Direct impact on income: reduced cost for access to: (i) light; (ii) news, information and entertainment; and (iii) electricity for those use electricity from other sources prior to formal access such as batteries.	Decreased cost of lighting for households (measured in terms of lighting per lumen hour); reduced cost of electricity for listening to radio and watching TV (measured in terms of cost of electricity to operate radio and TV per hour); reduced cost of electricity per kWh for household that were using car batteries or diesel gen-set prior to switching to grid electrification

Enhance rural productivity, development opportunities and reduce poverty through increased access to electricity.	Measures of rural productivity, development and poverty such as households using electricity for income generation like water pump, motor, electric fan, refrigerator and other electric appliances or tools; and farmers using electric water pump and motor for agricultural production and processing.
Safe drinking water: clean water for drinking, especially in areas where ground water contains arsenic.	Number of deep wells that supply drinking and clean water that use electric pumps; especially in areas where ground water contains arsenic

1.3 Original Global Environment Objectives (GEO) and Key Indicators (as approved)

The global objective of the project is to reduce atmospheric carbon emissions by overcoming market barriers for renewable energy development, including high implementation costs.

The key indicators were:

1. Promote adoption of renewable energy by removing market barriers and reducing implementation cost
2. Reduction of atmospheric carbon emissions/ greenhouse gas (GHG) emissions (nearly 250,000 tons of carbon dioxide avoided)

1.4 Revised PDO (as approved by original approving authority) and Key Indicators, and reasons/justification

The 2011 AF changed the PDO to "Increase access to electricity in rural areas of Bangladesh and help promote more efficiency energy consumption". The PDO was changed to better reflect the project focus on off – grid electrification (through the scaling up of the SHS component in AF 2009 and AF 2011) and energy efficiency (through the addition of the CFL component in AF 2009).

The KPIs of these AFs were (1) the number of SHS financed through the project, (2) the number of renewable energy mini-grids supported, (3) the number of CFLs installed under the project and (4) the number of new connections to the electricity grid that were financed under the project. A table with all targets and achievements can be found in Annex 10.

1.5 Revised GEO (as approved by original approving authority) and Key Indicators, and reasons/justification

The Global Objectives were not revised.

1.6 Main Beneficiaries:

The project benefits were widespread. At a community level, rural communities benefited from electricity access from new grid connections and SHS. SHS households benefitted from efficient and high-quality lighting that replaced inferior quality kerosene lamps. Overall, SHS and REB impact evaluations showed that rural households and enterprises benefitted from increased access to a reliable supply of electricity, which contributed to income-generating activities from

productive use of electricity; empowerment of women; improved quality of life through the use of (small) appliances; increased study time for children; and improved indoor air quality from reduced kerosene smoke.

Component	Target beneficiaries	Actual Beneficiaries
New Grid Connection (connections)	700,000	656,802
Solar Home Systems (systems)	994,000	1,231,720
Mini-grids (systems)	4 mini – grids	28 households & 158 commercial connections from 2 mini-grids
Losses (% reduction)	20%	13.7%

Institutionally, the PBSs benefitted from area rationalization that transferred to them pocket/peri-urban areas from BPDB, which had a better customer mix than the PBSs but were managed inefficiently under BPDB. By supporting rehabilitation of these lines and regularization of illegal connections, the project helped improve the financial position of the PBSs, while helping to bring discipline to the sector. Technical assistance support from the project helped build the institutional capacities of REB and IDCOL.

At the national level, the country benefitted from the large-scale distribution of SHS, with better service at lower costs and new grid connections, to rural consumers. Through SHS sales, Microfinance Institutions (MFIs) and Non-Governmental Organizations (NGOs) benefited from new business opportunities. In addition, the proven successes of the project have led to several other donors co-financing off-grid solar electrification in Bangladesh and have created a world-class renewable energy industry that is held as best practice globally.

The energy economy in Bangladesh as a whole was an indirect beneficiary of the reduced peak demand resulting from the distribution of CFLs, in part through the CFLs distributed by the project, and in part through the development of a new national CFL industry.

Globally, the IDCOL SHSs, REB system loss reduction and expansion displaced over 1.33 million tons of carbon dioxide (CO2) by project close, and IDCOL SHS component alone displaces over 300,000 tons per year over a 15-year project life by replacing kerosene use with solar electricity, providing a global benefit through the reduction of GHG emissions. The GHG emissions reduction of the project until project close (including IDCOL SHSs, system expansion and system loss reduction) was approximately 1.33 million tons, while the total GHG emissions reduction including the 15 year life of the IDCOL SHS will be more than 4.14 million tons by 2027.

1.7 Original Components (as approved)

The project, including AFs, spent resources mainly to (a) expand grid connection (REB); (b) expand off-grid connection (REB+IDCOL); (c) improve supply and demand side efficiency through loss reduction and deployment of CFLs (REB); and (d) capacity building of REB and IDCOL. The components under the original project were as follows:

Component A1: Rural Electrification System Expansion, Intensification and Rehabilitation: This component was designed to facilitate the handover of BPDB-operated power systems to REB to increase the efficiency of supply and reduce overall costs of electrification, including: a) the expansion of distribution facilities in 45 PBSs, including construction of 10,000 kms of new lines, rehabilitation of 2,500 kms of lines taken over previously and construction and augmentation of distribution substations and associated facilities and b) to facilitate and finance the takeover, rehabilitation and loss reduction of 9,400 kms of lines from BPDB.

Component 2: REB Technical Assistance (TA): To address REB and 45 PBS's institutional capacity needs, this component was designed to provide TA for socio -economic impact monitoring and evaluation, financial restructuring, environmental safeguard compliance and poverty reduction aspects of electricity provision.

Component 3: REB Solar Program: This component was designed to help establish a commercial framework for the off-grid lighting market in Bangladesh by supporting REB and PBS to develop a fee-for-service SHS program supplied to 14,000 off-grid households.

Component 4: REB Solar Technical Assistance. To support the REB Solar Program, this component was designed to provide TA to REB for a) market development and capacity building for PBSs, helping them to market, sell and service SHSs b) development of a quality assurance program to establish and monitoring technical standards for SHS components and systems and c) monitoring of the SHS program.

Component 5: IDCOL Renewable Energy Sub-loans this component was designed to provide IDCOL with project development support and financing to offer loans and grants for renewable energy development. This component aimed to provide SHS to 50,000 households through SHS through a micro-finance-based, direct sales program. The SHSs will be supplied and serviced by private companies in partnership with MFIs and NGOs.

Component 6: IDCOL Technical Assistance. This component was designed to support IDCOL's internal capacity and broaden its scope of activities by a) supporting technology promotion and market development activities b) building administration capacity with a focus on fiduciary and safeguard compliance c) increasing monitoring and evaluation capacity and activities and d) supporting renewable energy development of wind, hydro and biomass.

A more detailed description of each component and their outputs can be found in Annex 2.

1.7 Revised Components

AF 2009: The project received AF to 1) scale up the renewable energy component 2) introduce an energy efficiency and demand side management program and 3) meet REB's financing gap.

Component 1 - Scale up the renewable energy component. Through this, IDCOL aimed to provide an additional 300,000 households with SHS and expand other renewable-energy-based mini-grids.

Component 2 - Introduce a new component on energy efficiency and demand side management to mitigate supply shortages and improve the availability of electricity in the rural areas. This new component was introduced to deploy 10.5 million energy-efficient CFLs in exchange of incandescent lamps to help reduce peak demand under the first-phase of the ELIB program.

Component 3 - Meet the financing gap of the REB component to renovate distribution lines taken over from BPDB. In this component, additional financing was provided to REB to close the funding gap that arose due to exchange rate fluctuation that occurred between the time REB issued contracts for renovation of taken-over lines in 2008 and the time those contracts came due in 2009. This additional financing provided REB capital to continue rehabilitating the taken-over lines.

AF 2011: In response to the success of the SHS program, another AF was provided to a) scale up the SHS project component and b) provide additional technical assistance to IDCOL for quality assurance, training and outreach, and environmental management.

Component 1: Scale up the renewable energy component- This supported IDCOL by financing an additional 630,000 SHS and additional mini-grid and solar irrigation projects.

Component 2: Technical assistance to support a) quality assurance of SHS though photovoltaic (PV) and SHS lab and field testing / inspection, support to the Technical Standard Committee for quality improvement, and collection efficiency inspections; and b) training and consumer outreach and environmental improvement through battery and CFL recycling support.

1.9 Other significant changes

The project was due to close in June 30th, 2008 but was extended to June 30th, 2009 to allow for completion of remaining activities, mainly in the grid component (Component 1), that had been delayed due to delay in procurement, issues with line take-over and the moratorium that GoB issued in 2007 on new grid connections (see section 2.2.1 for more on issues with line take-over and connection moratorium). The procurement issues and moratorium resulted in un- utilized amount in the grid component. Also Special Drawing Rights (SDR) had depreciated significantly against the US dollar, resulting in the availability of more money. These un-utilized funds were re-allocated to meet the funding needs of the growing SHS component (the re-allocations were reflected in AF 2009). Together, these factors allowed the project to support an additional 186,000 SHSs over the original target of 50,000 by 2009 (for a total of 236,000.)

In 2009, an AF request was received for scale-up support to the fast-growing SHS component. In response to that request, in June 2009, the project was extended a second time, to December 31st, 2009. This first AF, for US$130 million, was approved in December 2009. In April 2011, a reallocation of US$24.57 million was made from the SHS component to meet the funding needs for the second-phase CFLs in response to a GoB request.

The second AF, for US$172 million, was approved in August 2011. AF 2011 revised the PDO to better reflect the project's new focus on off-grid electrification and energy efficiency.

In December 2012, the project was restructured by cancelling US$54.91 million (SDR 35.78 million) due to savings achieved in SHS component[3] under the second additional financing credit and scaling down of the CFL component under the first additional financing. This restructuring paper also updated the project's results framework to reflect the cancellations and to update targets to be attributable to IDA and co-financier (GEF) support only[4]. A project timeline is included in Annex 11.

2. Key Factors Affecting Implementation and Outcomes

2.1 Project Preparation, Design and Quality at Entry

2.1.1 Soundness of Background Analysis

The RERED project was, in part, a follow-up to the Bank's previous three grid electrification projects with REB. There was an urgent need for rationalization of the existing distribution network and expansion and intensification of the rural grid. The project recognized the important role REB and the PBSs were playing in extending the grid to rural areas. The project also recognized that, despite the fast pace of electrification, the national electrification goals could not be met by grid connections alone. In addition, providing grid electricity to certain sections of the rural settlements was economically unviable, as these rural settlements were not easily or cost-effectively accessible. Therefore the project considered off- grid solutions that built upon not only the Bank's experience with SHS in other Asian countries but also the success of the PBSs and community-based stakeholders (NGOs and MFIs) in Bangladesh.

Globally, NGOs and MFIs have demonstrated comparative advantages in operating at the community and household levels. In Bangladesh, the network of NGOs and MFIs was exceptionally strong and was widely accepted in rural communities. The project was skillfully designed to capitalize on the unique network of strong microfinance institutions, by building on their strengths and providing them with technical and financial support to implement off-grid options. Instead of relying on a standard rural electrification project design, the RERED project design was highly customized to Bangladesh's specific country context and its unusually strong network of NGOs and MFIs. At a time when the rural demand was growing, the RERED project initiated different interventions (expansion of grid and provision of SHS through IDCOL and the PBSs) to increase access in the rural areas.

At the time of the first AF, the country was facing severe power shortages; the impact of the power shortages was particularly severe in the rural areas, where electricity was sometimes

3 The savings were due the increased demand for smaller, lower cost systems with the availability of energy efficient LED based systems in early 2012, reduced refinancing rate and depreciation of local currency.

4 In case of SHS, the reporting of the targets was being done based on the achievement of the program which included the funding of the other financiers. This was modified to reflect the no. of SHS attributable to the IDA funds.

available only for a few hours a day. While efforts were underway to increase generation capacity, it was clear that it would be several years before additional capacity was available, and electricity deficits would continue as the Bangladesh economy grew. Thus the project supported continued scale-up of the renewable energy based options for increasing access, while also supporting the DSM measure of deploying energy-efficient CFLs in exchange for incandescent lamps.

2.1.2 Assessment of Project Design:

The project design incorporated lessons from the Bank's previous implementation experience with REB, as well as lessons learned from other countries (see 2.1.3), and the design of the original and AF components were adequate. First, under the original credit, the grid component simultaneously addressed two of the large needs at the time: additional connections and reducing losses to increase available power in the system. Second, the off-grid component targeted rural areas where grid connections were unavailable and were unlikely to reach in the foreseeable future. REB would implement the grid-based components of the project, and the off-grid component would adopt a two-pronged approach: fee-for-service and ownership models.

To implement the off- grid component, REB (through the PBSs) was tasked with extending a fee-for-service SHS program, whereby the systems would be installed and owned by REB, and consumers would pay a monthly fixed fee for using the systems.
IDCOL's approach was to sell the systems to consumers using a micro-finance scheme through the NGOs/MFIs (called "partner organizations", POs). Over the course of the project period, as the national demand for SHS grew, the project continually incorporated lessons learned from the pilot approaches and shifted its focus to the off- grid component. The project had a provision allowing for support to be scaled up for the model with the most promise. This design ultimately allowed the project enough flexibility to scale-up support to the successful ownership model.

By the time of the first additional financing, two things were clear. First, the increase in access through grid expansion would continue to be constrained due to the insufficient generation capacity. Second, the IDCOL model was proving to be much more successful. Therefore the AF 2009 supported scale-up of the SHS program through IDCOL.

To help reduce peak demand in the context of the continuing power generation constraints, the AF 2009 included support for the deployment of CFLs to replace incandescent lamps. Consumer uptake of the energy-efficient CFLs was low due to limited awareness, high costs, and poor quality of the available products. The project aimed to distribute high-quality CFLs for free in exchange for incandescent lamps in a nation- wide program that would have had an immediate effect on reducing peak demand in the country.

At the time of AF 2011, there continued to be limited grid expansion due to generation constraints and the moratorium on new connections, and various factors limited the Bank's ability to provide support to address the generation constraints in the country. Through AF 2011, the Bank continued to support the access agenda through the off-grid SHS program that had emerged, by that time, as one of the most successful off-grid electrification programs in the world.

The Development Objectives (DOs) support the 2000 CAS goals of increased energy access based on community institutions and micro-credit. The DOs are also consistent with the GoB's 2002 Vision and Policy Statement on Power Sector Reforms, which aim to provide the entire country with electricity service by 2020 (later revised to 2021); commercialize the sector; and increase efficiency, financial viability, and private investment. The CFL component added in 2009 is also relevant to the GoB's 2008 Energy Conservation Act. AF 2011 was consistent with the results-based CAS of FY11-14 that aimed to scale up support where results were demonstrated.

2.1.3 Lessons taken into consideration during preparation

The design, institutional framework and implementation arrangements were adequately appraised and reflected the lessons from other Bank renewable energy projects and reviews. The project took into account recommendations from a Bank review, *Rural Electrification: A Hard Look at Costs and Benefits; OED Precis, May 1995.* This suggested that grid extension only be selected for areas where it is demonstrated to be an economically viable option under conservative assumptions of economic costs and benefits. Additional influential lessons came from *Rural Energy and Development, September, 1996,* which recommends five main principles for better access to electricity: consumer choice, cost-reflective pricing, overcoming first-cost barriers, local participation, and good sector policies. Additionally, project design incorporated lessons learned from similar Bank projects and studies including *India Renewable Resources Development, Indonesia Solar Home Systems Project and Poverty and Gender studies in Indonesia and Sri Lanka*, May 2001.

The project borrowed lessons on design flexibility for easy monitoring and simple grant delivery models from the *Energy Services Delivery Project in Sri Lanka.* Applying lessons learned from Sri Lanka, RERED's design considered easy-to-implement grant and delivery models; commercially managed credit lines and grant administration; and the promotion of industry associations and NGOs as agents of growth.

Taking advantage of the Additional Financing instrument that allowed for quick scale-up support to a program that was demonstrating results, the Bank was able to continue supporting the successful SHS program, which emerged as the most viable and cost-effective option for millions of people living in the rural areas of Bangladesh. In the original credit, IDCOL supported a pilot renewable energy mini-grid, and based on the lessons learned from this mini-grid, AF 2009 included additional sub-projects for renewable energy. CFL procurement was guided by the GoB's Efficient Lighting Initiative of Bangladesh (ELIB) set criteria, and experience and lessons learned from deploying similar projects in other countries were incorporated in project design.

2.1.4 Adequacy of Client Commitment at Entry

The GoB's strong commitment to increasing electricity access in rural areas facilitated the project's success. The Constitution of Bangladesh requires the state to provide access to electricity in rural areas (Article 16). Also the GoB's 2002 Vision and Policy Statement on Power Sector Reforms aimed to provide the entire country access to electricity by 2020 (later

revised to 2021). The government's strong commitment was also highlighted by the efforts made by the GoB to overcome the opposition of the vested interest groups on the issue of transferring lines from BPDB to REB. In IDCOL's SHS program, the GoB allowed a large portion of IDA resources to be channeled through the non-government channel, indicating a strong commitment by the GoB to increasing access and improving services throughout the country. IDCOL's strong financing model and good relationships with the POs ultimately translated to the large-scale distribution of SHS and the creation of a SHS industry in Bangladesh. REB's commitment to reducing technical losses and to connecting additional households enabled them to make large strides towards access to efficient electrification in rural areas.

2.1.5 Risks and Mitigation Measures

The risks and mitigation measures (Project Appraisal Document (PAD), page 24) were well identified and appropriate, including the identification of 'timely transfer of BPDB lines and facilities' as a high risk. Recognizing this, the project team planned to closely monitor this risk during project supervision and put together a comprehensive transfer program agreed to by BPDB, REB and the GoB. The risk was further addressed by tying disbursements to actual progress in affecting the transfers. The financial sustainability of the PBSs was also identified as a risk, and efficiency improvements, line rationalization, and increased generation were suggested as the mitigation measures. At the same time however, the original project did not consider the supply constraints of power as a risk. This may be because, at that point in time, the country had started generating power from large IPPs, so load-shedding was relatively low (less than 10% of peak demand was unmet in 2002, compared to over 30% in 2009) and the supply scenario looked promising.

In addition, the risk of implementing a new SHS under REB, which traditionally specialized in grid, was considered. For this reason, the program's structure intentionally provided flexibility to adapt, and when it became clear that the IDCOL SHS model was more successful, it was possible to shift funding away from this component under REB.

During the preparation of AF 2009, the project team did consider several of the risks associated with the CFL component. Recognizing the risk associated with the quality of the CFLs, pre-shipment inspection agents were engaged to check quality during production process. Upon arrival of the CFL shipments, the national testing lab Bangladesh Standards and Testing Institute (BSTI) did life-time testing of samples collected from the supply.

On implementation, the project team recognized the complexity of the component and set up a Project National Steering Committee (NSC), under the chairmanship of Joint Secretary-Power Division, to oversee project activities. However, the NSC did not have the mandate to oversee CFL quality, monitoring or record keeping, and these challenged the success of the program.

AF 2011 recognized that quality requirements of SHS could be strengthened and that enforcement of quality should be improved. Although there was already a process in place for certification of suppliers and quality of installation verification, AF 2011 also put in place requirements for a national testing laboratory to help mitigate poor-quality panels.

2. 1.6 Quality at entry rating by Quality Assurance Group

In the first Quality Assurance Group (QAG) review, carried out in end 2002, the project was rated Highly Satisfactory for its strategic relevance and approach, driven by the clarity of the underlying DOs, the consistency with country development strategy and the CAS, innovations in project design and the depth of sector knowledge. The second QAG review was carried out in 2010. The DO was rated as 'Likely' to be achieved, while the quality of project design was rated as 'Moderately Satisfactory', as the DOs did not reflect the energy efficiency component that was introduced in AF 2009[5].

2.2 Implementation

2.2.1 Progress of Implementation

Implementation progress was rated 'Satisfactory' throughout the project. There were initial delays in implementation of the grid expansion and rehabilitation components due to the line hand-over issues; these were later overcome. Quality issues in the first phase of the CFL deployment resulted in non-achievement of the desired objectives for the component, while the second-phase CFL deployment could not be concluded under the project due to issues related to bidders.

Access:

Grid: The grid component faced initial delays due to delay in the handover of the first package of lines from BPDB to REB, which resulted in delays in credit effectiveness. Handover of the subsequent packages were also delayed. While there was strong commitment from the GoB for the line handover, there was resistance and other issues on the ground. These included a) resistance by the vested interest groups within BPDB; b) resistance by some consumers who had fallen into a non-payment pattern and feared that, if the lines were transferred to REB, they would have to begin making payment; and c) the discrepancy between the length of lines that were included in BPDB's plans and those that actually existed on the ground. Anticipating the complexity surrounding the land handover issues, the credit effectiveness and disbursement conditions were tied to hand-over of lines in packages. With the help of strong commitment from the GoB and close supervision by the Bank, the line hand-over issues were ultimately resolved.

The grid component faced further delays due to the power supply constraints that were beyond the control of the project. Given the generation shortages, in 2007 the GoB put a moratorium on new connections, despite the considerable demand for new connections, while it made efforts to address the generation shortages. The moratorium caused the actual number of connections made under the Project to be less than the target.

[5] The DO was subsequently revised in AF 2011to reflect the energy efficiency objective.

Off-grid: The implementation of the IDCOL SHS program proved to be much more successful than originally anticipated. The program started with five NGOs as the POs. By the project closing, the number had risen to 30 POs installing 60,000 SHS per month under a competitive business model. Against the original target of 50,000 SHS, the original credit supported 236,000 SHS by re-allocating savings from the other components. Over the course of the project period, as the national demand for SHS grew, the project shifted its focus to the successful business model of implementation through IDCOL, and two additional financings scaled up support to the renewable energy program. The Bank's continued support helped to mobilize wide-spread support from other donors, including the GPOBA, the Asian Development Bank, the Islamic Development Bank, the United States Agency for International Development and the Japanese Government. For more information on the IDCOL SHS program please refer to Annex 12.

On the other hand, the REB's fee-for-service approach for SHS faced implementation issues and did not meet the targets. As the REB's primary function and core expertise was to provide grid electricity, it found itself organizationally challenged in providing off – grid services. Its inability to contract the manpower to support the SHS program was one of the reasons for meeting less than the target output. Also, as customers had no ownership in the fee-for-service approach, there was neglect and abuse of the systems by customers, which resulted in the frequent break-down of equipment. In addition, in many cases it was not viable for the PBSs to send their staff to collect bills or perform maintenance, as the cost of bill collection was higher than the revenue collected. This was a sharp contrast to the ownership model of IDCOL.

Supply Side Management: A continued and sustained reduction in system losses occurred in the lines taken over from BPDB: losses fell from 59.94% in 31 PBS in 2002 to 13.7% in 2009. The efficiency increase was due to the rehabilitation of lines, changeover of meters, regularization of some consumers and improvement in collection efficiency. There were initial delays in this component due to the line handover issues described earlier.

Demand Side Management: The demand side management component faced two major challenges: quality of the CFLs procured under the first phase and performance-guarantee-related issues of the bidders in the second-phase CFLs.

Implementation of the CFL component was a challenging endeavor. It proposed a nation-wide distribution of 10.5 million CFLs involving four urban utilities and 15 rural PBSs. To add to the challenges, the GoB decided to distribute nearly half of the lot in a single day (demonstration effect), with customers coming to collection centers to replace their incandescent lamps with CFLs. The logistics of the nation-wide distribution on a single day proved to be enormous, but strong Government commitment made it possible. While the single-day distribution was largely successful (5 million were distributed in a single day), there were issues in proper record-keeping to meet the stringent documentation requirements for Clean Development Mechanism (CDM) purposes.

Quality issues of the procured CFLs emerged after distribution. A post-installation survey within a few months of installations indicated a 34% of lamp failure rate. A life-time test by the national testing institute on sample CFLs indicated that the average lamp life of the CFLs was significantly less than the number of hours specified in the technical specifications. The

technical specifications required longer lamp life (10,000 hours) than the global standards (at that time) of 5,000-6,000 hours. A full life-time testing would have required more than a year, which was not possible before shipment of CFLs given the project's tight timeline (this was mean to be a quick win for the GoB, and it wanted to begin deployment as early as possible). The CFLs had passed all of the parameters that were tested pre-shipment (power factor, voltage tolerance etc.). The bidders did not have, at the time of bid, the historical test reports for the customized specifications. Test reports for standard lamps were submitted with the bids, but they had little relevance to the customized product that was being procured (longer lamp life, higher power factor, larger voltage fluctuations tolerance etc.).

Procurement of the second phase of the CFLs was initiated in eight lots immediately after the first-phase procurement (before the quality issues in the first phase emerged). Bidders were selected, but none of the contracts could be signed, either due to non-submission of performance guarantees or, in some cases, submission of fake performance guarantees for some lots. Eventually, the second phase of the CFLs had to be abandoned under the project, with the allocations cancelled before the credit closing date.

2. 2.2 Implementation Progress rating by QAG

The QAG review in 2010 rated the overall implementation progress as Moderately Satisfactory.

2.3 Monitoring and Evaluation (M&E) Design, Implementation and Utilization

M&E design & implementation:

The first objective of the project was to increase access to electricity in rural areas through grid and off-grid options. The M&E framework includes two indicators for the first objective: i) number of rural households provided access from grid; and ii) number of rural households serviced from renewable energy sources. The number of households and enterprises connected to the grid was obtained from REB/PBS monthly reports of new connections made. The data on the number of rural households serviced with renewable energy was collected through IDCOL/PO progress reports and SHS sales tracking.

The other objectives in the original framework relate to the social and economic impacts of electricity provision, including i) enhance the socioeconomic impact of electricity provision in rural areas; ii) enhance education through improved lighting; iii) improve quality of life; iv) empower women; v) have a direct impact on incomes; vi) enhance rural productivity and other development opportunities and reduce poverty; and vii) enable the provision of safe drinking water. These objectives were measured through impact assessments: 2005 and 2010 impacts of grid electrification by REB and a 2012 impact of SHS impact evaluation for the IDCOL program. These impact evaluations were able to capture the longer-term social and economic impacts of rural electrification that could not be quantified on a more regular basis. The details are included in Annex 5.

In addition to the above, IDCOL established a robust monitoring system for the SHS program. An Operations Committee of IDCOL comprising IDCOL management and PO representatives

conducted monthly meetings to discuss the results and issues involved in the SHS program. The PO's financing applications include details of the SHS installations that are then integrated into the IDCOL database for selecting random samples for inspections and verifications by IDCOL field inspectors. In parallel, independent technical audits are undertaken on a regular basis. IDCOL regularly submitted minutes of the Operation Committee meetings, which highlighted issues and solutions related to the program, and Financial Monitoring reports reporting on the installation numbers.

The third objective, introduced in AF 2009, aimed to reduce peak demand through deployment of CFLs to replace incandescent bulbs. The indicator was the number of CFLs distributed to replace incandescent bulbs. Each household that received a CFL and returned an incandescent lamp was recorded, per CDM requirements. Post-installation surveys were planned in regular intervals, per CDM requirements.

The fourth objective, introduced into the RF in the AF 2009, proposed to reduce the system loss in taken-over areas through the renovation of distribution of lines[6]. The intermediate indicators to track this were the total kms of lines renovated and the total system loss reduction. Both of these indicators were tracked by the REB/PBS internal reporting system and reported regularly to the project.

M&E utilization: The data collected through project M&E had a strong impact on improving project implementation. In particular, in the case of the SHS, feedback from the field helped the project team and IDCOL incorporate new technical specifications and technologies, such as LED lights, to better serve lower-income households. Feedback from the project teams also proved crucial for the establishment of improved SHS testing facilities and improved service provision for POs. In the case of the CFLs, though there were some deficiencies in record-keeping and updating the computer database to meet the stringent CDM requirements, post-installation surveys helped to detect early lamp failure rates and prompted REB to take remedial measures, including withholding final payments to the supplier and claim replacement of CFLs.

2.4 Safeguard and Fiduciary Compliance

Safeguards: *The rating was Satisfactory until the April- May 2012 mission, during which it was downgraded to Moderately Satisfactory due to the lack of a national guideline on safe disposal of CFLs.*

Although the amount of mercury in a single CFL is miniscule (an average of 5 milligrams, or 1/100th of the amount of mercury used in a mercury fever thermometer), collectively they could have serious environmental impact if improperly disposed. Due to this, the GoB agreed to develop national guidelines for the safe disposal of CFLs. The lamps were supposed to have a long lamp life, by the end of which a national guideline would have been in place. However, the

[6] This was an output level indicator in the original project. AF2009 provided funding gap for the line rehabilitation component and made this an outcome indicator.

development of national guidelines was delayed, and the lamps started to fail early. Adoption of a national guideline has been made a condition before distribution of CFLs under the repeater RERED II can commence.

While implementing the grid-based electrification component, REB addressed the project-related environmental issues and also integrated Environmental Procedures and an Environmental Management Plans in REB operations beyond the scope of this project. A full-fledged Environment Monitoring Unit was not implemented, however.

The major potential environmental concern arising from SHSs is the improper disposal of the lead-acid storage battery used in SHS. If not properly disposed, the lead sulfate can contaminate the surrounding lands and water bodies. To mitigate these risks, IDCOL developed a policy guideline for the disposal of expired batteries and strengthened the buy-back mechanism by introducing incentives for households to return expired batteries to the approved POs rather than to informal smelters. IDCOL required all the battery manufacturers and the battery-recycling facilities to be accredited under ISO 14001-2004 (Environmental Management Standard) and OHSAS 18001:1999 (Occupational Health & Safety Management Systems). By June 2011, any new battery manufacturer willing to supply to the SHS program had to be compliant with ISO and OHSAS requirements. These efforts led all of the 13 battery manufacturers and all three recycling facilities in the country to be compliant with the ISO 14001:2004 and OHSAS 18001:2007 certifications.

Fiduciary Compliance

Financial Management: In December 2008, the financial management rating was downgraded from Satisfactory to Moderately Satisfactory for the first time. This was due to the failure of REB in appointing the auditor. The rating was revised to Satisfactory in the next Implementation Status and Results (ISR) in May 2009 when the auditor was in place and REB had taken corrective measures to remove the qualified observation from its Project Audit Report. In May 2010, the rating was again downgraded due to audit observations and continued to be Moderately Satisfactory till the close of the project. Progress was made in addressing the audit observations, and only three remained to be addressed in December 2012[7]. Satisfactory resolution of the observations that are within REB control has been made a condition for disbursement for the energy efficient lighting (CFL) component under RERED II (refer to section 2.5 for a description of RERED II)[8].

[7] The outstanding audit observations were related to project accounts of REB regarding the CFL component and involve loss of revenues due to non-collection of value added tax (VAT) from consultant payments, not depositing forfeited performance security amount in government accounts and poor quality of supplies of CFLs.

[8] Settling the observation related to poor quality CFLs supplied is beyond the control of REB; REB has claimed replacement of CFLs but the supplier is disputing the claim. It will take time to reach a settlement with the supplier.

IDCOL had completed computerization of its accounting systems to allow for automatic generation of Financial Monitoring Reports (FMRs). However, due to legacy issues of importing opening balance, FMRs under the project could not be generated from the fully automated system. FMRs under the RERED II project, however, will be from the computerized system without manual input, thereby eliminating the scope for manipulation and error.

Procurement: In December 2008, the procurement rating was downgraded from Satisfactory to Moderately Satisfactory for the first time. This downgrade was due to delays by REB in concluding several procurement packages. Since most of these packages were related to materials needed for constructing new lines and connecting new consumers, and the GoB had put a moratorium on new connections given the power supply shortage, it was decided that the fund would be reallocated to the IDCOL component to support renewable energy development. The rating was thus revised to Satisfactory in May 2009. In 2010 it was downgraded again, however, due to delays by REB in concluding the first-phase CFL procurement and several complaints of alleged corruption received during the procurement process. The rating at the close of the project remained Moderately Satisfactory. The second-phase procurement of CFLs was initiated in late 2010 under the project (before the post-installation survey results from the first phase were available), but due to various issues (including issues related to the submission of fraudulent performance guarantees by the winning bidder), the procurement could not be completed and the second phase was cancelled.

Procurement of the SHS was the responsibility of the POs, who were to follow established commercial practices. Being the financial intermediary, IDCOL set stringent quality standards, including a five-year warranty for batteries, and strongly enforced these quality standards. As a result of these strictly enforced quality assurance measures, customer satisfaction has been consistently high, and SHS warranty requirements are among the longest and most honored in the world, while SHS costs remain some of the lowest in the world.

2.5 Post-completion Operation/Next Phase

The successful implementation of the SHS component of RERED by IDCOL resulted in a repeater RERED II project that was approved by the IDA Board in September 2012. This US$155 million operation provides funding to IDCOL to continue to support the SHS and to scale-up renewable energy based mini-grids, solar irrigation pumps, etc. following the same implementation arrangement as that of SHS. Building on the success of the SHS program, IDCOL has also started an improved cookstoves program with support from RERED II. A commercial financing study, initiated under the RERED project (and will be continued under the RERED II project), is exploring the options for transitioning the SHS program towards full commercial financing. In addition to continued World Bank Project support for the IDCOL SHS program, other agencies, including KfW Development Bank, the Asian Development Bank, the United States Agency for International Development and the German Development Agency (GIZ), have adopted IDCOL's successful distribution model and have continued to offer co-financing.

The second-phase CFLs are supported under the RERED II project with strengthened quality control measures (refer to section 6 for more details).

The Bank is currently in the process of preparing the next phase of support to the REB/PBS program, which will rehabilitate the existing rural distribution network to further improve the system's technical efficiency and address institutional weaknesses in the REB and PBSs, incorporating lessons learned from the RERED project.

3. Assessment of Outcomes

3.1 Relevance of Objectives, Design and Implementation

The project objectives and design are still highly relevant to national priorities and the Bank assistance strategy. The project has made an important contribution in achieving the GOB's vision of universal access to electricity by the year 2021. However, the rural access rate is still only about 40%, and increasing access rates is one of the key priorities of the GoB and the Bank.

The public-private partnership model of IDCOL proved to be an effective way of delivering off-grid services. The Bank, through RERED II, and other donors in Bangladesh continue to support the installation of SHS, and the model's success is continually proven. Despite some of the challenges with the CFL components, experience shows that CFLs are an effective way to reduce peak electricity demand, and RERED II includes a CFL component, designed using important lessons learned from RERED.
The Project remains consistent with the Bank's Country Assistance Strategy (CAS) for FY11-14, which has a focus on increased infrastructure provision, access and efficiency (outcome 1.3 under CAS Pillar 1) and reduced environmental degradation and strengthened natural resources management (outcome 2.3 under CAS Pillar 2).

3.2 Achievement of Project Development Objectives and Global Environment Objectives

The achievement of the PDO is rated ***Satisfactory***. This rating is based on the successful completion of the outputs outlined in the PAD and the AFs and the project's significant achievement in providing access to electricity to raise levels of social and economic development in rural Bangladesh. The QAG assessment in 2010 also rated the 'likelihood of achieving overall Dos' as Satisfactory.

Provision of Access (roughly 80% of actual IDA expenditure):

The indicators that measured provision of access in rural areas were 1) expand access to electricity in rural areas of Bangladesh through financing of solar home systems and 2) expand renewable energy options for off-grid energy supply in rural areas and 3) New Grid-Based Connections for Electricity. At appraisal, the target for the distribution of SHS by IDCOL was 50,000, and the project budgetary allocation was only 8% for IDCOL SHS (11% including both REB and IDCOL SHS components). By 2009, by taking advantage of the falling costs of solar PV and by utilizing the un- utilized amount in the grid component, the actual number of systems supported under the original credit was 236,000. Two AFs increased the project target to 994,000 SHS, and by project close, the project had supported 1,231,720 SHS. Together with support from the Bank and other development partners, IDCOL achieved installation of a total of 1.88 million by December 2012, increasing the electricity access rate to

an additional 6% of the total population nationwide. REB's smaller allocation for SHSs with a fee-for-service model installed 12,000 SHS in households in rural areas. In addition, three of the four mini-grids were implemented by IDCOL. As of 2012, two were operational, reaching 158 commercial enterprises and 28 households. These renewable energy mini-grids were implemented as a pilot for proof of concept under RERED, and the lessons learned from these pilots were incorporated in the design of RERED II. The implementation of such projects will be expanded under RERED II. In parallel, between 2002 and 2009, REB made 656,802 new grid connections, against an original target of 700,000 (For reasons behind the short-fall, see section 2.2).

The project succeeded in showing that consumers were willing to pay for electricity infrastructure. Unlike grid electricity service, which is heavily subsidized, SHS users paid nearly the full cost of an SHS, as well as the full cost of replacement and repairs. A small subsidy and microfinance made the SHS affordable to even low-income households in rural areas. During the project, 99% of households purchased SHS on credit, paying between 12,489 BDT for a 20 Wp (watts peak) panel to 40,911 BDT for an 85 Wp panel. The program was also able to decrease the subsidy of the SHS over time. At project inception in 2002, the subsidy for SHS was US$90 on the selling price of the SHS. As of AF 2009, the subsidy had been reduced to US$50 per household, and by 2011, the subsidy was only US$28 per household. By the end of the project, the subsidy had been further reduced to US$25. It is expected that the need for a subsidy will continue to decrease as the remaining market barriers are overcome, competition is enhanced in the market, and the SHSs become affordable enough to reach even more remote areas and poorer households. (See Annex 3 for detailed schedule of SHS subsidy reduction.)

The impact evaluation surveys of REB found that rural electrification increased household incomes by 21% and decreased household expenditures on lighting by 11%, while increasing households' access to appliances, like electric fans, television sets, refrigerators, cassette players, irons and mobile phone chargers[9]. Availability of domestic lighting in households increased the study time of both boys and girls significantly: the REB 2010 impact analysis showed study time in the evening increased by 21 minutes per day for boys and 12 minutes per day for girls between 2005 and 2010. The REB survey also showed that electrified households save money on kerosene, by using two liters less kerosene per month than un-electrified households, translating to an average monthly savings of roughly 136 BDT (US$1.70). Users of SHS use 3.68 fewer liters of kerosene per month than households without SHS, saving an average of 250 BDT (US$3.15). Both grid and SHS users are able to save money by charging mobile phones from the SHS.

Availability of rural electricity also increased women's empowerment. The 2012 SHS impact study found that SHS homes had statistically better empowerment outcomes, specifically general decision making and economic decision making, than households without SHSs. It also found that women had increased mobility and increased feelings of security due to lighting. In addition,

[9] In 2010 REB found that households with new grid connection under the project households began using electric fans, television sets, refrigerators, cassette players, irons and mobile phone charging. With SHS, half of all SHS users have a television.

the REB 2010 impact analysis also showed women's mobility had increased, and women reported feeling more secure when traveling to health complexes, clinics, schools, learning centers, NGOs and other places.

Grid electricity, as well as SHS, was used extensively for watching television, leading to better access to information, as well as providing entertainment. The greater availability of information had positive impacts on households. The 2010 REB study showed women were able to get more information about home and abroad through watching television, and subsequently were more aware of reproductive health, children's health, family planning and other social (early marriage, dowry) and environmental (forestry) issues. In SHS households, although there was no significant difference in health outcomes between the members of the SHS households and that of the non-SHS households, having a TV within the SHS households seems to make a significant difference in health outcomes for women. Among the SHS households, girls from those with a TV set were about four percentage points less likely to suffer from respiratory and gastro-intestinal diseases than their counterparts from SHS households without a TV set. The study also found that contraceptive prevalence was higher and recent fertility was lower among married women in households with SHS that use a television compared to household with no televisions. The REB 2010 study also suggested that access to reliable mobile phone charging facilitates stronger communication/information channels, allowing women to communicate with doctors in the case of emergency.

Overall, achievement of this objective is rated Highly Satisfactory based on the number of households electrified (through SHS and grid connection) and the evident benefits achieved from electrification of the households.

Demand Side Efficiency (roughly 3% of actual IDA expenditure):
More efficient energy consumption through installation of compact fluorescent lamps. Under this component, 10.47 million CFLs were distributed across Bangladesh in a large-scale nationwide program. The one-day distribution and the awareness campaign associated with the program helped to increase public awareness about the energy saving benefits of CFLs. At the beginning of the program in 2009, there were only two CFL manufacturers in Bangladesh manufacturing about 9.6 million CFLs in the country. By 2012, there were 19 CFL manufacturers, and over 30.64 million CFL bulbs were being manufactured in the country. This is clearly an indication of increased customer demand (particularly in the urban areas, where, before the project, customers had affordability but not awareness). The increased demand could be partly attributed to the publicity surrounding the large-scale CFL deployment supported by the project.

However, early lamp failure rates meant that the reduction in peak demand through introduction of CFLs was not sustained. Achievement of this objective is rated Unsatisfactory.

Supply-Side Efficiency (Roughly 17% of actual IDA expenditure)
Reduction of system loss of REB taken over pockets from BPDB through renovation. From 2002 to 2009, REB successfully took over and rehabilitated 11,295 kms of lines, reducing system losses from an overall average of 59.94% in 31 PBS in 2002 to 13.7% in 2009, compared to a 20% overall target. In parallel to this work, the country was struggling with

unmet demand and large-scale load-shedding. Reducing system-wide losses to 13.7% created large gains in available energy and provided more reliable service for the PBSs' consumers.

The achievement of rehabilitation of 11,295 kms of line fell slightly short against the original target of 12,000 km target due to two factors. First, because of court injunctions, 615 km of line could not be transferred. Second, some lines listed in BPDB books did not actually exist on the ground.

Achieving this objective is rated Satisfactory.

Technical Assistance (1% of actual project expenditure): Under the project, both REB and IDCOL received technical assistance to help build capacity and implement project components. REB built IT infrastructure in the PBSs and streamlined environment management practices and procedures. With project TA, REB developed a comprehensive monitoring and evaluation framework and a methodology for evaluating socio-economic and gender related impacts on electrification projects and used this to measure the impacts under the RERED project.

At the time of project closing, IDCOL had achieved significant capacity building through project TA to be able to manage successfully the growing renewable energy program. Some technical assistance activities introduced during AF 2011 (establishment of SHS testing facility and commercial financing study) were delayed and are being implemented under RERED II.

Achieving this objective is rated Satisfactory.

Global Environmental Objective:
The global environment objective to reduce carbon emissions was achieved, with a total reduction of more than 1.33 million tons until project close as the IDCOL off–grid component displaced over 300,000 tons per year of carbon dioxide (CO2) emissions over a 15-year life by replacing kerosene with solar electricity, providing an indirect global benefit to the globe through the reduction of GHG emissions. The GHG emissions reduction of the project until project close (including IDCOL SHSs, system expansion and system loss reduction) was approximately 1.33 million tons, while the total GHG emissions reduction including the 15 year life of the IDCOL SHS will be more than 4.14 million tons by 2027.

Achieving this objective is rated Satisfactory.

3.3 Efficiency

The efficiency of the project in economic and financial terms is rated Satisfactory.

SHS : Households using SHS benefited not only from better lighting services from electric lighting relative to lighting from kerosene but also from cost-savings stemming from smaller expenditures on kerosene and battery charging. To add to the project benefits, the CDM validation for the project has been completed and the agreed price is $ 11.65/ ton has been used in the analysis. The estimated overall financial internal rate of return (IRR) is 26%, lower than the AF 2011 estimate of 34%. The main driver of the difference was the increase in costs due to

an increase in duties and operations and maintenance costs. For CDM benefits the economic value of $30[10]/ ton has been used. The estimated overall economic internal rate of return (EIRR) is 42%, and the estimated net present value (NPV) is US$118 million. There was no EIRR calculation done at the appraisal stage for this component.

Grid Expansion & System Loss reduction Component: The expansion of grid connections leads to benefits like safety, better lighting, improved education and better indoor air quality. It is difficult to define these benefits in monetary terms. To calculate the financial viability of the investment, revenue from grid expansion is calculated based on the average tariff. The tariff rate is administered and subsidized, and over the years the increase in the bulk supply tariff (BST) was not passed on to the consumers in time, leading to a low FIRR (5.36%) to the investment. Even at the appraisal stage, the estimated FIRR was low (5%). The reasons highlighted were (i) administered tariffs that are not fully cost reflective (ii) the high capital cost of rural electrification; and (iii) the slow pick-up of loads in rural areas and the low intensity of electricity use. For the economic analysis, three revenue streams have been considered, revenue from sale of power, the incremental revenue from system loss reduction which is valued at the cost of alternative generation (diesel-based power plants, new private generation, and island generation for grid quality) and revenue from avoidance of GHG emissions from displaced kerosene. The EIRR of the investment with carbon benefit is 27% and without carbon benefits is 23.6%. The EIRR of the grid expansion at the time of appraisal was 16%.

	Project preparation		**ICR Analysis**	
	EIRR	FIRR	EIRR	FIRR
REB (Expansion & System Loss Reduction	16%	5%	27%	5.36%
SHS IDCOL				
PAD	N.A	12%	42%	26%
AF 2009	28%	34%		
AF 2011	44%	34%		

CFL component: The analysis at the time of preparation took into account the energy savings expected from the replacement of incandescent lamps with CFLs. This energy savings was quantified using the bulk supply tariff (for the financial analysis) and the avoided generation costs (for economic analysis). The lifetime savings of energy from using CFLs was the only benefit considered for the purpose of this analysis. The cost of this component was the cost of procurement of the energy efficient and high-quality CFLs, the cost of CFL distribution, the cost of implementing consumer awareness programs, and the cost of monitoring and evaluation plans. The FIRR and EIRR of the component were calculated to be 44% and 52%, respectively. Including the CDM benefits, the FIRR and EIRR of the program were calculated as 52% and 60% respectively. During implementation these returns were never realized due to the poor quality of the CFLs and high leakage factor, which led to negative cash flows and negative NPV.

[10] Source: Stern Review on the Economics of Climate Change

Annex 3 provides more details on economic and financial analysis of all the components.

3.4 Justification of Overall Outcome and Global Environment Outcome Rating

Rating: Satisfactory

The RERED PDOs and GEOs have been achieved. The objective of increasing access to electricity in rural areas in Bangladesh has been exceeded by a substantial margin. The SHS program is currently installing over 60,000 systems per month, making it the fastest-growing SHS program in the world. The objectives of project are still highly relevant to the GoB and to the World Bank CAS. On the energy-efficiency front, the supply-side efficiency component of system loss reduction also exceeded its targets; however, the intervention on CFLs was not successful. This intervention on large-scale CFL deployment was the first of its kind in Bangladesh and provided many valuable lessons for future engagement.

Based on the actual expenditure, it can be argued that the component on access was the most dominant (nearly 80 % of expenditures), with SHS accounting for the majority of the expenditures. Therefore, based on the overall breakthrough performance, the Project should be rated "Highly Satisfactory". However, the smaller component of the Project – CFL interventions constituting only 3% of the total project expenditure – was not as successful. So, to remain critical and cognizant of the shortcomings in performance of the smaller project components, the Project is finally rated "Satisfactory". This is to avoid downplaying the importance of any component that contributes to the overall project objective.

3.5 Overarching Themes, Other Outcomes and Impacts

(a) Poverty Impacts, Gender Aspects, and Social Development

A 2004 ESMAP study "Integrating Gender in Energy Provision Case Study of Bangladesh" recognized the REB's requirement for all of the PBSs to employ only women in their billing departments. In the power industry, traditionally dominated by men, employing exclusively women in the PBS billing departments provides a unique employment opportunity for rural women. As PBS billing departments become computerized, women receive training and increase their skillset.

A 2011 ESMAP publication "Integrating Gender Considerations into Operations" recognized gender best-practice projects from around the world and highlighted the RERED project's gender-informed design, noting that it included analysis of the likely impact on women's security, income generation opportunities and knowledge via access to modern media (radio, television). The report also highlighted that the project includes indicators for measuring outcomes for women and girls, such as the number of hours that girls study at night, access to news by women, improved reproductive health and increased HIV/AIDS information and awareness. This report is used to provide best practice in gender mainstreaming and gender informed design, and RERED is held as a model for other operations to follow.

REB 2005 and 2010 impact evaluations and SHS 2012 impact evaluation, discussed in section 3.2 and Annex 5, showed significant gender impacts.

(b) Job creation

IDCOL and each of the POs have created employment for rural communities through the establishment of the program. As of November, 2012 IDCOL had collectively created about 30,000 direct jobs and 50,000 indirect jobs through the program. As an example, one of the POs, Rural Services Foundation, started in 2002 with one employee and a small office in Dhaka. In 2012, it employed over 300 people and had 75 offices across Bangladesh. It employs people with low levels of education in rural areas of Bangladesh and provides on-the-job training to support to households purchasing SHS. Grameen Shakti and a number of other POs are providing training to village women on assembling some SHS components; these women are then becoming entrepreneurs, running their own technology centers, assembling SHSs, and providing maintenance services. Grameen Shakti, the largest PO, with a market share of more than 40%, estimates that they have created 5,000 direct jobs through their SHS program.

(c) Other Unintended Outcomes and Impacts (positive or negative)

Positive:
Battery recycling: ISO standards. The project helped to increase the standards in the national battery industry by requiring adoption of ISO 14001:2004 and OHSAS 18001:2007 standards for the battery suppliers to the SHS program. Eventually, at the end of the project, all 13 battery manufacturers and all 3 recycling facilities in the country became ISO 14001 and OHSAS 18001 compliant.

SHS industry: The large demand for SHSs in Bangladesh catalyzed a new industry of SHS that now manufactures all the major components of SHS. The project has 78 suppliers of solar PV and 13 battery manufacturers, all of which are located in Bangladesh. Within Bangladesh alone, the project has created over 6,000 jobs for people working in the SHS manufacturing industry.

Local CFL manufacturing industry: The CFL component created public awareness about the benefits of CFLs, resulting in increased CFL demand. By project closing, 17 new local manufacturers had started CFL production facilities in the country, tripling the local manufacturing capacity.

Strengthened and Diversified MFIs' Services: The project also proved that MFIs in Bangladesh could successfully diversify their services to include access to infrastructure services by coupling micro-lending with leveraged donor resources. This has served as a model for other low-income countries to demonstrate that donors need not finance all energy infrastructures and that users are willing to pay for energy services, given the right payment plan.

3.6 Summary of Findings of Beneficiary Survey and/or Stakeholder Workshops

Two impact evaluations were carried out related to the REB grid components, one in 2005 and the other in 2010, and a final impact evaluation was carried out for the IDCOL SHS component in 2012. The REB study found positive impacts of grid electrification on household incomes, use of technology in the home, women's empowerment and study time for boys and girls. The SHS impact evaluation found a positive and significant impact on study time and a correlation between those households with a TV and health outcomes and impact on women's mobility. A summary of these findings can be found in Annex 6.

4. Assessment of Risk to Development Outcome and Global Environment Outcome

Rating: Moderate

The achievements under the SHS system are expected to be sustainable. To ensure sustainability, RERED II is aimed at making the SHS business fully commercial, with the POs eventually borrowing funds at market terms from commercial sources by the end of the implementation of the project[11]. With this goal in mind, IDCOL has been gradually reducing the refinancing rate, from 80% to 70% over the course of RERED I. During the implementation of the RERED II, IDCOL will extend refinancing for only 60% of the micro-finance of the larger POs (POs that have a credit outstanding amount of more than BDT 250 million). The capital buy-down grant has also been reduced substantially – from $90 per SHS in 2002 to $25 per 30 Wp and smaller SHS. IDCOL has set a target to reach another 4 million SHS by 2016, with support from the Bank and other development partners.

IDCOL has established a separate renewable energy department and is in the process of hiring additional people to keep pace with the growing renewable energy program it is managing.

As discussed earlier, even though the initial phase of the CFL component was not successful, the project managed to create consumer awareness and develop the market for CFLs, especially in the urban areas. Building on the lessons learned, the second phase of the CFL component is being implemented under RERED II. Since CFLs have already gained popularity in the urban areas, under RERED II, a reduced number of CFLs will be distributed in rural areas only.

While the physical targets under the grid component were largely achieved, generation constraints are a risk for the new connections provided under the project. The GoB has taken measures to address generation constraints, which included awarding contracts for large scale IPPs, and also adding short-term power plants (albeit at higher cost). Significant loss reductions were achieved under the project, but to sustain this loss level, the utility needs to maintain the current infrastructure and undertake regular maintenance in the future. This may not be possible if the tariff revisions do not keep pace with cost of the supply of power. Recognizing the

[11] A commercial financing study initiated under RERED project is currently on-going under RERED II.

challenges that the REB/PBS program was facing, an organizational effectiveness study was initiated in 2009 with Bank support. As a follow-up to the study, extensive stakeholder consultations were held, and a reform action plan has been developed by REB that involves i) strengthening the REB Board with professionals; ii) establishing zonal offices of REB to better serve the expanding program; and iii) more delegation of authority to the PBSs. Details are in Annex 13. Even though the Bank's next phase of support to the REB/PBS program is expected to include support for implementation of the action plan, the grid component exhibits a potential risk to sustainability.

5. Assessment of Bank and Borrower Performance

5.1 Bank Performance

(a) Bank Performance in Ensuring Quality at Entry

Rating: Satisfactory

The project design incorporated lessons from the Bank's previous three engagements with REB, as well as lessons learned from Bank's engagements in renewable energy in other countries. The implementation arrangements put in place were on the whole appropriate to the context at appraisal. These implementation arrangements were strengthened during AF 2009 and AF 2011 to reflect the challenges faced during the implementation phase and from the new component. The institutional arrangements with the two implementing agency were clearly defined. The only shortcoming was that the team was unable to foresee and thus mitigate the capacity constraint that REB faced while delivering the off- grid energy services. Also in retrospect, keeping in mind the quality issues, it is felt that the national guidelines for CFL disposal should have been in place before the distribution of CFL. The risk assessment was satisfactory. The economic and financial analysis was based on detailed and reasonable assumptions. Overall the Bank performance in ensuring quality at entry is rated Satisfactory.

(b) Quality of Supervision

Rating: Satisfactory

This project demonstrates Bank's ability to be a "solutions Bank". The project started with various interventions to meet the PDO. The Bank and the project team recognized the constraints faced and took steps to mitigate the difficulties, such as those arising from the handover of lines and deployment of CFLs. Over time, as some interventions, such as the installation of SHS, were found to be more effective, the team built upon the successful interventions. The Bank team was responsive on the need for flexibility to address needed changes, as seen in the additional financings, restructuring and extensions. During supervision, the Bank team supported the borrower in overcoming difficulties, such as the delay in handing over lines from BPDB, and addressing concerns of the POs based on their experience in the field.

The focus of the Bank's team on quality assurance is evident from the monitoring and quality assurance framework agreed with IDCOL and the timely technical advice and support extended

to REB when the quality issues were faced in the CFL component. The lessons from the first phase of the CFL distribution were captured and incorporated in the planning of the CFL deployment component under RERED II. The Bank team was particularly responsive on the need for the flexibility to address needed changes, such as additional financing, restructuring and extensions.

At the same time however, the ICR team feels that the project development objectives could have been revised two years earlier – in 2009 rather than in 2011. At the time of the first AF in 2009, once the Bank team realized that there were no new activities under the grid component and the focus of the project was on the off–grid component and efficiency improvements, the PDOs and the results framework should have been revised. The timing of cancellation of funds was also slightly delayed. Because of the rapidly increasing installation rate of the SHSs, the cancellation amount for the SHS component could not be accurately established until late 2012. The CFL cancellation could have been effected earlier, but the Bank team waited to process both the SHS and CFL cancellations together in one restructuring paper. This delayed cancellation had no major negative impact, however, as IDA remained in the country, and it was ultimately done before project close. Despite these minor shortcomings, the Bank's sustained efforts in delivering the project development objective and ensuring quality during implementation are commendable. The overall the Bank performance in ensuring quality at supervision is rated Satisfactory.

(c) Justification of Rating for Overall Bank Performance

Rating: Satisfactory

This rating reflects the Bank team's good performance at the design and implementation phases. Both IDCOL and REB widely acknowledged the Bank's support and collaboration during supervision as a strong contributor. In IDCOL's own ICR, they mention the Bank's support as crucial to the success of the SHS project. REB noted that the Bank's performance exceeded its expectations and made a significant contribution to the rationalization of lines.

5.2 Borrower Performance

(a) Government Performance

Rating: Satisfactory

The GoB's commitment to and ownership of the project remained strong during the course of the project. The project was delayed initially, as one of the conditions for effectiveness (handing over of lines between BPDB and REB) was not met. GoB commitment was evident from the support that it extended to resolve these issues. Government support on the off-grid component has remained consistently high.

(b) Implementing Agency or Agencies Performance

Rating: Satisfactory

Infrastructure Development Company Limited (IDCOL) -Highly Satisfactory

IDCOL has played a pivotal role in the success of the SHS program. It had full ownership of the project and proactively developed solutions to arising problems, with input and support from the World Bank and the GoB as needed. It has been able to learn from experiences on the field and was flexible in making the required adjustments during the implementation phase. IDCOL has had the institutional flexibility to adapt to changes, including increasing its staff strength to meet the growing demand of SHS, and as a company, IDCOL is able to offer a market-based incentive package to its management and staff. It had a well-established monitoring and quality assurance framework to inspect and verify that the systems are installed in accordance with the approved technical standards. The performance of the implementation agency was exceptional and is rated Highly Satisfactory.

Rural Electrification Board (REB) – *Moderately Satisfactory*
REB successfully implemented the grid component of the project, but the institutional capacity of REB has deteriorated over time. This was evident by the number of audit observations by the GoB auditor on REB project accounts and delays faced in the procurement in components implemented by REB. The REB's performance in SHS was less than satisfactory. Since this was not the core business of REB, it found itself institutionally challenged to meet the targeted installation and maintain the SHS installed.

(c) Justification of Rating for Overall Borrower Performance

Rating: Satisfactory

The overall borrowers' performance is rated satisfactory. This rating reflects the positive performance of IDCOL and REB in implementing the project with a strong focus on the outcomes of the project, timely and effective actions in responding to project implementation issues (more so for IDCOL than for REB) and in doing so, being flexible to improvements guided by ongoing M&E results.

6. Lessons Learned *(both project-specific and of wide general application)*

Overall Lessons Learned:

A. Lessons on Off-Grid Component:

Culture of microfinance leads to greater trust and larger up-take: The well-established outreach of MFIs and NGOs in Bangladesh contributed to large-scale reach and greater uptake of SHSs. This was one of the major factors contributing to the success of the IDCOL model in comparison to the REB model. The institutional set-up and historical presence of many POs allowed for cost-effective and efficient outreach, while the familiarity of rural consumers with MFIs and NGOs lead to a greater amount of trust of the project POs and resulted in larger consumer up-take of SHS. The establishment of a Public Private Partnership (PPP), such as that

created under the project, sets a best practice example for other programs worldwide of how access can successfully be achieved through a cost-share model.

Poor households are willing to pay for energy services: By employing a microfinance model, the RERED project demonstrated that even low-income rural households were willing and able to pay for SHSs in order to have access to improved lighting services. Providing only a minimal subsidy per SHS and leveraging MFI services for regularized payment plans allowed poor rural households to purchase critical infrastructure services.

Consumer buy-back schemes reduce the perception of risk and increase uptake of SHS: At the beginning of the project, there were concerns over up-take among rural households, particularly due to the risk that the SHSs might become unnecessary if the households received grid electrification. In order to reduce the household's purchase risk, the POs offered to buy back any SHS in the case the grid arrived to the community. In most places, even where the grid did reach, consumers chose not to sell back their SHS. POs felt that this increased the initial uptake of SHS.

It is crucial to establish quality assurance of product performance at the beginning of a project, and quality monitoring and enforcement among POs is essential: The need for quality assurance for SHS was determined early in the RERED project and led IDCOL to adopt quality assurance mechanisms to ensure product performance. A testing lab should be established soon after the project begins to monitor quality and do random spot checks to ensure quality products throughout. In addition, it is critical that the quality monitoring does not stop at design and is enforced throughout the project. In the case of IDCOL, constant enforcement of technical standards and performance on the POs was critical to maintaining high-quality systems. RERED II has considered this in design, and under RERED II, a testing laboratory will be established and used to monitor quality at entry and to undertake random testing to ensure quality is maintained.

Selling systems on credit can be important for system maintenance: In addition to the traditional benefits of selling on credit, such as greater affordability for consumers, payment collection also offers another benefit: after-sales service. IDCOL has found that consumers that do not have working systems are less likely to pay, and when POs have to go to the households to collect payments, they are able to provide after-sales and maintenance service at that time. Employing financing systems in SHS programs may actually help to increase the maintenance and upkeep of the systems.

Flexibility to adapt to the changing market needs is crucial to the success of a project: As the project evolves, technology changes will occur – in the case of RERED, technology advancements reduced the cost and increased the efficiency of SHS, like introduction of LED bulbs helped to reduce costs of SHS. Project Technical Standards Committees should have the flexibility to update the technical standards to permit the use of improved and new components.

B. Lessons on Grid component:

Gender requirements, specifically in utility billing departments, can amplify project's gender effects: The REB / PBS model of employing all-female billing departments engaged women in the power sector, which is traditionally dominated by men. Providing training and PBS jobs to

women helped local women to build applicable skill sets, provided employment and helped to build the capacity of each of the PBSs.

Creative incentive schemes can increase collection efficiency and improve system performance: A system loss reduction program monitored by a dedicated task force was set up to increase PBS collection efficiency within a determined timeframe and was rewarded. Although many PBSs fell short of the determined targets, some did meet the targets, and others still improved collection efficiency substantially. When working with cooperative-based distribution systems, similar to PBSs, clear and established incentives can help achieve target performance.

Cost-reflective tariff are essential for the investments to maximize benefits: The improvement in operational efficiency in the PBS, i.e. system loss reduction, was not accompanied by commensurate tariff increase, which led to a low financial return on the investment.

C. Lessons from CFL component:

Stricter qualifications criteria to attract genuine bidders and enhance product testing: The experience of the first phase of the CFL component highlighted the need for testing before shipment and stronger eligibility criteria at the time of procurement to ensure the supply of high-quality CFLs. A few countries have now introduced a pre – qualification stage in which the manufacturing facility and product quality are verified by an independent party, and only the vendors that meet the eligibility conditions are allowed to submit their bids. There is also a need for in-country testing for CFL bulbs. Having testing centers will allow manufacturers to compare products and will allow products to be tested against the specific grid conditions in Bangladesh.

Monitoring of the system and record keeping is necessary to ensure actual installation and replacement: The distribution of CFLs under the ELIB program was done in two single days across hundreds of distribution centers, which proved to be cumbersome in complying with the stringent CDM documentation requirements across the centers. Incorporating this lesson learned, RERED II will incorporate door-to-door distribution for the second phase of the program that will ensure better control over distribution and documentation.

Guidelines for safe disposal recycling of CFLs should be established prior to distribution of CFLs: The first-phase CFLs distributed under the technical specifications of the project were supposed to last for 10,000 hours, giving adequate time for national guidelines to be in place before the distributed CFLs were to be disposed of and recycled. However, the CFLs started to fail much earlier than anticipated, before the guidelines were in place. Resulting improper disposal of these CFLs led to health concerns. Therefore, it is crucial to put in place national guidelines on safe disposal of CFLs prior to distribution of CFLs.

7. Comments on Issues Raised by Borrower/Implementing Agencies/Partners

(a) Borrower/implementing agencies

The evaluation of the project by IDCOL and REB (as reflected in the completion report prepared by them) is consistent with that of the Bank. The ICRs prepared by IDCOL and REB are

included in Annex-7. Comments were also received from IDCOL and REB. These comments have been appropriately incorporated in the final ICR.

(b) Co-financiers
N/A

(c) Other partners and stakeholders *(e.g. NGOs/private sector/civil society)*
N/A

Annex 1. Project Costs and Financing

(a) Project Cost by Component (in USD Million equivalent)

Rural Electrification and Renewable Energy Development - P071794 & Renewable Energy Development - P074040						
Components	Appraisal estimate (USD millions)				Actual/ Latest estimate (USD millions)	Percentage of appraisal
	2002	2009	2011	Total		
GRID SYSTEM INTENSIFICATION, EXPANSION AND REHABILITATION INCLUDING TA	**264.63**	**19**		**283.63**	306.28	108%
REB SOLAR PROGRAM AND TA	**8.78**			**8.78**	4.53	51.5%
IDCOL RENEWABLE ENERGY COMPONENT AND TA	**24.89**	**196.4**	**252.5**	**473.49**	433.86	92%
REB CFL Program		**15**		**15**	14.18	95%
Total Baseline Cost	**298.3**	**230.4**	**252.5**	**780.9**	758.85	97%
Physical Contingencies	0.00	0.00	0.00	0.00		
Price Contingencies	0.00	0.00	0.00	0.00		
Total Project Costs	**298.3**	**230.4**	**252.5**	**780.9**	758.85	
PPF	0.00	0.00	0.00	0.00		
Front-end fee IBRD	0.00	0.00	0.00	0.00		
Total Financing Required	**298.3**	**230.4**	**252.5**	**780.9**		

(b) Financing

Rural Electrification and Renewable Energy Development - P071794 & Renewable Energy Development - P074040							
Source of Funds	**Type of Financing**	**Appraisal Estimate (USD millions)**				**Actual/ Latest Estimate (USD millions)**	**Percentage of Appraisal**
		2002	2009	2011	Total		
Borrower		92.34	4		96.34	136.28	141%
Local Communities		6.78	87.3	73	167.08	137.12	82%
International Development Association (IDA)		190.98	130	172	492.98	462.86	94%
Global Environment Facility		8.2			8.2	8.19	100%
GPOBA			8.3	6.7	15	14.15	94%

Annex 2. Outputs by Component

Table: Component-wise Loan / Grant Utilization

Component	Estimated Utilization (US$M)	Actual Utilization (US$ M)
A1: Rural Electrification System Expansion, Intensification and Rehabilitation	171.68	170.94
A2: REB Technical Assistance, B2: REB Solar Technical Assistance, C2: IDCOL Technical Assistance	2.98	2.46
B1: REB Solar Program	4.63	0.045
B2: REB Solar Technical Assistance	0.37	Combined with other TA
C1: IDCOL Renewable Energy Sub-loans	11.44	54.44
C2: IDCOL Technical Assistance		Combined with other TA
Additional Financing 2009:		
Component 1: Scale up the renewable energy component	100	80.69
Component 2: Energy efficiency and demand side management to mitigate supply shortages and improve the availability of electricity in the rural areas (Introduce CFLs)	15	14.18
Component 3: Meet the financing gap of the REB component to renovate distribution lines taken over from BPDB	15	8.88
Additional Financing 2011		
Component 1: Scale up the renewable energy component	166	107.77
Component 2: Technical Assistance	6	.89

Component A1: Rural Electrification System Expansion, Intensification and Rehabilitation: When the REB project ended in 2009, this component had achieved the rehabilitation of 11,295 kms of taken-over lines, falling 705kms short of the 12,000 target due to a) legal issues with BPDB refusing to turn over some kms of lines, b) discrepancies between the number of lines that existed in BPDB maps and those that exist on the ground and c) the refusal of some consumers to allow the handover of lines from BPDB to the PBSs. 169 BPDB/DESA feeders with high losses (59.94%) were taken over, and the project sought to reduce the loss of all 169 of these feeders to the optimal level, and thereby reduce overall losses. In 2009, the project had brought down the system loss of 162 feeders to the optimal level, and reduced overall system loss of all lines to 13.70%. The losses in other 7 feeders were not reduced because they were linked to the 705km of lines that could not be taken over, due to above reasons.

Output	Target	Achieved
Rehabilitation of lines	12,000	11,295
Construction and augmentation of substations	Construction of 7 new substations and augmentation of 23 taken over sub-stations	Construction of 7 new substations and augmentation of 23 taken over sub-stations
Reduce loss levels of high loss feeders to optimal levels	169 BPDB/DESA feeders with high losses (59.94%) were taken over by PBSs, objective to reduce loss of 169 feeders to optimal level	System loss of 162 feeders brought down to optimal levels. In 2008, system loss of all lines at 13.70%

Component 2: REB Technical Assistance: The TA component proposed to facilitate the institutional development of TA of REB and PBSs through a) installation of internal communications system in REB units and PBSs b) assessment and expansion of GIS mapping system for REB and PBSs c) provide training in technology and management systems to REB and PBSs and d) develop customized operational and financial software. In addition, this component also proposed to establish an Environmental Compliance Unit in REB to enable REB and the PBSs to carry our Environmental Assessments and a Socio-Economic Evaluation and Monitoring Cell to assist REB measure the impacts of electrification. It also included TA for REB and PBSs to develop load promotion campaigns.

- ***Institutional Development:*** By 2009, REB completed the institutional development through LAN connections in headquarters and 39 PBSs, the expansion of a GIS mapping system and distribution planning to 18 PBSs, trainings and development of a web-based online Load Shedding Information (LSI).

- ***Environmental Compliance Unit:*** REB established an Environment Monitoring Cell (EMC) and trained REB and PBS staff to undertake the necessary environmental impact assessments (EIA) and management plans (EMP).

- ***Socio-Economic Evaluation and Monitoring Cell:*** In 2005 and 2010 REB developed a comprehensive monitoring and evaluation framework and methodology for evaluating socio-economic and gender related impacts on electrification projects, and adapted this to measure the impacts under the RERED project.

Ultimately REB and PBSs did not need to develop load promotion campaigns. While demand was a concern during the project preparation, during the first several years of the project demand grew sharply, and there was no need for load promotion.

Component 3: REB Solar Program: Under the REB SHS program, 11,796 SHS systems were installed. By the close of the REB project in 2008, the IDCOL model of solar provision through POs had been widely successful and achieved such an uptake that the program shifted solar focus away from the REB model to IDCOL one.

Component 4: REB Solar Technical Assistance. To support the REB Solar Program, this component was designed to provide TA to REB for a) market development and capacity building for PBSs, helping them to market, sell and service SHSs b) development of a quality assurance

program to establish and monitoring technical standards for SHS components and systems and c) monitoring of the SHS program.

Component 5: IDCOL Renewable Energy Sub-loans This component aimed to provide SHS to 50,000 households through SHS through a micro-finance-based, direct sales program. At the time of the first AF in 2009, IDCOL had far exceeded this target, having achieved 236,000 SHS across the country.

Component 6: IDCOL Technical Assistance. This component was designed to support IDCOL's internal capacity and broaden its scope of activities by a) supporting technology promotion and market development activities b) building administration capacity with a focus on fiduciary and safeguard compliance c) increasing monitoring and evaluation capacity and activities and c) supporting renewable energy development of wind, hydro and biomass.

At the time of project closing, IDCOL had achieved a great deal in technical assistance, and a plan to carry out the remaining tasks under RERED II. Initiatives to design a battery recycling plant had been done in-house, and an audit under RERED II will assess its efficacy. Monitoring and evaluation activities were undertaken through a sector-wide comprehensive SHS study undertaken in 2012 and completed in early 2013. IDCOL also financed a solar mini-grid, six solar irrigation pumps, two biomass based power projects and one biogas based power project.

In 2009, an AF was approved for:

Component 1 - Scale up the renewable energy component. IDCOL aimed to provide an additional 300,000 households with SHS and expand other renewable energy projects in solar, biomass, and biogas. By June, 2011, at the time of the second additional financing, there were 336,000 SHS installed, nearly exhausting the first additional financing.

Component 2 - Introduce a new component on energy efficiency and demand side management to mitigate supply shortages and improve the availability of electricity in the rural areas. The target was to install 10 million high quality CFLs. The target was achieved through the distribution of 10 million CFL bulbs in two separate distribution periods: June, 2010 they distributed roughly 5.5 million through a large day nation-wide awareness campaign. In October, 2010, they distributed the remaining 5 million over a number of days. The total number of CFLs included in the CDM inventory maintained by IDCOL is 10,475,235. However, due to procurement issues discussed in section 2.4, Safeguard and Fiduciary Compliance, the procured bulbs did not last 10,000 hours, and while the distribution targets were met, the component fell short of achieving all possible results

Component 3 - Meet the financing gap of the REB component to renovate distribution lines taken over from BPDB. The additional financing provided REB the capital to continue rehabilitating taken over lines. This financing gap was necessary due to fluctuations in exchange rates.

In 2011 there was another additional financing package requested for the scale up of the SHS project component and additional technical assistance to IDCOL for the implementation of this project. The two components supported by the 2011 additional financing are:

Component 1: Scale up the renewable energy component Aimed to distribute an additional 630,000 SHS and several additional mini-grids. The target for the SHS under the second additional financing was met by project close in December, 2012 with a total of 1,231,720 SHS installed under the project. Out of the three mini-grids, one was not functional by project closing. For the mini-grid that was not functioning, there were a number of reasons, including introduction of energy-saving CFLs, and lag time between baseline assessment and installation, that led to an oversized mini-grid which was not financially viable to operate. Making sure the baseline assessments were relevant to project design was a valuable lesson taken into consideration in the development of RERED II.

Component 2: Technical assistance This component aimed to increase technical assistance specifically for a) Quality Assurance of SHS though PV and SHS lab and field testing / inspection, support to Technical Standard Committee for quality improvement, and collection efficiency inspections b) training and consumer outreach and environmental improvement through battery and CFL recycling support At the time of project closing training and outreach was achieved, and the international consultant completed technician accreditation and conducted training of trainers. Additional trainings will be conducted under RERED II. The quality assurance work and laboratory design were underway and additional activities will continue under RERED II to design test protocols and procurement equipment for the testing facility.

Annex 3. Economic and Financial Analysis:

A. Off – grid component : Solar Home Systems

The analysis in the 2002 PAD was based on simple assumptions. The first and second AFs refined the analysis with field data collected during implementation. The analysis in the PAD assumed $70 subsidy per system and 68% loan share. Over the years as the market for SHS developed, the subsidy per SHS declined to$25 and the loan share decreased.

	No. of SHS	Subsidy per SHS ($)	IDCOL Loan share (%)
2003	10,038	90	68%
2004	19,297	80	68%
2005	26,558	60	68%
2006	36,936	50	68%
2007	68,899	50	68%
2008	95,843	46.5	68%
2009	166,139	45	68%
2010	304,742	32	68%
2011	450,214	28	68%
2012	552,415	25	60%

The PAD analysis only took into account the distribution of 50Wp systems. However, by the end of 2012, SHSs available under the project ranged from 20 Wp to 130 Wp. Under RERED, 1.23 million SHS were installed through the POs. Out of these, about 78% were 50 Wp size and below, 12% were in the range of 55-65Wp, and around 13% were above 65 Wp. Less than 1% of the systems sold were less than 20Wp size[12].

Taking the costs and benefits over the life of a SHS (20 years), the net benefits of the systems installed under RERED program were calculated in terms of financial rate of return (FIRR) and economic rate of return (EIRR). The FIRR takes into account direct benefits of using the system (cost savings from kerosene and battery recharging) and direct costs of owning the system (including the replacement cost of batteries and other accessories). The EIRR is calculated based on the same benefits and costs but net of taxes and subsidies. The CDM validation for the project has been completed and the agreed price is $ 11.65/ ton for the financial analysis (this is above the $10/ ton assumed in the analysis done in the second additional financing) and at the economic value of $30[13]/ ton for the economic analysis.

[12] These small systems cannot run TVs and hence were not as popular with rural households.

[13] Source: Stern Review on the Economics of Climate Change

The key differences in the cost estimate in the previous analysis and ICR analysis is attributable to the 67% efficiency of the SHS i.e. the Wh / day available from a 20 Wp SHS has been shown to be closer to 60 and not 90, as originally assumed. In addition, taxes on various components differed, as they increased during the period of project implementation. The Operations and Maintenance (O&M) cost also changed to include the annual charge by the POs of 300 BDT/ SHS and 50 BDT/SHS for purchase of distilled water for batteries. The revenue and cost have been adjusted to reflect the 2013 prices.

Snapshot of FIRR of IDCOL SHS

	Costs (Millions of BDT)						Benefits (Millions of BDT)							
		Replacements					Avoided	Avoided					Net Benefits	Net Benefits
Year	Capex	Lights	Controller	Battery	O&M	Adjusted costs	Kerosene	Charging	CERs	Total Benefits	Adjusted benefits	Net Benefits	(Million BDT	(Million USD)
2003	211				3.0	376	43	57	1	101	177	(113)	(199)	(3)
2004	437	9			9.3	778	129	136	4	269	459	(186)	(319)	(4)
2005	609	27			18.1	1,067	248	219	8	475	775	(179)	(292)	(4)
2006	736	71	8		28.7	1,324	391	305	12	709	1,113	(135)	(211)	(3)
2007	1,000	121	16		43.1	1,760	586	439	19	1,044	1,556	(137)	(204)	(3)
2008	1,622	178	23	65	66.5	2,775	905	692	29	1,626	2,309	(328)	(466)	(6)
2009	1,309	276	36	134	85.3	2,447	1,154	746	37	1,937	2,576	98	130	2
2010	4,860	373	54	187	155.4	6,867	2,126	1,814	67	4,007	4,888	(1,622)	(1,979)	(25)
2011	3,334	646	84	226	203.4	5,122	2,753	1,818	88	4,659	5,311	165	188	2
2012	13,836	788	85	307	402.8	16,652	5,523	4,931	173	10,627	11,477	(4,792)	(5,175)	(66)
2013	1,966	1,719	237	562	431.1	4,915	5,784	2,916	186	8,885	8,885	3,969	3,969	51
2014		1,653	210	535	431.1	2,829	5,784	2,916	186	8,885	8,885	6,056	6,056	78
2015		2,551	607	1,677	431.1	5,265	5,784	2,916	186	8,885	8,885	3,619	3,619	46
2016		1,719	312	1,248	431.1	3,710	5,784	2,916	186	8,885	8,885	5,175	5,175	66
2017		1,653	210	4,549	431.1	6,843	5,784	2,916	186	8,885	8,885	2,042	2,042	26
2018		2,551	607	1,165	431.1	4,753	5,784	2,916	186	8,885	8,885	4,132	4,132	53
2019		1,719	312	535	431.1	2,997	5,784	2,916	186	8,885	8,885	5,888	5,888	75
2020		1,653	210	1,677	431.1	3,970	5,784	2,916	186	8,885	8,885	4,914	4,914	63
2021		2,551	607	1,248	431.1	4,836	5,784	2,916	186	8,885	8,885	4,048	4,048	52
2022		1,719	312	4,549	431.1	7,011	5,784	2,916	186	8,885	8,885	1,874	1,874	24
2023		1,653	210	1,165	431.1	3,458	5,784	2,916	186	8,885	8,885	5,427	5,427	70
											FIRR			**26%**
											NPV	**NPV**	**Million BDT**	**4830**
													Million USD	**62**

Snapshot of EIRR of IDCOL SHS

	Costs (Millions of BDT)						**Benefits (Millions of BDT)**					
		Replacements					Avoided costs			Adjusted	Net Benefits	Net Benefits
Year	Capex	Lights	Controller	Battery	O&M	Adjusted Costs	Kerosene	Charging	CERs	Benefits	(Million BDT)	(Million USD)
2003	203				3.0	362	44	66	3	200	(163)	(2.08)
2004	420	7			9.3	747	133	155	10	510	(237)	(3.04)
2005	586	22	6		18.1	1,032	255	247	20	851	(181)	(2.31)
2006	708	57	13		28.7	1,267	403	338	32	1,213	(54)	(0.69)
2007	963	98	18		43.1	1,672	604	484	48	1,693	21	0.26
2008	1,561	143	29	52	66.5	2,629	932	765	74	2,514	(115)	(1.48)
2009	1,260	222	44	108	85.3	2,286	1,189	805	95	2,778	492	6.31
2010	4,679	300	68	150	155.4	6,528	2,189	2,032	172	5,360	(1,169)	(14.98)
2011	3,210	520	68	181	203.4	4,768	2,836	1,968	226	5,733	965	12.37
2012	13,321	634	191	247	402.8	15,978	5,687	5,551	447	12,619	(3,359)	(43.06)
2013	1,893	1,382	169	452	431.1	4,326	5,959	3,004	478	9,441	5,114	65.57
2014		1,329	488	430	431.1	2,678	5,959	3,004	478	9,441	6,763	86.70
2015		2,051	251	1,348	431.1	4,081	5,959	3,004	478	9,441	5,360	68.72
2016		1,382	169	1,003	431.1	2,985	5,959	3,004	478	9,441	6,455	82.76
2017		1,329	488	3,658	431.1	5,905	5,959	3,004	478	9,441	3,535	45.33
2018		2,051	251	936	431.1	3,669	5,959	3,004	478	9,441	5,772	74.00
2019		1,382	169	430	431.1	2,412	5,959	3,004	478	9,441	7,028	90.11
2020		1,329	488	1,348	431.1	3,596	5,959	3,004	478	9,441	5,845	74.93
2021		2,051	251	1,003	431.1	3,736	5,959	3,004	478	9,441	5,705	73.14
2022		1,382	169	3,658	431.1	5,640	5,959	3,004	478	9,441	3,801	48.73
2023		1,329	488	936	431.1	3,184	5,959	3,004	478	9,441	6,257	80.22
										EIRR		**42%**
										NPV	**Million BDT**	**9236**
											Million USD	**118**

From both an economic and financial viewpoint the project has high and robust internal rates of return (IRR), even with efficiency levels, increased taxes and O&M costs. The economic IRR is 42 % and the financial IRR is 28%.

B. Grid Component (Expansion & System Loss Reduction)

This component assisted in expanding distribution facilities in 45 PBSs through the construction of 11,295 kms of new lines and construction and augmentation of distribution substations and associated facilities. Also there was a reduction in system losses: losses fell from 59.94% in 31 PBS in 2002 to 13.7% in 2009[14]. In the analysis done at the time of project appraisal to estimate the revenue earned the weighted average tariff of PBS in FY2001 was used i.e. Tk 3.32/kWh. The tariff rate is administered and subsidized. Hence, it does not adequately reflect economic benefits. For the economic analysis, to obtain the benefits of the project, the consumer's savings by switching to electricity from other modes of energy use was considered and the average willingness to pay was assumed to be Tk4.80/kWh.

At appraisal, based on the above assumptions the project shows a FIRR of 5 percent. The FIRR is low and this was explained by: (i) the high capital cost of rural electrification; and (ii) the slow pick-up of loads in rural areas and the low intensity of electricity use; and (iii) administered tariffs that are not fully cost reflective. It was anticipated that as the sector matures and tariffs rise this issue would be mitigated. But over the years the increase in Bulk Supply Tariff (BST) was not passed on to the consumers in time, leading to a low FIRR (5.36%) to the investment in the ICR calculation.

Between 2002 and 2008, retail tariff charged by the PBSs were not allowed to increase although the BST was increased by about Tk 0.34/kWh in 2007. In October 2008, the BST was increased by Tk 0.15/kWh but the commensurate increase in retail tariff was made effective from December 2008. Between February 2011 and September 2012, the BST increased by Tk 1.56/kWh in phases while the average revenue rate of the PBSs increased by only Tk 1.53/kWh during the same period. Even after the 15% increase in tariff in September 2012, the aggregate cost of power supply of all the PBSs is Tk 6/kWh against the average revenue rate of Tk 5.43/kWh.

In the ICR economic analysis, three revenue streams have been considered-
a) Revenue from sale of power which is valued at average rate of tariff. This is on the conservative side as the average tariff does not reflect the cost of supply (discussed in the above paragraph).
b) Incremental revenue from reduction in system losses: The units saved have been valued at the alternative cost of electrification. The estimates range from 15 taka / unit (diesel based generation) to 32 taka /unit (island generation for grid quality). The analysis has assumed the progression of alternative cost of generation from around 4 taka in 2003 to 15 taka in 2013.

[14] After REB ceased reporting on system loss to the RERED project, they noted that system loss fell even more due to project intervention, to around 11.4%.

c) Revenue from avoidance of GHG emissions from displaced kerosene. The investment led to 656,802 connections and the kerosene displaced per household is 45.6 liter/ year[15]. This avoidance of kerosene led to a reduction in GHG emissions which is valued at the economic carbon price of 30 US$/ ton.

Snapshot of revenue streams for REB expansion & system loss reduction component

Incremental revenue from System Loss reduction					Carbon Benefits					Revenue from sales
Units Sold (MwH)	Units Purchased (MwH)	Units saved (KwH)	Revenue due to system Loss reduction (Million BDT)	No. of new connections added every year	Household Connections (Kwh/ year)	Cumulative connections	Kerosene reduced	Avoided GHG from displaced kerosene	Revenue from Carbon benefit (Million Taka)	Revenue from Sales (Million BDT)
280348	476,945			171763	775.00	171763	7832396	21930.71	51.32	11191.74
486533	680,942	86,275,341	22.21	135117	775.00	306880	13993725	39182.43	91.69	16087.01
573562	707,752	157,545,535	185.91	96472	775.00	403352	18392855	51499.99	120.51	18014.74
608464	742,935	171,766,638	363.43	88995	775.00	492347	22451020	62862.85	147.10	17807.69
508043	601,947	154,218,740	950.06	62634	775.00	554981	25307128	70859.96	165.81	18094.89
497347	568,852	162,975,999	993.92	50430	775.00	605411	27606756	77298.92	180.88	20955.86
467749	532,077	154,994,066	938.40	33211	775.00	638623	29121190	81539.33	190.80	22170.83
236249	266,677	79,496,362	884.35	18179	775.00	656802	29950171	83860.48	196.23	25733.73
				0		656802	29950171	83860.48	196.23	27945.00
				0		656802	29950171	83860.48	196.23	36533.00
				0		656802	29950171	83860.48	196.23	36533.00
				0		656802	29950171	83860.48	196.23	36533.00
				0		656802	29950171	83860.48	196.23	36533.00
				0		656802	29950171	83860.48	196.23	36533.00
				0		656802	29950171	83860.48	196.23	36533.00
				0		656802	29950171	83860.48	196.23	36533.00
				0		656802	29950171	83860.48	196.23	36533.00
				0		656802	29950171	83860.48	196.23	36533.00
				0		656802	29950171	83860.48	196.23	36533.00
				0		656802	29950171	83860.48	196.23	36533.00
				0		656802	29950171	83860.48	196.23	36533.00

The revenue and cost have been adjusted to reflect the 2013 prices. The EIRR of the investment with carbon benefit is 27% and without carbon benefits is 23.64%. From an economic analysis viewpoint the project has high and robust internal rates of return (IRR) .At the time of appraisal an EIRR of 16% was calculated.

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[15] Source: 2012 SHS Impact Analysis. This is a conservative estimate – other numbers used by IDCOL for CDM are as high as savings of 72 liters/year/household.

Snapshot of EIRR for REB expansion & system loss reduction component

Year	Adjusted Total Cost (million BDT)	Adjusted Revenue (Million BDT)	Net Annual Benefits (Million BDT)	Adjusted Annual Benefits (Million BDT)	Adjusted Annual Benefits (Million USD)
2003	27067.31	19787.78	-4136.10	-7279.53	-93.33
2004	27999.11	27703.56	-172.84	-295.55	-3.79
2005	27189.65	29863.49	1640.39	2673.84	34.28
2006	26607.22	28759.60	1370.94	2152.38	27.59
2007	25064.68	28624.04	2388.83	3559.36	45.63
2008	25837.27	31425.53	3935.39	5588.26	71.64
2009	28042.43	30989.05	2215.50	2946.62	37.78
2010	29902.61	32713.47	2303.98	2810.85	36.04
2011	30824.46	32081.01	1102.23	1256.55	16.11
2012	38993.40	39667.57	624.23	674.17	8.64
2013	36105.00	36729.23	624.23	624.23	8.00
2014	36105.00	36729.23	624.23	624.23	8.00
2015	36105.00	36729.23	624.23	624.23	8.00
2016	36105.00	36729.23	624.23	624.23	8.00
2017	36105.00	36729.23	624.23	624.23	8.00
2018	36105.00	36729.23	624.23	624.23	8.00
2019	36105.00	36729.23	624.23	624.23	8.00
2020	36105.00	36729.23	624.23	624.23	8.00
2021	36105.00	36729.23	624.23	624.23	8.00
2022	36105.00	36729.23	624.23	624.23	8.00
2023	36105.00	36729.23	624.23	624.23	8.00
			EIRR		27.00%
			NPV	Million BDT	5,718
			NPV	Million USD	73.31

C. **Demand Side Management - Deployment of energy-efficient CFL:**

The additional financing in 2009 funded the deployment of 10.5 million CFLs in areas with the highest electricity demand. At time of project preparation, the benefits of the program were expected to be the avoided cost of installing power generation capacity equal to the electricity saved by the CFLs compared to incandescent lamps and the O&M cost of running these electricity generation plants. A further benefit was expected from the introduction of CFLs that is the reduction in Green House Gas (GHG) reductions due to the reduced need for energy from the power stations. These GHG emissions reductions could have been claimed by the Government under the CDM. The sale of certified emissions reduction (CERs) through CDM, in the global carbon market would bring additional revenues to the Government.

The analysis at the time of preparation, took into the energy savings due to replacement of incandescent lights (IL)s with CFLs. This energy savings was quantified using the Bulk Supply tariff (for financial analysis) and in avoided generation costs (for economic analysis). The lifetime savings of energy from using CFL was the only benefit considered for the purpose of this analysis. The cost of this Component was the cost of procurement of the energy efficient and high quality CFLs, CFL distribution costs, cost of implementing consumer awareness programs, and monitoring and evaluation plans. The FIRR and EIRR of the program were calculated to be 44% and 52% respectively. Including the CDM benefits, the FIRR and EIRR of the program was calculated as 52% and 60% respectively.

But the poor quality of CFLs undermined the energy and peak MW savings, estimated GHG reductions and therefore CDM credits and the potential carbon revenues. The key assumptions that were made at the time of the project preparation which did not hold true and impacted the actual results were

1. CFL Lifetime: As defined under the technical specifications of the project, the life of each CFL was expected to be 10,000 hours but post installation surveys suggested that the failure rate was as high as 20%-50% in the first few months of installation
2. Program Leakage Factor: The losses due to breakage etc. were estimated at 5% but the technical studies show that the leakage factor was as high as 13%.
3. Revenues from CDM: Price of CERs in the Carbon Market was estimated at $10/tCO2e. Due to poor quality of CFL and inability to meet the documentation requirements for CDM these revenues could not be realized.

These returns were never realized due to the poor quality of CFLs and high leakage factor leading to negative cash flows and negative NPV.

Annex 4. Bank Lending and Implementation Support/Supervision Processes

(a) Task Team members

Names	Title	Unit	Responsibility/ Specialty
Lending			
Subramaniam V. Iyer	Sr. Financial Analyst		TTL
Chandrasekar Govindarajalu	Energy Specialist		
Md. Iqbal	Energy Specialist		
Chrisantha Ratnayake	Sr. Power Engineer		
Kishor Uprety	Sr. Counsel		
Suraiya Zannath	Sr. Financial Management Specialist		
Mohamnmad Sayeed	Disbursement Officer		
Sumith Pilapitiya	Sr. Engineer		
Douglas Barnes	Sr. Energy Specialist		
Zafrul Islam	Sr. Procurement Specialist		
Raihan Elahi	Energy Finance Specialist		
Tuntivate Voravate	Consultant		
Hasna Khan	Consultant		
Anwar Hossain	Consultant		
Adam Harvey	Consultant		
Paul Van Aalst	Consultant		
Alfred Friendly	Consultant-Editor		
Zibun Nessa Pinu	Team Assistant		
Anna Goodman	Program Assistant		
Supervision/ICR			
Aminur Rahman Chowdhury	Consultant	SARFM	
Arun Banerjee	Consultant	SASDI	
Ashok Sarkar	Senior Energy Specialist	SEGEN	
Burhanuddin Ahmed	Sr Financial Management Specia	SARFM	
Chrisantha Ratnayake	Consultant	AFTG1	
Christopher James Warner	Sr Technical Spec.	CPFCF	
Erik Magnus Fernstrom	Senior Energy Specialist	AFTG2	
Fabio Pittaluga	Senior Social Development Spec	LCSSO	
Katherine Deaton Steel	Energy Specialist	AFTG2	
Malcolm Cosgrove-Davies	Sector Manager, Energy	LCSEG	
Md. Abul Fayez Khan	Program Assistant	SASDO	
Md. Faijul Islam	Information Analyst	SARIM	
Md. Iqbal	Senior Energy Specialist	SASDE	
Mildred Gonsalvez	Program Assistant	EASPW	

Mohammad Abdullah Sadeque	Consultant	SASDA	
Mohammad Mahbubur Rahman	Financial Management Specialist	SARFM	
Nilufar Ahmad	Consultant	SASDU	
Nusrat Jahan	Consultant	SARFM	
Prasad V. S. N. Tallapragada	Consultant	AFTG1	
Ravindra Anil Cabraal	Consultant	SASDE	
Rosanna Chan	Economist	SASFP	
Saif Quadir	Temporary	SASDE	
Shahidur R. Khandker	Lead Economist	DECAR	
Shakil Ahmed Ferdausi	Senior Environmental Specialist	SASDI	
Sheikh Naveed Uddin Ahmed	Consultant	SASHN	
Subodh C. Mathur	Consultant	AFTG2	
Sumith Pilapitiya	Lead Environmental Specialist	SASDI	
Toufiq Ahmed	Senior Procurement Specialist	SARPS	
Voravate Tuntivate	E T Consultant	EASWE	
Zibun Nessa Pinu	Program Assistant	SARPS	
Zubair K.M. Sadeque	Senior Energy Specialist	SASDE	TTL

(b) Staff Time and Cost

Stage of Project Cycle	Staff Time and Cost (Bank Budget Only)	
	No. of staff weeks	USD Thousands (including travel and consultant costs)
Lending		
FY01	48	131.35
FY02	52	290.77
FY03		-0.31
FY04		0.00
FY05		0.00
FY06		0.00
FY07		0.00
FY08		0.00
Total:	100	421.81
Supervision/ICR		
FY01		0.00
FY02		0.00
FY03	52	167.82
FY04	48	111.33
FY05	31	107.36

FY06	22	63.12
FY07	20	137.70
FY08	17	88.15
FY09	45	0.00
Total:	235	675.48

Annex 5. Beneficiary Survey Results

Two impact evaluations were carried out related to the REB grid components, one in 2005 and the other in 2010, and a final impact evaluation was carried out for the IDCOL SHS component in 2012. The objectives and findings of each survey are briefly summarized below.

Solar Home Systems:

In 2012 the World Bank, together with Bangladesh Institute of Development Studies (BIDS), carried out a household survey to assess the socioeconomic benefits of the SHS in rural Bangladesh.

Methodology & Approach: The survey was undertaken in consultation with IDCOL and the various POs. A large household survey of SHS adopters and non-adopters; a survey of branch offices of the POs; and a community survey were all conducted with pre-verified questionnaires. The total number of households surveyed in 128 villages (64 treatment or supplied with SHS, 64 control without such supply) was 4,000 (1,600 SHS adopters in treatment villages, 400 non-SHS households in treatment villages and 2000 non-adopters in control villages). The population for the sample of households was based on records that POs proved IDCOL of households that purchase SHSs. The villages and households were chosen at random. Several analytical techniques were used to process the various sets of data. These included: general descriptive analyses of households; disaggregated household member descriptions; econometric exercises to analyze factors that influence decision to install a SHS and the size of the system; propensity score matching analyses with adopters and non-adopters in the same village and non-adopters in control villages to understand the impact of the SHS; a simulation analysis to understand the potential size of the market in future for specific capacities of SHS; and another simulation exercise to understand the willingness to pay and implications of various financing mechanism involving the subsidies (level including zero subsidy).

Findings: Findings from the analysis of the survey data show certain benefits of the SHS for the beneficiary households. The main findings from this study are summarized below:

Energy Consumption: The households irrespective of the SHS status were dependent on kerosene and biomass for their energy requirement. About 80% of the households use fuel wood or non-fuel wood biomass for cooking and related activities. While 62% of the SHS households reported to use kerosene, the incidence is significantly higher at 99% among the non-SHS households. The actual difference on kerosene use on average between an SHS user and non-user is 3.67 liters per month per household and translates into more than 88 million liters per year at the present level of diffusion of SHS. The consequent direct reduction of carbon di-oxide emission is more than 240 thousand metric tons.

Gender impact: The sense of security was found to be much higher among women in SHS households. Also SHS was found to influence positively women's mobility, general decision-making and also economic decision-making including purchase of household goods. Women were found to use more time for tutoring children, watching TV, socializing, visiting friends and neighbors with the adoption of SHS that also allows them to run a TV. Both male-headed and

female-headed households acknowledged the positive role of SHS in facilitating children's education (54.7% for male-headed and 62.5% for female-headed). Interestingly, respondents from female-headed households (87.5%) were willing to buy another SHS, saying that it gives them comfort in their lives, whereas only 45.3% members from the male-headed households considered this as an important factor to decide for another SHS. However, neither was willing to acquire an additional unit because of its potential for higher income.

Education Impact: Children's study time increases with SHS adoption, more so for girls than for boys. Girls' study times in the evening increased by 12.1 minutes per day on average compared to 8.5 minutes for boys.

Health impact: The disease prevalence has significantly reduced among SHS households. Greater awareness through greater connectivity to TV coupled with better indoor environment (replacing kerosene lamps) may have contributed to lowering the prevalence of diseases. Among the SHS households, girls from those households with a TV set are about 4 percentage points less likely to suffer from respiratory and gastro-intestinal diseases than their counterparts from SHS households without a TV set. The corresponding reduction in the prevalence of the same diseases for boys is about 1 to 5 percentage points.

The adopter households have been found to be systematically different from non-adopter households both in the treatment and control villages.

a. Female headed households are more prominent among adopters compared to non-adopters while age of household head has little over-all influence. Household size and age are however are of not much importance.
b. Adopter household heads, however, are better educated as more than 40% have secondary level education or beyond while the proportion is only half of that among non-adopters. An interesting finding is that women's education may have a positive role as among adopter households 76% has at least one woman who has completed primary level education while 20% has women with secondary complete education. For non-adopters the proportions are 60 and 10% respectively.
c. Non-agricultural occupation is predominant among adopter household heads. On the other hand, the land holding is also much higher among such households. The average land holding are 245 and 209 decimals for total and agricultural land among adopters. For non-adopters these are only about half or less.
d. Clear differences in level of income are observed. Adopter households have on an average BDT 160,000 income (approximately US$ 2,000) per year. This is 80% more than the non-adopter household incomes.
e. Self-assessed food security is much higher among adopter households, around 40% of whom consider themselves to be in surplus category while the percentage for non-adopters are only half as much. The adopters' possible future income may also be higher as they spend 50-80% more for children's education than non-adopters.

On the whole the adopters are better endowed with assets and income as well as education. The econometric analyses carried out in the study confirm that this to be true even when other factors are controlled for. The partial analyses using the above factors did not allow the study to examine the independent effects on actual choice to acquire/buy an SHS. Econometric analyses

indicate that variables such as total annual income, education of head of the household, non-agricultural occupation, women's education and whether the household has a woman as its head do positively and statistically significantly influence the choice of installation of a solar home system.

Grid Electrification:

REB, with the help from the World Bank, first carried out an evaluation study in 2005 to assess the outreach and socioeconomic benefits of rural grid electrification supported under the RERED project. This study covered households, commercial entities, industries, and irrigation units and households. A follow-up survey was done in 2010 on the same respondents.

Methodology and Approach:

2005: In 2005 REB undertook the study "Socio-Economic Monitoring and Impact Evaluation of Rural Electrification and Renewable Energy Program in Bangladesh: A Baseline Study". The objectives of the study were a) to develop methods and guidelines to monitor and measure impact and benefits of rural electrification; b) to undertake a large baseline survey using the quantitative methodology; c) to develop qualitative methodology to assess impact/benefits of rural electrification; and c) to assist and train REB and PBSs to build their capacity to carry out evaluations in future. A two-stage sampling design was used with villages as the primary sampling units and the households the ultimate units. REB conducted a total of 27,934 interviews (against the target of 26,750). The interviews were distributed across domestic, small commercial, irrigation and industrial respondents and between electrified and non-electrified respondents. Non-electrified households were included mainly for the purposes of comparison. In addition to the surveys, participatory rural appraisal (PRA) methods were used to elicit information from users and non-users of electricity and the participants included both men and women. A total of 48 PRAs and 6 semi-structured interviews were conducted.

2010: In 2010 a follow up survey was conducted. Out of a total of 27,912 units surveyed in 2005, 21,266 of the same were resurveyed in 2010 (76.19 %). The 2005 sample units were based on a) with grid connections b) solar connections, and c) without electricity and the resurveyed units showed some change in status. Thus, out of the retraced 10,843 units with grid connections in 2005, 90.7% were found to have the same status in 2008 while 8.5 % became disconnected from the grid another 1.7 % reported a side connection. The number of retraced solar units was 789, of which 15% became connected to the grid, while another 40% became non-electrified. There were 7753 units in the third category (non-electrified) of which almost 29 % subsequently became electrified. In other words, a significant number of units in different categories changed their electrification status between 2005 and 20010. It was observed that a significant number of units could not be retraced in 2010.

Findings:

Electrification: The percentage of villages electrified as a result of the Project increased from 57% in 2005 to 77% in 2010. The percent of household connected also increased from 33% in 2005 to 37% in 2010. The average monthly use of electricity by grid-connected households was 50 kWh/month/household in 2010, compared to 42.6 kWh/household/month in 2005[16].

Income: Household incomes increased by 21% and expenditure increased by 11% between 2005 and 2010. For non-electrified commercial units, there was little change in income over time, while for electrified (on grid) units, gross incomes rose by over 2.8 times between 2005 and 2010[17] Electricity also enabled both men and women to extend their working hours well into the evening. Shops, stores, rice mills and small trades that had electricity were able to stay open for longer hours. For example, women in the Monipuri communities earned more after getting connected through involvement in income generating activities such as running shops in the homestead premises, sewing or weaving at night after completing their domestic chores.

Study time: Study time in the evening went up by 21 minutes/day for boys and 12 minutes/day for girls between 2005 and 2010.

Gender: Women reported greater diversity of economic activity due to electrification, along with a sense of greater security in the evenings, and greater mobility. Women also reported impact on decision-making roles on social matters, especially those related to children's education, healthcare and marriage. Female survey respondents reported that their mobility had increased, and they felt more secure when traveling to the health complex, children's school, village learning centers, NGOs and other places. Televisions also increased access to information - women were able to receive more information about home and abroad through watching television. Mobile phones also increase women's communication, through regular access to family members and allowed them to access doctors in the case of emergencies.

[16] The low growth in demand could be a result of supply shortages. Lack of new generation capacity addition over the years resulted in severe supply disruptions, and the rural areas share a disproportionate share of the supply cuts.

Annex 6. Stakeholder Workshop Report and Results

N/A

Annex 7. Summary of Borrower's ICR and/or Comments on Draft ICR

IDCOL:

SECTION I: ASSESSMENT OF THE BORROWER'S OPERATION'S OBJECTIVE, DESIGN, IMPLEMENTATION AND OPERATIONAL EXPERIENCE

1.1 Project Objectives

The Project's aim was to support Bangladesh's efforts to raise levels of social development and economic growth by increasing access to electricity in rural areas. In achieving this objective, IDCOL's role was to promote the use of solar home systems (SHS) in remote rural areas of the country.

Another objective of the Project was to facilitate development of small power projects on pilot basis using renewable energy sources to be owned and operated by private sector/NGOs.

1.2 Design

IDCOL promoted sales of SHS to off-grid households through microfinance by selected Participating Organizations (PO) drawn from MFIs/NGOs/private entities. IDCOL provided refinancing support (sub-loan) to the POs covering up to 70%-80% of their micro-credit extended to households for SHS purchase. IDCOL also provided grant support to reduce capital cost of SHS rendering the technology affordable for the rural people as well as technical assistance to overcome social and marketing barriers.

Concessionary loan and grant was also provided to the private sector/NGOs to support pilot level development of solar mini-grid, biogas-based and biomass-based power plants.

1.3 Implementation

IDCOL recruited POs through a fair, transparent and competitive process conducted by the PO Selection Committee to work under the project as per approved selection criteria. The roles of the POs were to select the project areas and potential customers, extend loans, install the systems and provide maintenance support. IDCOL provided grants and soft loan to the POs, set-forth technical specification for solar equipment through the Technical Standards Committee, developed publicity materials, provided staff and customer training, and monitored PO's performance.

The households were required to pay minimum 10% of the system cost as down-payment to get a SHS. The rest of the cost is taken as micro-credit at 12-16% interest per annum on outstanding balance.

After installation of SHS, POs made electronic disbursement request to IDCOL for refinance and grants. After in-house checking, IDCOL conducted physical verification of the SHSs installed. IDCOL released grants and 70%-80% refinance amount only if the inspection result was satisfactory.

1.4 Operational Experience

IDCOL started the project with some existing players in solar technology based on certain evaluation criteria. IDCOL in support of these POs raised conducted large scale awareness campaign within the rural community through billboard, poster, leaflet, radio/television spots etc. Initially, it was difficult for the POs to convince people in the rural areas about solar technology. IDCOL's comprehensive awareness campaign has been very useful to raise awareness about the usefulness of SHS.

Developing appropriate and cost efficient technical design and setting proper specification of SHS components was a challenge. IDCOL formed an independent Technical Standards Committee comprising local professionals and experts in the field to set-forth appropriate technical standard and specification for the technology to be financed by IDCOL. The Committee has successfully performed this task.

Proper installation of SHS as well as providing after sales service was very important for project performance. For this, IDCOL arranged necessary training for the PO staff. Ensuring installation of approved equipment was also important. IDCOL recruited technical inspectors who visited customer households on a regular basis and provided feedback, based on which IDCOL required the POs and suppliers to take remedial measures, in case of any discrepancy found.

IDCOL arranged monthly operations committee meeting to discuss implementation progress of the project and took operational decisions in consultation with the POs. Collection of installments was one of the most important tasks under the project to ensure project expansion. IDCOL's collection verification inspectors routinely verified collection efficiency of the POs and advised necessary measures to be taken if collection efficiency of any branch of the POs were found unsatisfactory.

SECTION II: ASSESSMENT OF THE OUTCOME OF THE OPERATION

The design and implementation modalities of SHS component proved to be very efficient and well accepted by the beneficiaries as well as other stakeholders of the project. It basically promoted ownership model where customers will become owners of the systems once loans are repaid.

IDCOL's initial target under Credit No. 3679-BD was to install 50,000 SHS by June 2008. It achieved this target in August 2005, almost three years ahead of the project completion period and US$ 2 million below the estimated cost. Following this success, the World Bank reallocated funds from other categories and also provided two additional financing mainly to support IDCOL's SHS program. IDCOL also received financing support from other development partners like KfW Development Bank, Asian Development Bank, Islamic Development Bank and the Japanese Government. Under the program, a total of 1,877,696 SHS have been installed up to December 2012 with an average growth rate of 58% per annum. Year-wise installation of SHS was as follows:

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Installation	11,697	20,635	27,579	37,151	69,562	103,301	169,916	325,067	468,978	643,810
Installation (cumulative)	11,697	32,332	59,911	97,062	166,624	269,925	439,841	764,908	1,233,886	1,877,696
Growth		76%	34%	35%	87%	49%	64%	91%	44%	37%

Out of this, IDCOL financed 1,218,543 SHS from RERED against the target financing of 990,000 SHS. As a result, SHS program, a small portion of REREDP at the initial stage of implementation concluded being the main project component.

IDCOL also financed a solar mini-grid, six solar irrigation pumps, two biomass based power projects and one biogas based power project. The implementation modalities of small power project component also seemed effective for some technologies like solar irrigation pump and solar mini-grid. IDCOL is getting good response from the project sponsors for these technologies and going to launch these on program scale.

Table: ***Target and achievement scenario of the project***

Credit no.	Target		Achievement	
	Physical	**Financial**	**Physical**	**Financial**
3679-BD	50,000 SHS	SDR 36.10 million	236,768 SHS	SDR 36.10 million
4643-BD	319,000 SHS	SDR 52.98 million	341,104 SHS	SDR 52.98 million
5013-BD	630,000 SHS	SDR 85.40 million	640,671 SHS	SDR 79.73 million
Total	**990,000 SHS**	**SDR 174.48 million**	**1,218,543 SHS**	**SDR 168.81 million**

SECTION III: FACTOR AFFECTING IMPLEMENTATION

A number of factors have influenced implementation of SHS program. These are as follows:

a) **Ownership of SHS:** After making full installment payments beneficiaries would become owner of SHS. For this reason, customers were keen to proper use and maintenance of SHS as well as making payments to the POs.

b) **Financial contribution of all parties:** IDCOL ensures financial contribution of POs as well as customers. As a result, POs were dedicated to collect installments from the customers for future investment which facilitated proper after-sales service.

c) **Price determination by the market:** IDCOL allowed the market forces to determine the price. It never interfered in price determination. Rather, it ensured competition among the POs and equipment suppliers from the very beginning. Now, POs have multiple suppliers for each SHS component. Similarly, every corner of the country has number of POs selling SHS to the customers.

d) **Independent selection of POs and suppliers:** IDCOL has kept PO and supplier selection processes independent that ensured selection of qualified POs and suppliers.

e) **Cost-efficient and standardized technical design:** The cost-effective, low-maintenance, and standardized technical design of SHS provided optimal energy solution for the low income rural households.

f) **Quality control:** IDCOL maintained strong monitoring by its quality control team which ensured proper installation and after sales service of the SHS.

g) **Smooth supply of equipment:** Local support industries ensured smooth supply of all SHS components at competitive prices.

h) **Micro-credit experience:** Bangladesh has a very good track record in micro-finance. People in the rural areas have experience in loan repayment which has ensured good collection performance of IDCOL's program. IDCOL POs had vast experience in micro-credit operations.

i) **Government Support:** Support from the GoB has been very instrumental in successful implementation of the project. Government arranged all necessary funds from various development partners and channeled it to IDCOL at a concessionary rate. It also bore foreign exchange risk which was crucial to provide concessionary loan to POs. It also provided fiscal incentives including exemption of import duties on solar panels.

SECTION IV: EVALUATION OF THE BORROWER'S OWN PERFORMANCE

IDCOL, a government owned financial institution, has been very successful in achieving the objectives under REREDP. It has been able to exceed the targets set under three different IDA credits. About 1.9 million SHS have been installed in remote rural areas of Bangladesh with IDA as well other donor's funds. This has the following positive impacts:

- Ensured access to electricity for more than 9 million people of the country which is 6% of the total population.
- Reduced import of 115,000 tons of kerosene per year worth USD 90 million and
- Reducing emission of 325,000 tons of CO2 in the atmosphere
- Created about 30,000 direct and 50,000 indirect jobs

On achieving first target under credit no. 3679-BD, Mr. Praful C. Patel, the then Vice President of the World Bank's South Asia Region mentioned the following about IDCOL's program in his congratulatory message:

"Projects reaching their target three years early are very uncommon. When the RERED Project was under preparation, back in 2002, the idea that 50,000 SHS might be installed in rural Bangladesh within a period of five years (2003 – 2008) seemed highly ambitious. However, we now find ourselves proved wrong in the best possible way. This project stands as an excellent example of the transformations that can be achieved by committed people working in a good institutional environment. ..... The World Bank is proud of its association with such a project. …."

On achieving milestone of 1 million SHS, Ms. Ellen A. Goldstein, Country Director of the World Bank's Bangladesh mission mentioned the following:

"…Thanks to the tremendous work of IDCOL and its partner organizations, the SHS program is now the fastest growing program in the world, reaching more than 30,000 households every month. A collaborative effort by all the stakeholders - Government of Bangladesh, IDCOL, the partner organizations, the development partners, and above all the numerous beneficiaries of the rural areas- has made possible what has been achieved today…"

SECTION V: EVALUATION OF BANK'S PERFORMANCE

IDCOL received full support and cooperation from the World Bank which ensured smooth implementation of the project. Bank jointly formulated project design and implementation process with IDCOL which has been proved to be very effective in achieving the project objectives. The Bank arranged necessary fund for the project from various sources depending on the implementation progress and as per the requirement of IDCOL. The Bank's resident mission regularly monitored the project implementation and assisted IDCOL and its POs by providing necessary suggestions and guidance. Fund disbursement process was very smooth and quick.

SECTION VI: LESSONS LEARNT

IDCOL's SHS program has been a collaborative effort of all stakeholders. All have provided their fullest efforts to make the project successful. Involvement of all parties in project design as well in operation has assisted accomplishment of project objectives. Financial contribution of both POs and customers ensured proper installation, after sale service and loan recovery. Extensive monitoring and quality control by IDCOL added a new dimension in project implementation. These may be considered in designing future projects.

Successful implementation of some renewable energy projects on pilot basis also paved the way for undertaking large scale dissemination program in the future.

SECTION VII: PROPOSED ARRANGEMENT FOR FUTURE OPERATIONS

IDCOL has set a target to finance 4 million SHS by 2015. It has already arranged a portion of the funding requirement from the World Bank under REREDP II and is going to sign loan agreement with JICA shortly. The Bank has also arranged some fund from USAID to provide grant support to smaller SHS to be installed under REREDP II.

Ultimate objective of IDCOL's SHS program has been commercialization of SHS. In view of this, it gradually phased out grant support for SHS from USD 90 per SHS to zero from 2013 (except for small SHS). The market has now become almost ready to operate without grant. Only small SHS, supporting poorer segment of the community, is receiving grant support which will also be withdrawn shortly. IDCOL is also tightening the loan terms for the POs. Initially, POs received 10 years loan at 6% interest rate which is now 5-7 years loan at 6%-9% interest

rate depending on loan exposure. Within few years, IDCOL's SHS program will be ready to absorb loan in commercial terms without any grant and technical assistance.

IDCOL already financed few renewable energy projects on pilot basis like solar irrigation pump, mini-grid, biomass and biogas-based power projects etc. It is now looking to implement such projects in large scale. The Bank has already arranged some grant fund from Bangladesh Climate Change Resilience Fund for solar irrigation pumps and some fund from USAID for other applications. IDCOL will also receive some credit fund from JICA for these applications. KfW is also considering some grant fund to support these initiatives.

Apart from these, IDCOL is now planning to provide technical assistance to few African countries in implementation of renewable energy programs. IDCOL has gained sufficient knowledge and experience in renewable energy which may be shared with the countries lagging behind. It is already in contact with few such countries. The World Bank and some other development partners are assisting IDCOL in this regard.

Rural Electrification Board:

Section-I : **Assessment of the operation's objectives, design, implementation and operational experience**;

Under the umbrella project RERED Rural Electrification Board had 11 Projects. Those are as follows:
1)System loss reduction (SLR) of taken over lines, 2)Expansion and Intensification of 12 PBSs, 3)Expansion and Intensification of distribution system of 15 PBSs (2nd Phase), 4)Expansion and Intensification of 18 PBSs (2nd Phase), 5)Rural electrification through Solar Energy, 6)Diffusion of renewable energy technologies-2nd phase, 7)Socio-economic monitoring & impact evaluation of rural electrification program in Bangladesh, 8)Environmental assessment and management training for rural electrification program in Bangladesh, 9)Institutional development plan for REB & Rural Electrification Program Revised, 10)Financial consultancy services for developing financial restructuring plans for 45 PBS, 11)Efficient lighting initiative in Bangladesh (Part I).

Among these Projects sl. no. 1 is of sustainable development in nature & 11 is energy efficiency related, sl. no. 2, 3, 4 are related to expansion and intensification of existing distribution lines, sl. no. 5 & 6 are relating to solar energy and finally sl. no. 7, 8, 9 & 10 are study related to different aspects of REB/PBS.

The main objectives of each of the projects are described below:

Main objective of 'System loss reduction of taken over lines' project was to reduce the system loss of the lines that have been taken over by REB from PDB within the shortest possible time by providing additional manpower and logistic supports to strengthen PBS's efforts. The purpose of this project was to avoid dual investment by taking over BPDB distribution pocket points within PBS's area.

In fact, the project has been implemented with a view to reduce the system loss of taken over lines and also to improve the bill collection efficiency from the consumers connected from those lines. By disconnecting illegal consumers, motivating the people and by renovating PDB lines, the goal has been achieved. For example initially average system loss of PDB lines in different PBSs was 59.94%. After renovating taken over lines, the system loss has been reduced to 13.70%.

Expansion and Intensification of 12 PBSs (Revised), Expansion and Intensification of distribution system of 15 PBSs (2nd Phase) (Revised) and Expansion and Intensification of 18 PBSs (2nd Phase)(Revised) are of same nature. All these three projects were done for Expansion and Intensification of distribution lines following the principle of Area Coverage Rural Electrification (ACRE) and increasing the periphery of RE network. Common objective of these projects were to ensure electricity for rural development as well as to improve the national economy by bringing the entire country under electrification program in different phases. These projects have been taken to intensify and extend the distribution network of the targeted PBSs. Which Improves economy of the country by providing electricity in the rural areas for increasing agriculture production, employment creation, development of cottage industries, household uses, health, education and community services in the project area.

In the project 'Rural electrification through Solar Energy' by installing 11,796 solar home photo voltaic module in remote and isolated areas of Sirajgonj PBS, Natore PBS-2, Cox's Bazar PBS, Pabna PBS-2, Barisal PBS-1 & Sunamgonj PBS where grid electricity has no access and possibility of running grid line is non-permeable because of financial and technical limitations. Harnessing solar energy in the form of usable electricity is sustainable, environment friendly which would be used for house-hold and commercial use for the rural people of remote areas. Objectives of the project include also diffusion of alternate sources of energy and expansion of it to meet the increasing demand of electricity in context of energy crisis.

It is expected that the project would exert positive impact to the socio-economic development in improving the quality of rural life and augmenting the income of the people to some extent.

In the project 'Diffusion of renewable energy technologies-2nd phase' the main objective is to provide 6,000 solar home PV system to the remote and isolated rural areas having no access to national grid electricity.

In the project 'Environmental assessment and management training for rural electrification program in Bangladesh', the objective was to train the environment monitoring cell (EMC) and concerned manpower of REB/ existing PBSs officials. The objective of the project was to develop necessary institutional capacity regarding environmental impact assessment (EIA) and environmental management plan (EMP). Also to develop a detailed environmental and social appraisal manual each outline the environmental and social appraisal procedures and guide lines necessary to ensure that REB loans are in accordance with the environmental, social and resettlement policies established by GOB and the World Bank.

In the project 'Socio-economic monitoring & impact evaluation of rural electrification program in Bangladesh' the main objective was to enhance socio-economic impact of electricity provision

in rural areas which includes education, quality of life, women empowerment, direct impact on income, enhance rural productivity and safe drinking water.

In the objective of the project 'Financial consultancy services for developing financial restructuring plans for 45 PBS' was to improve the debt servicing capacity of REB for sustainable viability of the PBSs. The principal objective of this project is to overcome the disparity and to develop a financially viable system for the PBSs of different consumer and system characteristics; REB has under taken the project for investigating the application, along with other financial restructuring measures, of implementing Variable on Lending Term (VOLT) for individual PBS instead of Uniform on Lending Term (UOLT). It is observed from the VOLT Application index of the study report that out of 45 PBSs, 24 PBSs can pay interest at the rate of 3% to 5% and 13 PBSs have the ability to pay interest at the rate of 0.25% to 2.75% while the rest 8 PBSs cannot afford interest after payment of installment fallen due in a year.

In the project 'Efficient lighting initiative in Bangladesh (Part I)' it had been estimated to distribute 10.5 million energy saving Compact Fluorescent Bulb (CFL) in place of incandescent bulbs, resulting in savings up to 250 MW power. To meet up the objective of the project total amount of 10.5 Million CFL bulbs has been distributed by different electricity utility services under the project 'Efficient lighting initiative in Bangladesh (Part-1)'.

Section-II : Assessment of the outcome of the operation against the agreed objectives;

In the 'System loss reduction of taken over lines' project actually a total amount of 9,445 KM of PDB/ DESA line was handed over to PBSs. Of them, 8,478.93 KM of lines (6,564.50 KM under action plan and 1,914.43 KM beyond action plan) were handed over to the PBSs under SLR project. These lines include both non-municipal as well as municipal areas containing less than 3 (three) MW load. In this period against targeted 12,000 KM lines 11,295 KM renovation work was completed. Construction and augmentation of 30 sub-stations (7 new and 23 augmented) was completed.

System loss of 162 feeders could be brought down from 59.94% to minimum level of 13.70%. In addition, through implementing this project 5,51,865 nos. of consumers were connected into RE system. Initially 38 PBSs were selected under SLR project. But no PDB lines existed under 06 PBSs, so we had to deal with the taken over lines in 32 PBSs. In 32 PBSs, 11,295 KM lines renovation work has been done against 12,000 KM lines.

There were provisions of 02 Magistrate Courts. These courts were situated in Dhaka. At the initial stage, mobile courts operations were conducted in different PBSs. From February 2005 to December 2009 in those 59 months 23,518 nos. of cases were filed. Out of which 10,700 nos. cases were settled and 12,818 nos. of cases were on going. 128 mobile court operations were conducted by which 9,06,350.00 Taka as government fine was collected, 4,93,99,129.00 Taka of penal bills was collected and 7,47,61,493.50 Taka of outstanding bills was collected. Finally the total amount of 12,41,60,622.50 Taka has been recovered in favour of REB.

Previously the functions related to distribution system were done with the help of NRECA, USA. Presently the same tasks had been performed by the PBSs trained manpower. By reducing

system loss, net saving of PBSs becomes higher, as economic condition becomes better; consumers were benefited directly under this project. So, sustainable development of the project has been enhanced.

In 'Expansion and Intensification of 12 PBSs (Revised)' project, generally this project has been implemented for enhancing national economic growth and overall for the socio-economic development of rural areas of Bangladesh. Out of 8,458 KM targeted new lines 8,405 KM new line has been constructed where 2,883 KM taken over lines have been renovated and 14 nos. sub-stations have been constructed by which 2,28,741nos. consumers of different categories have been connected.

In 'Expansion and Intensification of distribution system of 15 PBSs (2nd Phase)' project by constructing 12,396 KM line, 15 nos. of new sub-stations and augmentation of 8 nos. of existing sub-stations, 4,09,200 nos. of consumers different categories have been connected under targeted 15 PBSs.

In 'Expansion and Intensification of 18 PBSs (Revised)' project by constructing 14,100 KM line, 18 nos. of new sub-stations and augmentation of 5 nos. of existing sub-stations, 3,46,944 nos. of consumers of different categories have been connected.

In the project 'Rural electrification through Solar Energy'11,796 SHS have been installed in the isolated areas. Against 11,000 connections the project was successfully done by installing 11,796 SHS. In the project 'Diffusion of renewable energy technologies-2nd phase' 1,200 SHS have been installed in the remote and isolated rural areas. Implementation of these projects have been promoted the alternative sources of energy and its expansion to meet the increasing demand of electricity in context of energy crisis. This project also has created the job opportunities in the remote areas.

In the project 'Environmental assessment and management training for rural electrification program in Bangladesh' trained 19 persons under EMC training schedule, of them 9 persons from EMC and 10 team leaders of electrical consultants. 332 persons from 70 PBSs have been trained under PBS training schedule. By this project REB has achieved its objective by developing necessary institutional capacity regarding environmental impact assessment (EIA) and environmental management plan (EMP).

After completion of the project 'Socio-economic monitoring & impact evaluation of rural electrification program in Bangladesh' it has been achieved that rural electrification enhanced emphatic socio-economic impact in the rural areas of Bangladesh. Literacy rate in the electrified house hold is 73%. Where in 2005 complete illiteracy rate was 21%, by 2010 it has come down to 14%. Average household annual income in 2005 increases from Taka 92,983.00 to in 2010 at 94,096.00 Taka. Domestic use of electricity increases in 2005 from 42.6 KW to 59.00 KW in 2010.

In the project 'Efficient lighting initiative in Bangladesh (part I)' 10.5 Million nos. of energy saving CFL bulbs were distributed and it has been found that about 146 MW energy was saved.

Section-III : Factors affecting Implementation, including overall enabling environment, factors relevant to specific components;

The SLR project started in 2002-2003 and completed in 2006. But due to delay in handling over PDB lines to REB, The World Bank suspended disbursement of 85.00 MUS$. As a result, materials could not be procured in time which in turn hampered the project works and ultimately the project could not be completed in stipulated time. So, the project period was over-run by 87.50%.

Moreover, it has to be noted that after disbursement of first tranche, the World Bank stopped the release of fund because of non-fulfillment of handling over lines as per credit agreement. Considering all these factors and utilizing the World Banks committed fund after being released, the implementation period was extended from 2002-2003 to 2007-2008. Again it was extended up to June 2009 without incurring additional cost. Due to non-availability of (Reimbursable Project Aid) RPA, project period was further extended up to December 2009.

In the 'System loss reduction of taken over lines' project 810 KM renovation work could not be accomplished due to non-handling over of lines, non-existence of PDB lines and consumers. Moreover, in some cases there were legal matters and as that was under trial and court embargo. Finally 705 KM renovation work could not be done due to aforesaid reasons. System loss of rest 07 feeders could not be reduced due to incomplete renovation work. In order to complete the renovation, some rehabilitation work has been done exceeding individual PBSs sanctioned work.

In 'Expansion and Intensification of 12 PBSs (Revised)', project Consumer connection was suspended during 2006-2007 FY due to Government embargo. Due to scarcity of supply of electricity, Government has imposed embargo on all types of line construction as well as providing consumer connection from November 2006-September 2007. Afterwards at the same ground providing consumer connection was again stopped from March 2010-December 2010. In the case of 'Expansion and Intensification of distribution system of 15 PBSs (2nd Phase)' and 'Expansion and Intensification of 18 PBSs (Revised)' project due to delay in handling over PDB lines to REB, the World Bank suspended disbursement of 85.00 MUS$. As a result materials could not be procured in time which in turns hampered the project works. As a result minor short fall in consumer connection occurred in fulfilling the project target.

In the project 'Diffusion of renewable energy technologies-2nd phase' due to non-funding from donor part of the project, out of 6,000 SHS, 1,200 SHS have been procured and installed.

Section-IV : Evaluation of the borrower's own performance during the preparation and implementation of the operation;

The rural electricity distribution system is based on the ownership and management of power distribution network by independent consumer owned co-operatives (PBS) functioning under the umbrella of an apex organization (REB). Both REB and PBSs have maintained a good track record in terms of operational and financial management. Though the performance of PBSs has been found to be significantly better, the financial condition of many of the PBSs continues to remain weak. Study conducted by Power Cell have indicated that financial condition of PBSs are

weak due to poor consumer mix and financial condition of many PBSs can be improved if small but concentrated load areas are transferred from PDB to PBSs.

Under these circumstances, Government has taken decision to rationalize operational areas of distribution utilities working in the same areas. As per latest government decision, all electric supply units and pockets having a load of 03 MW or less within a PBS geographical area will be handed over by PDB to PBSs. With this understanding, World Bank has agreed to finance loss reduction efforts in taken over areas as well as to support further extension of new lines of the PBSs.

In some cases of implementing projects due to aforesaid situation and suspension of committed fund from the World Bank, the project works were hampered. But REB was not solely responsible for these delaying situations. REB whole-heartedly tried to accomplish the project target.

Section-V : Evaluation of the performance of the Bank, any co-financiers or of other partners during the preparation and implementation of the operation;

Identification of the project components and analysis of technical, financial and economic issues during project preparation and appraisal was fully satisfactory. It has been accepted that project PBSs will need some time to become financially viable. At the time of project preparation, sector reform goals were not being pursued by the Bank or the Borrower. Enlarging the scope of responsibilities of the PBSs by rationalizing operational boundaries with the existing supply utilities was also not considered to be of major importance. Further, alternative technical developments in dispersed electricity supplies which could have effectively completed with grid extension were not viable at the time of project preparation. Under the RERED project there were difference in comparison to original PPs targeted work have to be accomplished. Also it is to be noted that after disbursement of funds, World Bank stopped the release of fund because of non-fulfillment of handing over lines as per credit agreement. Considering all these factors and utilizing the World Banks committed fund after being released, the implementation period was extended in almost all the projects.

Bank's dialogue with the Government focused on much more than the agreed objectives of the specific project and a significant contribution to rationalization of rural distribution networks was finally achieved. Accordingly the Bank's performance was rated as satisfactory.

Section-VI: Overall lessons learned as related to both borrowers' performance and Bank performance;

During implementation of the projects we learn things stated below:

- The target of RERED project of World Banks focus was to reduce system loss against taken over lines from PDB. If we go through the detail of the rich PBSs after completion of the project we will see that commercial system loss has been reduced remarkably.
- Most of the rich PBSs feeders and sub-stations were over loaded due to non-up gradation of distribution lines.

- Due to lack of manpower during the project implementation period the project work was highly hampered.
- Due to incomplete renovation work due to non-existence of lines and consumers, sue etc. targeted goal could not be accomplish in time and also due to delay of release of committed fund of World Bank. Materials could not be procured in time which in turn hampered the project works and ultimately the project could not be completed in stipulated time.
- Consumer connection was suspended during 2006-2007 FY due to governmental decision. Therefore, minor short fall occurred in consumer connection target.

Section-VII : Description of the proposed arrangements for future operation of the various project components;

REB needs to upgrade it's over loaded feeders and sub-stations and also renovate incomplete distribution lines as well. Also a large number of distribution transformers are presently over loaded and this over load situation need immediate addressing. Presently there are about one million analog meters are installed in the RE network and these meters need to be replaced by digital meters. As scope of work of REB is expanding, now it is our crying need to develop our manpower and also improve human resources through professional training in order to cope up with the global environment.

Section-VIII : Conclusion;

For sake of uniform and unique development of the country and to minimize the rural – urban difference rural electrification has an unparalleled role. Rural electrification already brought a phenomenal change in rural life. Rate of education has been increased; economic growth of rural people is remarkably visible, activity of rural people especially women empowerment and working opportunity has been increased radically through rural electrification. All these happened due to electrification and which was possible by the assistance of the World Bank.

Annex 8. Comments of Co-financiers and Other Partners/Stakeholders

N.A

Annex 9. List of Supporting Documents

1. Project Concept Note
2. Project Appraisal Document RERED, 2001
3. Project Appraisal Document, RERED II, 2012
4. Aide Memoires
5. Implementation Status Reports
6. Additional Financing Papers (2009 and 2011)
7. Restructuring paper (December 2012)
8. Implementation of the Bangladesh Compact Fluorescent Lamps (CFL) Program: Efficient Lighting Initiative for Bangladesh (ELIB) Technical Note June 2010, February, 2011 & August, 2011.
9. REB Midterm Report: Socio-Economic Monitoring & Impact Evaluation of Rural Electrification and Renewable Energy Program, 2006
10. REB Final Report: Follow-Up (Panel) Survey of Socio-Economic Monitoring & Impact Evaluation of Rural Electrification and Renewable Energy Program, 2010
11. BIDS Research Team: An Evaluation of the Impacts of Solar Home Systems in Bangladesh, 2012
12. Quality Assessment of Lending Portfolio (QALP-2) (QAG), 2010
13. REB Project Completion Reports (PCRs)
14. Policy Research Working Paper 4859, Welfare Impacts of Rural Electrification A Case Study from Bangladesh, The World Bank Development Research Group Sustainable Rural and Urban Development Team, March 2009
15. "Are micro-benefits negligible? The implications of the rapid expansion of Solar Home Systems (SHS) in rural Bangladesh for sustainable development", Energy Policy, 2010

Annex 10 : Key Indicators & Achievements

PDO level results indicator		Baseline	Original Target	Formally revised target			Actual	Year of Achievement	Comments
		2002	**2008**	(AF I) 2009	(AF II) 2011	(RP) 2012			
Expanded access to rural households through financing of solar home systems	Number of SHS	0	64,000	600,000	994,000		1,231,720	2013	Investment in this component were scaled in the the two additional financing further scale up the solar home systems component of the project
Expand renewable energy options for off-grid energy supply in rural areas	Number of mini- grids	0	3	3	4		3	2011	Two of the plants are operational at present. The third plant is had to be shut down as it was no longer viable
More efficient energy consumption through installation of compact fluorescent lamps	Number of bulbs	0	-	10,000,000	27,500,000	10,000,000	10,475,235	2010	The second phase of the CFL component is dropped with the project restructuring. The target now reflects only the CFL first phase
Grid Based connections for access to electricity	Number	0	700,000	NA	NA	NA	656,802	2009	
Intermediate Indicators									
Intermediate Result (Component One): Additional households receiving access to electricity through renewable energy sources									
Revised Intermediate Result (Component One): Additional households receiving access to electricity-: Revised in 2012									
Number of solar home systems installed.	Number	0	64,000	600,000	994,000		1,231,720	2013	
Number of renewable energy based mini-grid systems	Number	0	3	3	4		3	2011	
Number of households connected to the grid	Number	0	700,000	NA	NA	NA	656,802	2009	
Three packages of lines transferred to REB	Km of lines	0	9,400	12,000	NA	NA	11,295	2009	The original target was 9,400 KM of lines transfer which was later revised to 12,000 KM during the first additional financing.
To reduce system loss of distribution lines taken over from BPDB		More than 40% system loss	System loss reduced to less than 20%				13.7%	2009	This was not a part of 2012 restructuring paper but was an intermediate outcome earlier
Intermediate Result (Component Two): Promote more efficient energy consumption through installation of compact fluorescent lamps									
Number of incandescent bulbs replaced with energy efficient compact fluorescent lamps	Number			10,000,000	27,500,000	10,000,000	10,475,235	2010	

Annex 11: Project Timeline and Major Events

Event	Date	Description
Project effective	December 31st 2002	
First project extension	June 2008	Extended to June 30th 2009 to allow for completion of remaining activities mainly in the grid component
Second project extension	June 2009	Project extension to allow for preparation and submission of additional financing request
Additional financing (AF) and third project extension	December 2009	Additional financing request for scaling up support to the fast growing SHs component
Second additional financing and restructuring of PDO	August 2011	AF for SHS component and CFL component, PDO restructured to better reflect project objectives
RERED II project approved by the board	September 2012	Prior to project close, the board approves a second RERED II project to continue work on IDCOL SHS component, REB CLF component and introduce a new biomass component for household cooking through IDCOL
Restructuring of the project for cancellation of funds	December 2012	SDR 35.78 million (US$54.91 million) due to savings in solar home systems and scaling down of the CFL component
Project closed	December 31st 2012	

Annex 12: The Successful IDCOL SHS Model

IDCOL model has been a surprising success. At project design, there were people who thought 50,000 SHS could not be done in Bangladesh, but by Dec 2012 1.23 million SHS have been installed all over Bangladesh by the project (additional SHSs have been supported by other donors for a total of 1.8 million), a remarkable achievement within a period of 10 years. Since beginning the program, IDCOL has been recognized by international organizations as the benchmark for how distribution of SHS can be done successfully, and the model is also now being adapted for household cooking technologies in South Asia. Many papers written about the model, including Energy Policy "Impacts of Solar Home Systems on Social Development in Rural Bangladesh" and Renewable and Sustainable Energy Reviews: "Multitude of Progress and Unmediated Problems of Solar PV in Bangladesh", demonstrating how the model has been successful.

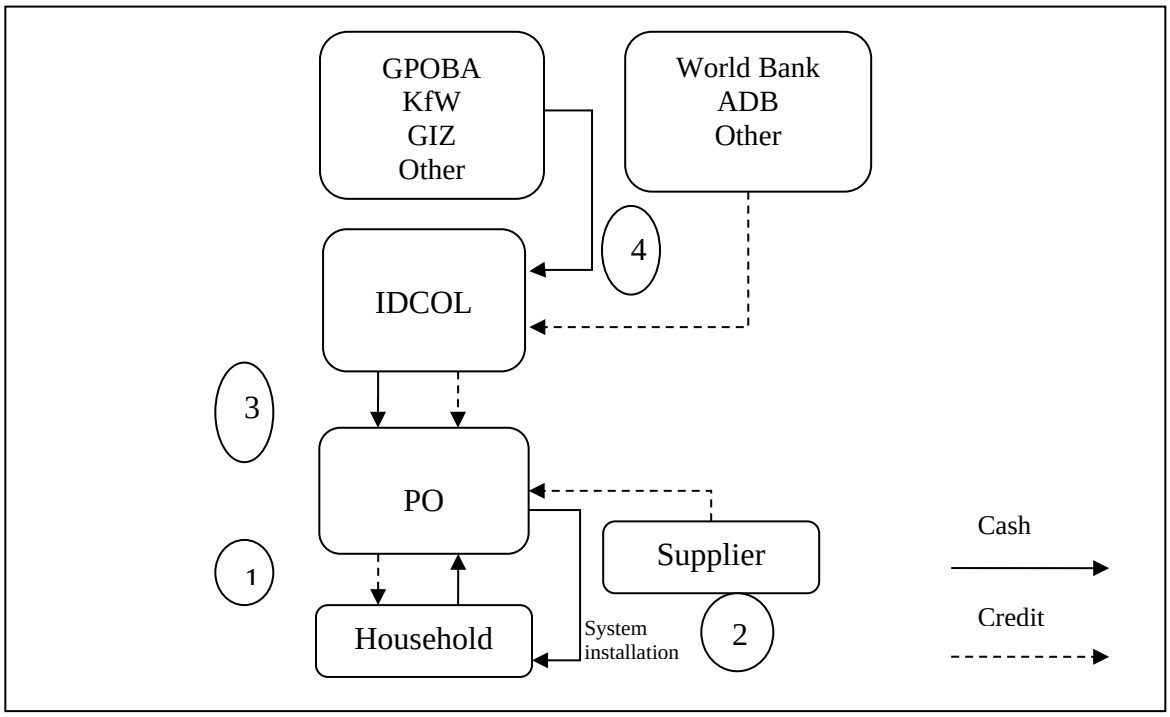
IDCOL manages the funds to support the programs. The sole responsibility of appraisal of fund requests, approval and disbursement of fund rests with IDCOL. It channels the fund through its partner organizations (POs) to the customers. An independent PO Selection Committee[18] selects the POs based on pre-determined eligibility criteria. IDCOL extends grant and loan support to the existing POs that sign Participation Agreement (PA). These POs identify the households and enterprises or other organizations for installing the SHS. The POs extend micro-credit to consumers to buy the systems and, in turn, obtain re-financing from IDCOL for up to 80% of the loans extended to consumers. On the financing mode for SHS under IDCOL sponsorship, there is a down payment that has to be made and also a payment in installment which also carries interest.

Figure 1 shows the basic structure of the SHS program. Structure of financing is as follows:

1. Under the PA, the households are required to pay minimum 10% of the system cost net of grant as down-payment. The remaining 90% is financed by loan. The lending terms from the POs would be at 12-15% per annum, as in other microfinance services they provide.
2. On receipt of the down-payment, the POs enter into a sale/lease agreement (provisions of which are approved by IDCOL) and install the system supplied by the Supplier. The systems must meet the specifications approved by the independent Technical Standards Committee (TSC) formed by IDCOL under the REP to approve quality equipment for the program.
3. After the installation, the PO applies to IDCOL to receive refinancing of their loan as well as applicable grant. IDCOL inspectors carry out physical verification of the SHS installed. Based on satisfactory verification, IDCOL provides grant to the POs for smaller SHS and also refinances 60% - 80% of their loan amount extended to the households.

[18] The committee consists of representatives from Economic Relations Division (ERD), Bangladesh Institute of Development Studies (BIDS), NGO Affairs Bureau, Palli Karma Shahayak Foundation (PKSF) and IDCOL

4. IDCOL then claims the loan funds used for refinancing from the World Bank, KfW Development Bank, Asian Development Bank, Islamic Development Bank and the Japanese Government . On receiving the funds from IDCOL, the PO pays back the suppliers. POs also import the equipment through L/C.



The key elements of the IDCOL SHS are:

Capacity Building of POs

Staff and Customer training: IDCOL conducts training programs to build awareness among the staff of the POs and the customers. Training is provided to the staff of the POs on SHS configuration, positioning of SHS, installation procedure and guidelines with measurements, maintenance and troubleshooting of SHS, guidelines for monitoring and inspection of SHS, market development, micro-credit methods for marketing, and maintenance of battery used in SHS. 75% of the total expense is sponsored by IDCOL and the rest is shared by the POs. Since SHS is entirely new to the households, consumer trainings are conducted regularly to educate them. They are trained on how to use the SHS and fix petty problems without waiting for the technicians.

Logistic support to POs: Each PO is given a computer for efficient documentation related to SHS installation. They are provided with tool boxes, motorcycle, demonstration kit, hydrometers and battery chargers according to their requisition for rendering better services to customers. Major share of the costs is sponsored by IDCOL.

Promotional support to POs: IDCOL develops and distributes publicity materials to raise awareness and popularize the use of SHS in different parts of the country. Posters, stickers,

leaflets, T-shirts, and billboards have been distributed and more will be provided to the POs for wider publicity of solar and other renewable energy technologies. TV and radio spots have also been developed and aired.

Maintain the standard of equipment

An independent **Technical Standards Committee (TSC)** is responsible for selection of equipment and the suppliers under IDCOL's REP. TSC comprises members from Engineering University, Rural Electrification Board, Local Government Engineering Division and IDCOL. The role of TSC is to determine technical standards for equipment to be financed, review the product credentials submitted by the suppliers, and approve the eligible equipment, and evaluate the feedback from the suppliers/dealers and POs to develop the industry standards for the PV equipment.

Verification / Inspection & Monitoring

Technical Inspector: IDCOL has technical inspectors who visit the SHSs installed in the remote areas of Bangladesh. They are posted under ten regional inspection offices of IDCOL under one regional supervisor in each office. If any technical fault is found during the inspection, they inform the respective POs and advise them to fix the problem within a certain time period. Regional supervisors follow up to ensure that the POs address these problems. Future disbursements against those systems will be withheld by IDCOL until the problems are resolved.

Inspection is also carried out from the PO's end. The representative of POs who are responsible to collect the monthly instalment inspects the SHS system during their visit of collecting the monthly instalment. In addition to this, officials of different level visit SHSs from time to time. Funds are released to the POs only after IDCOL is satisfied that SHSs have been installed.

Call centre: IDCOL has a call centre for receiving complaints from the customers. The call centre numbers are provided to the customers during installation of the SHS. Customers can directly contact IDCOL through these numbers and lodge their complaints. IDCOL relays the problems to the respective POs and advises them on how to fix them. Later on, IDCOL verifies the status of the problem by calling the customers directly. Future disbursements to the POs for the systems about which complaints have been received from customers are withheld by IDCOL until the problems are resolved. IDCOL officials also visit different remote areas to verify the physical and technical specifications of installed systems.

Technical audit: IDCOL carries out the technical audit by a third party periodically, at least once a year, to measure the quality standards of the installed SHS. During the technical audits individual household inspections and product testing are also performed. The results of the technical audit are shared with the respective POs as well as the equipment suppliers. IDCOL follows up on whether the problems identified thought technical audits have been addressed

Operations Committee: Chaired by the CEO of IDCOL and consisting of program-in-charges from all POs and representatives from IDCOL, OC regularly meets to look after the operational aspects of the SHS program, which include issues like installation of 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. In addition to the requirements as set in the PAs, decisions made in the OC meetings are also binding on the POs.

Battery Recycling

The RERED project had a very strict program for battery recycling. Batteries that have expired are all collected by the POs from the households and handed over to the battery manufacturers for recycling. To ensure proper recycling, IDCOL made it mandatory for all battery manufacturers to adopt ISO 14001-2004 (Environmental Management Standard) and OHSAS 18001:1999 (Occupational Health & Safety Management Systems) by June 2012 and after that time IDCOL no longer accepted any battery manufacturer without having these certifications. By project close, all battery manufacturers under the program had adopted ISO standards.

In order to incentivize consumers to recycle batteries, the POs pay the customers a portion of the cost of new battery as salvage value of the warranty-expired battery of similar capacity. The battery manufacturers then reimburse the salvage value amount to the POs on receipt of such batteries. Subject to availability of funds, IDCOL then pays USD$5 equivalent Taka as collection cost to POs. POs do not sell any new battery to the existing SHS customers without collecting the expired ones.

Success Factors

Several factors have contributed to the striking success of this program:

- A sense of ownership by consumers resulting in proper system care
- Customer training imparted by the POs enabling the customers to carry out regular repair and maintenance work themselves
- Social acceptability of the POs at the community level and the existence of a micro-credit culture in rural Bangladesh resulting in customer readiness to try the systems
- Institutional set-up of the POs enabling them to reach remote customers in a cost-effective and efficient manner
- Setting technical standards and Quality Control mechanisms such as physical inspection by technical inspectors and Independent technical and financial audit & technical standard committee. Enforcement of the standards through strong supervision and monitoring by IDCOL
- Risk sharing between IDCOL and the POs, proper customer selection, and attention by both IDCOL and the POs to collection efficiencies (the POs achieved an average collection efficiency of 94% and are servicing their debts owed to IDCOL on a timely basis)
- Ability to achieve low costs (SHS costs including a five year warranty for batteries and three years of maintenance is $8-9/Wp (net of subsidy)

Annex 13: REB Action Plan

The rural cooperatives (Palli Biddyut Samities, PBSs) under the oversight of REB have served the country well connecting about 8 million rural households. However, the institutional capacity of the REB/PBSs has not kept pace with the rapid expansion of the program. The weakened governance structures of the REB/PBS system have emerged as a key issue threatening the future sustainability of the rural electrification program. The gradual decline in the governance environment in the REB/PBS system originated largely from weak leadership at REB (starting in early 2000, REB has been led by civil servants, most of them lacking the required competence to run a specialized agency like REB).

In order for strengthening REB's operational and management capacity, an international consulting firm, SMEC in association with Power Planning Associates Ltd., UK and ACE Consultants Bangladesh Ltd., was appointed in 2009 for carrying out "Study to Assess Effectiveness of Current Organizational & Management Structure of REB of Bangladesh". This was supported under the Bank-financed Power Sector Development Technical Assistance (PSDTA) project.

The report came out with the observation that there was no strategic plan to develop and monitor GOB's Rural Electrification (RE) objectives. PBSs' financial performance deteriorated significantly over the past 10 years, and RE expansion outstripped REB's capacity to monitor and control each and every aspect of the PBSs which in turn has affected the effective development of RE management. Hence the most immediate pressing concerns affecting the capacity of REB were to develop a comprehensive strategic plan which restored financial sustainability, and to ensure more efficient management of the rural power sector.

The main recommendations of the study were to incorporate REB as a Company under the Companies Act with separation of Board and management. The study also recommended creation of Zonal Rural Electricity Companies (ZREC) consolidating several PBSs under each such company. Under such structure, REB as a company will retain only the financing role, while the planning and design, procurement, and construction functions will be handed over to the ZRECs. In the long term, capable PBSs will be fully independent as a full-fledged utility.

The SMEC report was presented in a stakeholder workshop in May 2010, and the recommendations were not accepted by GOB, REB and other stakeholders. It was indeed apparent that the SMEC report recommendations were not backed by adequate analyses. The report identified the weaknesses and challenges well, but the study recommendations were not apparently addressing the problems/challenges.

As a follow-up, the Bank fielded a team of senior consultants to collaborate with GOB and REB to come to an agreement on the key challenges facing the RE program and review the options to address them. After a wide range of consultations with various levels of staff from REB and the PBSs, consensus emerged that REB needed to strengthen its capacity and the PBSs needed to be delegated more authority to ensure timely decision making and effective services to the clients. A reform action plan was developed on three key broad areas: i) strengthening REB Board with professionals; ii) establishing zonal offices of REB for managing the growing program; and iii)

more delegation of authority to the PBSs. The action plan is currently under review by the Ministry while some elements like more delegation of authority to the PBSs have already started to be implemented.

Strengthening REB Board. The action plan includes proposal for one new full-time member with an engineering qualifications to be included in REB Board. Two new part-time members (one from the Power Grid Company of Bangladesh), and one academic with Finance background) will be included in REB Board.

REB Zonal offices. Eight new Zonal Offices have been proposed in the revised organogram with higher authority under eight Additional Chief Engineers. The proposed Zonal Offices will need 1,166 persons in place of the present 52 of Executive Officers' offices. 19 new offices/departments have been proposed in the revised organogram, as well as a few new positions to cater to the new work dimension. The total number of positions in the revised REB organogram stands at 2,074 in place of present approved 1,218.

Delegation of Authority to the PBSs. The PBSs have been divided in two categories, Category-A PBSs are to be headed by Senior General Managers, and to have Additional General Managers; and the rest of the PBSs would be under Category-B with revised set-up to be headed by General Managers. PBSs are to be delegated with higher responsibility with wider scope of work in respect of finance, engineering and administration. A revised Service Code for the PBSs has been proposed as well. Some of the proposals for increased delegation of authority have already started to be implemented.

The Bank is currently in the process of designing its next engagement with the REB/PBSs extending support for augmentation and rehabilitation of the rural grid distribution network. Implementation of the action plan is expected to be a critical element in this next phase of support.

Annex 14. Project Achievement toward PDO and Indicators

Expand access to electricity in rural areas of Bangladesh through financing of solar home systems. This was achieved through the internationally recognized success of the sale of SHS by IDCOL partner organizations (POs). It was also contributed to by the establishment of pilot renewable energy mini-grids.

- *SHS:* A total of 1,231,720 million SHS were installed through the project with support from the Project.

REB: The REB's fee-for-service approach provided SHS to 11,796 households.

Expand renewable energy options for off-grid energy supply in rural areas: Three renewable energy mini-grids were implemented by IDCOL, two of which reached 201 consumers, 158 commercial and 28 households.

More efficient energy consumption through installation of compact fluorescent lamps. This was achieved under the first AF through the distribution of roughly 10.5 CLF blubs. Though there were issues with the quality of the bulbs, the distribution raised awareness among rural households, and increased the prevalence of CFL use across the country.

Grid Based connections for access to electricity. Between 2002 and 2009 REB made 656,802 new grid connections, against an original target of 700,000. REB fell short of the target due to a government issued moratorium in 2006 which, due generation constraints and large-scale load shedding in the country, prohibited additional grid connections from being made.

Reduction of system loss of REB taken over pockets from BPDB through renovation. Between 2002-2009, 11,295 km of line were transferred from BPDB to REB and renovated decreasing system loss from an overall average of 59.94% over 31 PBS in 2002 to 13.7% in 2009.

In addition to these indicators measured in the ISRs, there were several additional indicators included in the original PAD that measured the achievement towards the overall PDO of "raising levels of social development and economic growth by increasing access to electricity in rural areas of Bangladesh." These included:

Education - enhanced through improved lighting. The impact evaluation studies supported under the project showed a change in education in both newly grid connected households and households with SHS. The REB 2010 impact analysis showed study time in the evening goes up by 21 minutes/day for boys and 12 minutes/day for girls in the grid connected households. Findings from 2012 SHS impact assessment shows boys and girls in SHS households on average study 10-12 minutes longer compared to their counterparts in non-SHS households. The SHS study also found that boys and girls in SHS households have completed more schooling than those in non-SHS households. Because of the increased quality of SHS lighting over the traditional kerosene illumination, it is also expected to have an impact on the number of years of schooling, but is still too early to conclude this. REB's impact analysis on grid connected

households found that illiteracy rates went down in 2010 to 14% from 21% in 2005 and that the average number of years in school increased to 6.86 in 2010 over 6.43 in 2005.

Quality of Life – improved from higher safety, comfort and convenience; such as improved lighting inside and outside, replacing kerosene and use of appliances (TV, radio, fan, refrigerator).

Safety and Security: REB 2010 impact analysis showed women's mobility had increased, reporting feeling more secure when traveling to health complexes, clinics, schools, learning centers, NGOs and other places. The 2012 SHS impact analysis similarly found increased mobility and increased feelings of security among female respondents.

Access to improved appliances: In 2010 REB found that households with new grid connection under the project households began using electric fans, television sets, refrigerators, cassette players, irons and mobile phone charging. With SHS, half of all SHS users have a television.

Women Empowerment: Improved education among girls and easier access to news and information specifically on women developmental issues through television and radio

Empowerment: Certain aspects of women's empowerment have improved as a result of the adoption of SHS, such as independence in their mobility, ability to purchase household goods and economic decision making in various household and children welfare issues. The SHS impact study found that SHS homes had statistically better empowerment outcomes, specifically their mobility, general decision making and economic decision making, than those households without SHSs. REB 2010 study showed women were able to get more information about home and abroad through watching television, and subsequently were more aware of reproductive health, children's health, family planning and other social (early marriage, dowry) and environmental (forestry) issues.

Access to Information – specifically on health: Although there was no significant difference in health outcomes between the members of the SHS households and that of the non-SHS households, having a TV within the SHS households seems to make a significant difference in health outcomes for women. Among the SHS households, girls from those with a TV set were about 4 percentage points less likely to suffer from respiratory and gastro-intestinal diseases than their counterparts from SHS households without a TV set. The study also found that contraceptive prevalence was higher and recent fertility was lower among married women in households with SHS that use a black and white television. REB 2010 study suggested that access to reliable mobile phone charging allowed women to communicate with doctors in the case of emergency.

Direct impact on income: reduced cost for access to: (i) lighting; (ii) news, information and entertainment; and (iii) electricity for those using electricity from other sources prior to formal access such as batteries. Analysis of REB 2005 survey data found that rural electrification increases household income by 21% and expenditure by 11%. The REB survey also showed electrified households save money on kerosene, by using 2 liters less of kerosene per month than electrified households. Users of SHS use 66% less kerosene per month than

households without SHS. Both grid and SHS users also save money by access to cost-free mobile phone charging.

Enhance rural productivity, development opportunities and reduce poverty through increased access to electricity. REB 2010 study reported electrification improving incomes and the association with increased labor use and wages of commercial enterprises. Also according to REB, there were a total of 742,194 units connected to the grid in 2008. Most of these commercial units are in the service sector (shops, saloons, restaurants). It was found that income was increased by Tk.214.8 billion per annum for commercial enterprises. For non-electrified commercial units, there was little change in income over time, while for electrified (on grid) units, gross incomes rose by over 2.8 times between 2005 and 2010. Econometric estimates using alternative estimation techniques confirm that electricity usage has a positive and significant impact on income and productivity, but in practice, supply constraints have impeded the flow of benefits.

Safe drinking water: clean water for drinking, especially in areas where ground water contains arsenic. Although a handful of new pumps were installed using new project connections, this indicator quickly became irrelevant as the government took alternative measures to discourage people from drinking from deep-wells. In 2006 under a nationwide arsenic testing program supported by the Government of Bangladesh and UNICEF, a program was implemented to distinguish safe wells from arsenic-contaminated wells using red or green color markings. After this, people knew which wells were safe and which were contaminated, and this indicator became obsolete and the work on clean drinking water was no longer within the scope of the RERED project.

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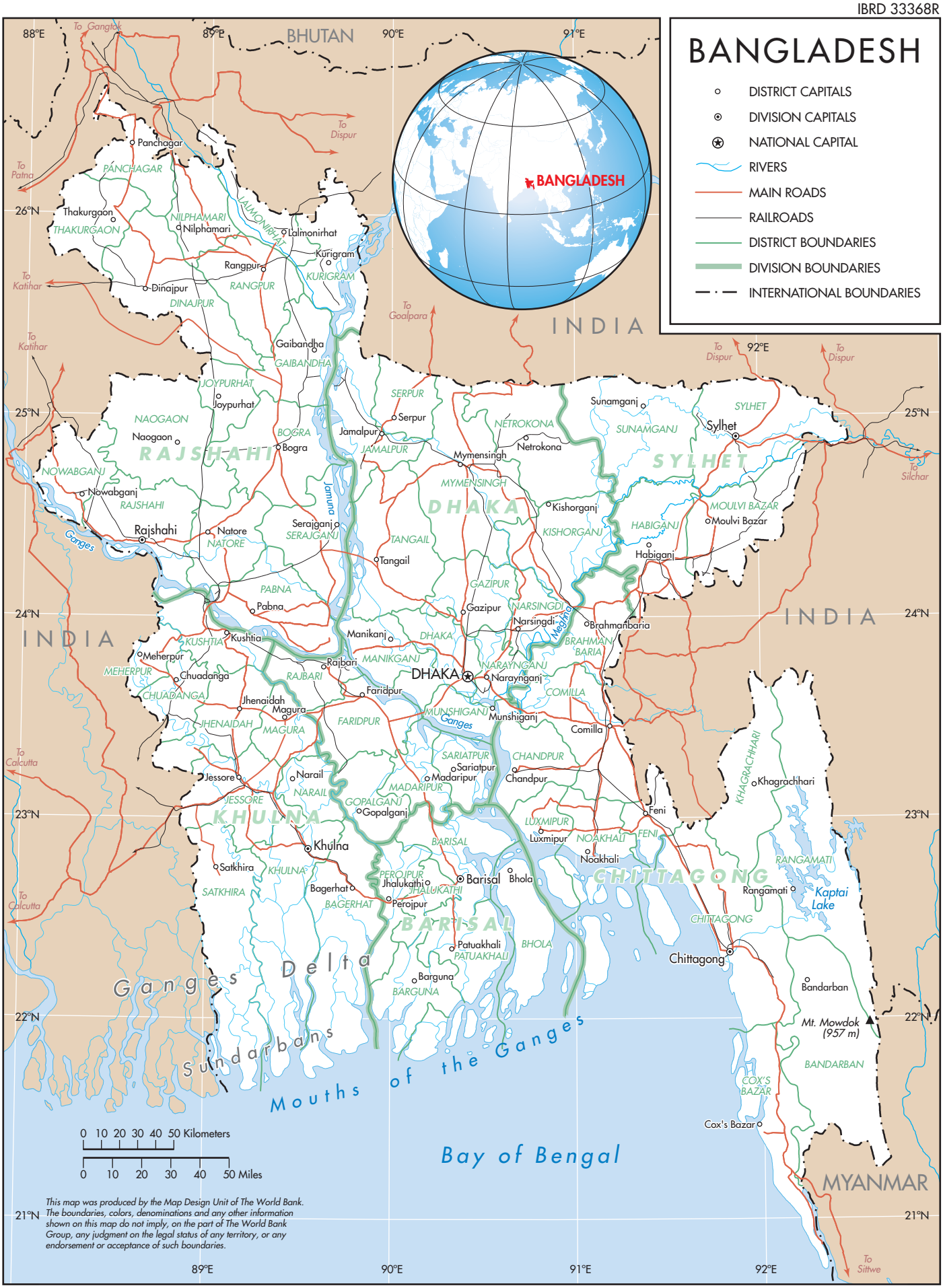

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