Document of
The World Bank

Report No: ICR2151

IMPLEMENTATION COMPLETION AND RESULTS REPORT
(IDA-H2630 TF-90858 TF-57330)

ON AN

IDA GRANT
IN THE AMOUNT OF SDR2.37 MILLION
(US$3.5 MILLION EQUIVALENT)

AND A

GLOBAL ENVIRONMENTAL FACILITY GRANT
IN THE AMOUNT OF US$3.5 MILLION

TO

MONGOLIA

FOR THE

RENEWABLE ENERGY AND RURAL ELECTRICITY ACCESS PROJECT

December 17, 2012

China and Mongolia Sustainable Development Unit
Sustainable Development Department
East Asia and Pacific Region

CURRENCY EQUIVALENTS

Currency Unit = Mongolian Tugrik (MNT)

At Appraisal Effective October 31, 2006	At Completion Effective June 30, 2012
MNT 1,165 = US$1.00 US$1.478 = SDR 1.00	MNT 1,330 = US$1.00 US$1.52= SDR 1.00

FISCAL YEAR
January 1 – December 31

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
Aimag	Equivalent to province
ASTAE	Asia Sustainable and Alternative Energy Program
CAS	Country Assistance Strategy
CO_2	Carbon Dioxide
CPS	Country Partnership Strategy
EA	Energy Authority
GEF	Global Environment Facility
GEO	Global Environment Objective
GOM	Government of Mongolia
GON	Government of the Netherlands
GHG	Green House Gas
ICR	Implementation Completion and Results Report
IDA	International Development Association
kLh	Kilo Lumen Hour
kWh	Kilowatt Hour
M&E	Monitoring and Evaluation
MMRE	Ministry of Mineral Resources and Energy
MNT	Mongolian tugrik
MOF	Ministry of Finance
NGO	Non-government Organization
NREC	National Renewable Energy Center
PAD	Project Appraisal Document
PDO	Project Development Objective
REAP	Renewable Energy and Rural Electricity Access Project
PID	Project Information Document
PIU	Project Implementation Unit
PV	Photovoltaic
RET	Renewable Energy Technology
R/RDHS	Renewable or Renewable-diesel hybrid system
Soum	Subdivisions of Aimag, equivalent to prefecture or rural village
SC	Soum Center
SSC	Sales and Service Center
SHS	Solar Home System
SIL	Specific Investment Loan
TA	Technical Assistance
WTS	Wind Turbine System

Vice President:	Pamela Cox, EAPVP
Country Director:	Klaus Rohland, EACCF
Country Manager	Coralie Gevers, EACMF
Sector Managers:	Mark Lundell, EASCS
Project Team Leader:	Peter Johansen, EASWE
ICR Team Leader:	Peter Johansen, EASWE

MONGOLIA
Renewable Energy and Rural Electrification Access Project

CONTENTS

A. Basic Information			
Country:	Mongolia	Project Name:	Renewable Energy for Rural Access Project (REAP)
Project ID:	P099321,P084766	L/C/TF Number(s):	IDA-H2630,TF-90858,TF-57330
ICR Date:	12/17/2012	ICR Type:	Core ICR
Lending Instrument:	SIL, SIL	Borrower:	Government of Mongolia
Original Total Commitment:	XDR2.37M, USD3.50M	Disbursed Amount:	XDR2.31M, USD3.03M
Environmental Category: C,C		**Focal Area**: C	
Implementing Agencies: Ministry of Mineral Resources and Energy (MMRE) supported by Energy Authority			
Cofinanciers and Other External Partners: Government of the Netherlands			

B. Key Dates

Renewable Energy for Rural Access Project (REAP) - P099321				
Process	**Date**	**Process**	**Original Date**	**Revised / Actual Date(s)**
Concept Review:	02/16/2006	Effectiveness:	05/04/2007	05/04/2007
Appraisal:	10/02/2006	Restructuring(s):		08/05/2009 11/04/2011
Approval:	12/19/2006	Mid-term Review:	11/30/2008	09/21/2009
		Closing:	12/31/2011	06/30/2012

MN- Renewable Energy for Rural Access - GEF - P084766				
Process	**Date**	**Process**	**Original Date**	**Revised / Actual Date(s)**
Concept Review:	02/16/2006	Effectiveness:		05/04/2007
Appraisal:	10/02/2006	Restructuring(s):		08/05/2009 11/04/2011
Approval:	12/19/2006	Mid-term Review:	11/12/2009	09/25/2009
		Closing:	12/31/2011	06/30/2012

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:	Moderately Satisfactory	Implementing Agency/Agencies:	Satisfactory
Overall Bank Performance	Satisfactory	Overall Borrower Performance	Satisfactory

C.3 Quality at Entry and Implementation Performance Indicators			
Renewable Energy for Rural Access Project (REAP) - P099321			
Implementation Performance	**Indicators**	**QAG Assessments (if any)**	**Rating:**
Potential Problem Project at any time (Yes/No):	No	Quality at Entry (QEA)	None
Problem Project at any time (Yes/No):	No	Quality of Supervision (QSA)	None
DO rating before Closing/Inactive status	Highly Satisfactory		

MN- Renewable Energy for Rural Access - GEF - P084766			
Implementation Performance	**Indicators**	**QAG Assessments (if any)**	**Rating:**
Potential Problem Project at any time (Yes/No):	No	Quality at Entry (QEA)	None
Problem Project at any time (Yes/No):	No	Quality of Supervision (QSA)	None
GEO rating before Closing/Inactive Status	Satisfactory		

D. Sector and Theme Codes

Renewable Energy for Rural Access Project (REAP) - P099321		
	Original	Actual
Sector Code (as % of total Bank financing)		
Central government administration	8	10
General education sector	1	0
Health	1	0
Renewable energy	90	90
Theme Code (as % of total Bank financing)		
Climate change	25	25
Regulation and competition policy	25	25
Rural services and infrastructure	50	50

MN- Renewable Energy for Rural Access - GEF - P084766		
	Original	Actual
Sector Code (as % of total Bank financing)		
Central government administration	34	34
Renewable energy	66	66
Theme Code (as % of total Bank financing)		
Climate change	40	40
Regulation and competition policy	20	20
Rural services and infrastructure	40	40

E. Bank Staff

Renewable Energy for Rural Access Project (REAP) - P099321		
Positions	At ICR	At Approval
Vice President:	Pamela Cox	James W. Adams
Country Director:	Klaus Rohland	David R. Dollar
Sector Manager:	Mark R. Lundell	Junhui Wu
Project Team Leader:	Peter Johansen	Arturo S. Rivera
ICR Team Leader:	Peter Johansen	
ICR Primary Author:	Ivy H. Cheng	

MN- Renewable Energy for Rural Access - GEF - P084766		
Positions	**At ICR**	**At Approval**
Vice President:	Pamela Cox	James W. Adams
Country Director:	Klaus Rohland	David R. Dollar
Sector Manager:	Mark R. Lundell	Junhui Wu
Project Team Leader:	Peter Johansen	Arturo S. Rivera
ICR Team Leader:	Peter Johansen	
ICR Primary Author:	Ivy H. Cheng	

F. Results Framework Analysis

Project Development Objectives (from Project Appraisal Document)
The development objective of the proposed project is to increase access to electricity and improve reliability of electricity service among the herder population and in off-grid soum centers.

Revised Project Development Objectives (as approved by original approving authority)
PDO was not revised.

Global Environment Objectives (from Project Appraisal Document)
The global environment objective is to remove barriers to the development and use of renewable energy technologies in grid and off-grid connected systems and reduce emissions of carbon dioxide. The rehabilitation of the soum mini grid will further reduce diesel fuel consumption of the hybrid systems with additional CO_2 emissions reduction benefits.

Revised Global Environment Objectives (as approved by original approving authority)
GEO was not revised

(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 :	% of herders served by reliable SHS and small WTS			
Value (quantitative or Qualitative)	15%	50%		62.5%
Date achieved	12/31/2006	12/31/2011		06/30/2012
Comments (incl. % achievement)	Appraisal target significantly surpassed.			

Indicator 2 :	Number of people in off-grid Soum centers with reliable and affordable electricity generated by renewable energy or hybrid systems			
Value (quantitative or Qualitative)	Negligible	16,000		18,410
Date achieved	12/31/2006	12/31/2011		06/30/2012
Comments (incl. % achievement)	Appraisal target exceeded by about 2,410 persons or 15%.			

(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 :	Estimated GHG emission reduced as a result of the project (CO_2 ton/year)			
Value (quantitative or Qualitative)	0	9,000 ton/year		11,333 ton/year,
Date achieved	12/31/2006	12/31/2011		06/30/2012
Comments (incl. % achievement)	Appraisal target exceeded by 2,333 ton/year or about 26%.			

(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 RET Information Centers/SSCs created			
Value (quantitative or Qualitative)	0	50		50
Date achieved	12/31/2006	12/31/2011		06/30/2012
Comments (incl. % achievement)	Target fully met.			
Indicator 2 :	Total sale of SHS systems under the Project			
Value (quantitative or Qualitative)	0	50,000		67,224
Date achieved	12/31/2006	12/31/2011		06/30/2012
Comments (incl. % achievement)	67,224 systems supplied and operating satisfactorily or still under warranty. Exceeded appraisal target by 17,224 systems or about 34%.			

Indicator 3 :	Number of Soum User Associations Established			
Value (quantitative or Qualitative)	0	30		15
Date achieved	12/31/2006	12/31/2011		06/30/2012
Comments (incl. % achievement)	15 Soum center grids are managed under Aimag utilities, the other 15 soum center grids under the project were connected to the national grid and no SUA was established.			
Indicator 4 :	Number of Soum Utilities providing systematic reports of costs and revenues			
Value (quantitative or Qualitative)	0	30		15
Date achieved	12/31/2006	12/31/2011		06/30/2012
Comments (incl. % achievement)	15 systems transferred to the Aimag utilities; 15 Soums connected to the grid so no Soum utility is operating the new RETs.			
Indicator 5 :	Number of Soum grids rehabilitated			
Value (quantitative or Qualitative)	0	30		15
Date achieved	12/31/2006	12/31/2011		06/30/2012
Comments (incl. % achievement)	Of the 30 grids selected, GOM rehabilitated 15, leaving 15 for REAP. All had scope of work expanded.			
Indicator 6 :	Number of RET/hybrid systems built (to replace existing diesel plants)			
Value (quantitative or Qualitative)	0	20		15
Date achieved	12/31/2006	12/31/2011		06/30/2012
Comments (incl. % achievement)	Of the 20 selected, GOM connected 5 to the national grid, leaving 15 for REAP. Of which 4 funded by IDA/GEF/GON, and 11 funded by GOM.			
Indicator 7 :	National Grid-connected Renewable Energy Action Plan			
Value (quantitative or Qualitative)		Final Report by 2009		Final Report completed
Date achieved	12/31/2006	12/31/2011		06/30/2012
Comments (incl. % achievement)	Mongolia adopted a Renewable Energy Law in January 2007, which covered the intended content of this action plan.			

G. Ratings of Project Performance in ISRs

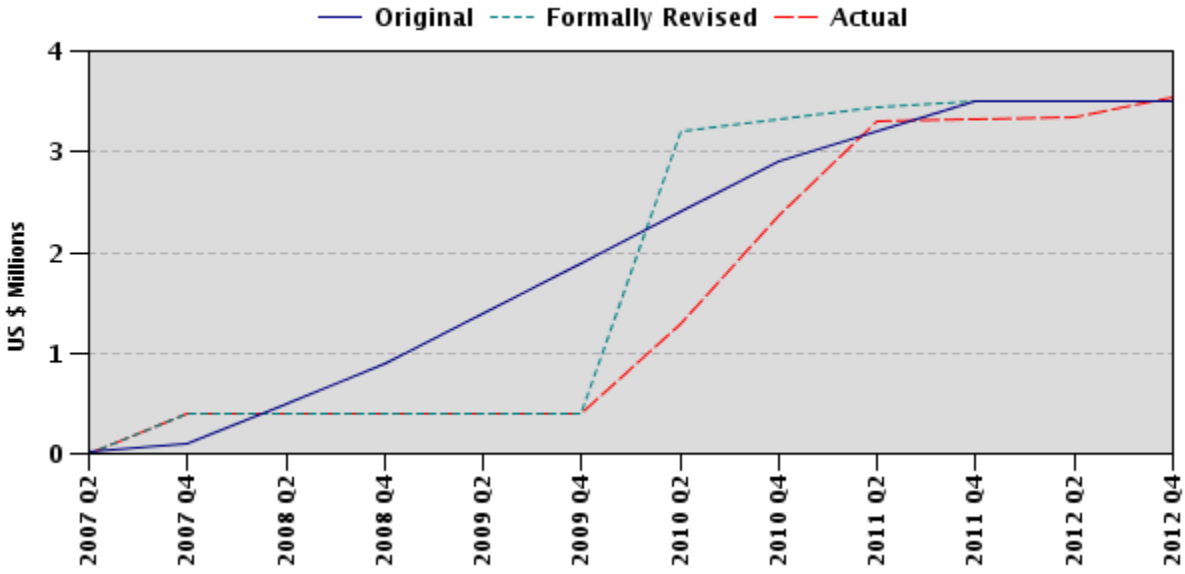
-						
No.	Date ISR Archived	DO	GEO	IP	Actual Disbursements (USD millions)	
					Project 1	Project 2
1	01/09/2008	S	S	S	0.40	0.40
2	04/22/2009	S	S	MS	0.40	0.60
3	12/11/2009	S	S	S	1.30	0.78
4	06/27/2011	HS	S	HS	3.33	2.57
5	01/18/2012	HS	S	HS	3.35	2.68

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	
08/05/2009	N		S		MS	0.40		To allow bulk procurement of SHS, more substantial grid rehabilitation, and GOM reorganization
08/05/2009				S	S		0.60	
11/04/2011			HS		HS	3.35		Reallocation of savings and closing date extension
11/04/2011		N		S	HS		2.68	To be in sync with IDA

I. Disbursement Profile

P099321



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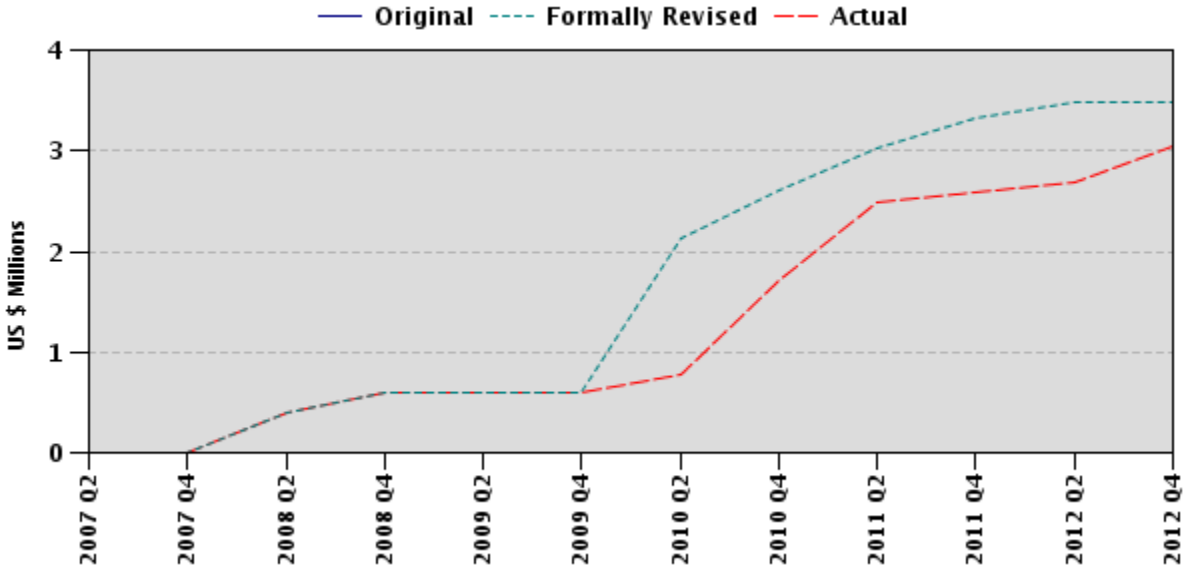

1. Project Context, Development and Global Environment Objectives Design

1.1 Context at Appraisal

At the time of project appraisal, Mongolia had already made strides in achieving macroeconomic stability and fundamental structural reforms since its transition to democracy and a market based economy. The prevailing development challenge was to improve the lives and welfare of its people and reduce poverty by accelerating sustained and equitable economic growth. This agenda was particularly daunting in Mongolia's vast rural areas where more than a million people (over 40 percent of the population) lived, either as nomadic herders or as residents of Soum (equivalent to prefecture or village) centers which were hubs of public and commercial institutions serving the herders.

The power sector in Mongolia was essentially made up of three markets. The largest included all grid-connected regions where service reliability was relatively high. It accounted for about 97 percent of total supply. The second market consisted mainly of stand-alone diesel generators operated by local administrations in off-grid Soum centers (SC). Reliability of service varied by location and season due to high operating costs, frequent interruption in diesel supply, funding constraints, poor cost recovery and high system losses. These systems accounted for about three percent of the country's total electricity supply. The third market covered the widely scattered nomadic herders. It was highly decentralized and largely undeveloped as most herders had no access due to limited affordability and substantial logistic difficulties. This market represented only a trace quantity of electricity usage that amounted to less than one percent of the country's total.

The Government of Mongolia (GOM) was keenly aware of its rural population's predicament. It was also eager to find a solution that would take advantage of the country's rich renewable energy resources (mainly wind and solar) while preserving the traditional nomadic lifestyle of the herders. With these objectives in mind, a rural electrification strategy based on a combination of grid and off-grid solutions was formulated. It consisted primarily of renewable energy technologies (RET) such as the adoption of solar home systems (SHS) and wind turbine systems (WTS), two mature and highly portable technologies, for the herders; and the development of renewable or renewable-diesel hybrid systems (R/RDHS) for the SCs. Key barriers to successful implementation of this strategy were identified: institutional and regulatory vacuum as the economy moved to a market-based system; lack of information and experience with international best practices; shortage of funds; and high risk perception among key stakeholders such as consumers, government and the private sector.

The Renewable Energy and Rural Electricity Access Project (REAP) was designed to help remove some of these barriers through an integrated program of technical assistance (TA) and physical investments. It was consistent with the prevailing FY 2005-2008 Country Assistance Strategy (CAS) and aligned with the Government's rural

electrification strategy. The Bank was in a unique position to assist GOM as it had been a major partner in the energy sector with support for the ongoing Energy Sector Project (Cr 4673-MN, approved in FY2001). Its continued support was considered crucial in revitalizing the rural electrification effort which was showing obvious signs of stagnation as donor funding was depleted. The Bank's involvement not only would bring its international experience and knowledge to bear but would also help leverage new commitments from the international donor community (refer to Section 2.1).

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

The development objective of the project was to increase access to electricity and improve reliability of electricity service among the herder population and in off-grid SCs. The key indicators included: (a) increase in the percent of herder population with access to reliable electricity services provided by SHSs and WTSs; and (b) increase in the number of people in off-grid SCs with improved reliability of electricity services supported by R/RDHS.

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

The global environment objective was to remove barriers to the development and use of RET in grid and off-grid systems and reduce emissions of carbon dioxide (CO_2). The rehabilitation of the Soum mini grids would further reduce fuel consumption of the hybrid systems, with additional CO_2 emissions reduction benefits. The key indicator is avoided CO_2 emissions resulting directly from the project.

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

The PDO and the key indicators were not revised.

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

The GEO and the key indicator were not revised.

1.6 Main Beneficiaries

The main beneficiaries of the project are: about 67,000 herder households which acquired SHSs at subsidized prices (at a discount of about 50 percent); private sector and government enterprises that distribute, sell and service SHSs across the country; rural electricity consumers including households, small businesses and public entities such as schools and clinics in selected Soums; Soum power utilities that had their mini grid rehabilitated and new RET equipment installed; Aimag (equivalent to province) utilities that eventually took over the operation of the RETs; and private businesses in rural Mongolia that marketed associated goods and services such as small electrical supplies and appliances because of increased electricity access. In addition, the TA and training

activities also benefitted public power sector institutions as well as national and local governments of Mongolia.

1.7 Original Components (as approved)

The project is comprised of three components:

Component A: Herders' Electricity Access (US$11.6 million) – to develop and enhance a rural retail and service network for SHSs and small WTSs; and to facilitate the acquisition of at least 50,000 systems by herders over five years (with an estimated US$10 million leveraged investment by herders). The objectives would be achieved through TA in sales and service network development, equipment quality control, marketing and sales/service support; and smart subsidies to buy down acquisition costs.

Component B: Soum Center Electricity Service (US$10.1 million) – to develop the institutional and technical capacity of off-grid SC electricity services; and to invest in mini grid rehabilitation and R/RDHSs. The objectives would be achieved through TA and physical investments. Specifically, TA in the development of a policy and regulatory framework for Soum electricity service; establishment of Soum electricity user associations and SC utilities; technical and feasibility studies for the construction of small R/RDHSs and rehabilitation of Soum grids; and energy management in various Soum level public institutions. Investments would include rehabilitation of mini grids in about 30 off-grid SCs; and conversion of existing diesel generation units to R/RDHSs in about 20 of the rehabilitated mini grids.

Component C: Institutional Capacity Building (US$1.3 million) – to strengthen national renewable energy policy development and to support project management. The objectives would be achieved through assistance in the development of a regulatory framework; support for project management, monitoring and evaluation (M&E); and institutional development of the National Renewable Energy Center (NREC) through training, business planning and work program development.

1.8 Revised Components

The components were not officially revised but the scopes of some subcomponents was modified in response to changes in the operating environment brought about by the ongoing government reform, and in an effort to keep pace with GOM's initiatives to speed up rural electrification to meet evolving electricity demand. The modifications were endorsed by Bank management in two Level II restructurings in August 2009 and November 2011, as summarized in Section 1.9 below.

1.9 Other significant changes

As discussed under Section 2.2 - Implementation, the Herders' Access Component suffered a sluggish start, and the SC Rehabilitation Component was not able to keep pace with the Government's expedited implementation of its rural electrification program (including the rehabilitation of 15 of the 30 grids selected for the project, using its own

resources outside of REAP commitments). The purpose of the August 2009 restructuring was to scale up implementation of Component A by allowing bulk procurement of SHSs through the reallocation of US$3.2 million from the Government of the Netherlands (GON) grant financed "smart subsidy" subcomponent; and to provide for more substantial rehabilitation or replacement of the 15 remaining dilapidated Soum mini grids under Component B.

The reorganization of GOM in 2009 impacted the implementation arrangements for the project. The new Ministry of Mineral Resources and Energy (MMRE) which replaced the former Ministry of Fuel and Energy became the main agency responsible for REAP. The Energy Authority (EA), established to implement the Government's energy sector policies and projects, also took over from the National Renewable Energy Center (NREC). Consequently, supervision of the Project Implementation Unit (PIU) became the responsibility of the EA, while oversight remained with the REAP Steering Committee under the MMRE. These changes necessitated amendments to the various grant and financing agreements but in reality had limited impact on the day-to-day functioning of the PIU as its staff remained largely intact during and after the transition.

The project likely benefitted from additional Government budget allocations for rural electrification. For instance, in 2007, the adoption of Resolution 50 provided MNT 61.3 billion (about US$51.1 million equivalent) to connect 50 SCs to the central grid, and MNT 8.7 billion (about US$7.2 million equivalent) to build R/RDHSs to power 10 SCs. The expedited investment program might have enhanced REAP's flexibility in that it was able to focus more on Component A. It also enabled the project to concentrate its resources on the rehabilitation of fewer mini grids (15 out of 30 planned) and installation of fewer RETs (15 out of 20 planned) under Component B. The swift adoption of the Energy Law in 2007 rendered some of the planned TA activities obsolete. All these changes, while not detrimental to the project's ultimate success in meeting its PDO and GEO, did require a flexible approach to implementation. They also, regrettably, created some quality and sustainability issues associated with Component B. (Refer to Section 2.2 and Annex 2)

The purpose of the November 2011 restructuring was to reallocate savings of about US$290,000 from Components B and C to modestly scale up the "smart subsidy" program under Component A; and to extend the closing dates by six months from December 31, 2011 to June 30, 2012.

2. Key Factors Affecting Implementation and Outcomes

2.1 Project Preparation, Design and Quality at Entry

Soundness of Background Analysis. The project was consistent with the prevailing CAS's core objectives of consolidating Mongolia's transition to a market economy and reducing vulnerability by enhancing rural development and environmentally sustainable development. It was aligned with the Government's Economic Growth and Poverty Reduction Strategy and Energy Strategy. REAP also complemented several on-going

Bank-financed projects including the Energy Project and the Sustainable Livelihoods Project. The Bank's involvement was instrumental in securing grant financing which accounted for over 73 percent of the project's external funding, specifically US$3.5 million from the Global Environment Facility (GEF) and US$6.0 million from the Government of the Netherlands (GON).

Assessment of Project Design. The project was implemented with contributions from four partners - IDA, GEF, GON and GOM whose objectives and components were dovetailed and became integral parts of REAP. The PDO and GEO were clearly stated, realistic and important for Mongolia's rural power sector. The outcome indicators focused on quantifiable results for which the project could reasonably be held accountable. That said, the indicators were essentially physical targets which could not capture the more qualitative outcomes. While the project's achievements in improving electricity access were overwhelmingly positive, the PDO/GEO indicators could only tell a partial story. Moreover, the indicators could risk masking the less successful outcomes of the non-physical capacity building components (refer to Section 2.2 paragraph on TA and training) which might ultimately affect the long term success and sustainability of REAP (refer to Section 4: Risks).

The project approach was selected from several alternatives and took into account the Bank's experience in RET and rural electrification. The design also reflected lessons learned, most particularly in terms of promoting sustainability, need for a sound regulatory framework, community participation, private sector development, affordable solutions, and linkage with other ongoing initiatives.

Adequacy of GOM's Commitment. Preparation of the project involved extensive consultation with various concerned government agencies and received strong government commitment. This included a high-level project coordinator from the Ministry of Fuel and Energy and a significant co-financing of US$10 million representing about 43.5 percent of total project cost. An inter-agency/ministry steering committee and an adequately staffed Project Implementation Unit (PIU) were also established before project launch.

Assessment of Risk at Appraisal. Specific critical risks were identified, of which those involving retail market development and local absorptive capacity were rated substantial, and limited experience with the particular size-class of the hybrid systems targeted was rated moderate. Mitigation measures such as advance agreement with GOM on a policy framework; encouraging private sector participation; tapping into existing rural networks; close linkage and collaboration with other ongoing sector programs and project teams; and TA and feasibility studies tailored to address technical weaknesses were integrated into the project design and monitoring plans. In retrospect, it appeared the risk assessment was inadequate in that the appraisal team had still over-estimated the potential capacity and interest of the private sector, most notably in its ability to self finance SHSs in large quantities; reaching remote regions of the vast country; and assuming the role of Soum utilities operators.

2.2 Implementation

The project was implemented successfully in that it, along with parallel and related Government initiatives, had achieved, and in many instances surpassed, its original outcome indicator targets, most significantly in the area of herder access as summarized in Annex 2. These important achievements notwithstanding, project implementation did experience a number of obstacles which required significant modifications to the approach or plan as envisioned at appraisal. The main issues and resulting adaptations are summarized below.

Inclusion of Bulk Procurement of SHSs. The project was designed to pilot the establishment a network of private dealers that would self finance the purchases of SHSs and then sell them to herders either on their own or through the Sales and Service Center (SSC) network that was also to be established under REAP (through a process of selection, training and certification). Due to the limited financing capacity of the private dealers to buy in bulk, and their inability to establish an extensive sales network to reach the geographically scattered herders, implementation of the herders' access component suffered a very sluggish start (only about 200 SHS units were sold by the middle of 2009, two years after the IDA/GEF grants became effective).

Given the success of the Government's parallel program whereby SHSs were pre-financed and purchased in bulk, and then promptly distributed through the far reaching government channel of Soum administrations, a decision was taken to modify the SHS component to emulate the government model. Consequently, the project was restructured in August 2009 whereby US$3.2 million (or eighty percent) of the GON grant which was budgeted to provide smart subsidies (of about 50 percent per unit) at the retail end was reallocated to co-finance the bulk procurements of SHSs. The 20,000 systems, procured in three batches to allow revolving use of recovered funds at about $160 per unit, were in turn sold to herders at the same subsidized prices through both government and private channels. The approach (80 percent bulk purchase and 20 percent private retail) proved highly effective in speeding up the progress of herder electrification, as indicated in Annex 2 Component A4b, and the steep upward curve of the IDA disbursement profile.

More Extensive Rehabilitation of Soum Grids. The original design was to rehabilitate the main feeder of 30 selected SC mini grids with the understanding that further investment would be required in five to ten years. In 2007, with funding from the Resolution 50 initiative, the Government promptly rehabilitated and connected 15 of the 30 selected mini-grids to the main grid. Thereafter the government requested, and the Bank agreed, that the remaining 15 dilapidated grids be more substantially rehabilitated or replaced under REAP in order to avoid the need for further rehabilitation in the medium term. It should be noted that while the project scope (and costs) only accounted for rehabilitation of 15 distribution systems, total coverage remained 30 Soums.

Higher Capacity Soum Center RETs. The original design was to provide RETs to 20 grids selected out of the 30 rehabilitated grids. As five of the 20 selected grids were already connected, the project was left with 15 SCs. The GOM solely funded 11 systems early on. The resulting reduction in number allowed the Bank/GEF/GON funds to

finance the construction of larger capacity RET systems in the four remaining Soums (in two Aimags) in response to faster than envisioned economic and demand growth, and the Soums' desire to increase reliable supply and decrease diesel dependency. The 150-200 kW photovoltaic systems installed (vs. 50-100 kW systems envisioned at appraisal) were designed to cover 80-90 percent of the projected demand during the first 5 years after installation, i.e. a very significant degree of penetration.

Government financed RETs. The 11 systems financed by GOM were acquired and installed following its own procurement and contracting practices. This resulted in many sub-standard quality wind-turbine systems being installed that either needed major repairs, or partial or total replacements. In some cases they involved legal actions against the contractor where damages were awarded to finance the replacements. To cover funding shortfalls, about $0.9 million of IDA funds was also used for some replacements of RET components. However, the PIU learned from this experience and from the more rigorous quality requirements for the four Bank funded systems and after the replacements all fifteen systems were in an operational condition.

Modification of TA and Training Activities. The project had a strong focus on institution building, and many of the activities were training and TA based. While significant progress was made, many activities designed at appraisal were modified, delayed or not carried out. To some extent, rapid changes in the operating environment made the adaptation necessary in order for REAP to stay relevant throughout the implementation period. For example, the adoption of a Renewable Energy Law in January, 2007 largely eliminated the anticipated need for REAP to support the development of a regulatory framework and associated legislation for grid-connected RET systems. With regards to the development of a policy and regulatory framework for off-grid SC electricity service operation, the situation also underwent substantial changes in that either the newly rehabilitated systems were connected to the main grid or the newly installed RET systems were destined to be handed over to the nearest centralized Energy Supply Companies at the Aimag level. The transfers, all concluded by the time of this ICR, were mainly due to the limited operation capacity at the Soum level and the lack of private sector interest in assuming operation of a RET. The decision was accepted by the Bank and related TA activities were in part modified to support the operation of Aimag utilities. After the SHS component was restructured, support for the development of a legal and institutional framework for bulk procurement was also appropriately added.

Completion of the SHS battery management program was delayed as it was determined that recycling and disposal of old batteries were only needed after the SHSs had been in use for at least five years. While this was reasonable within the context of the project, it did not take into consideration the need for battery disposal/recycling for the 33,000 or so SHSs distributed during the initial phase of GOM's National 100,000 Solar Ger Electrification Program (National Program) prior to REAP. Those SHSs were older (the first installed 8 years ago) and with moderated battery life. The increasingly pressing issue of used battery management was an area where REAP could have been more helpful.

Implementation of the SC utility policy and regulation subcomponent was also delayed. The grid connection and transfer of the rehabilitated grids and RETs out of the Soum utilities changed the scope and complexity of this task. Three areas of support were identified: improvement of tariff policy to ensure utility sustainability and consumer affordability; development of regulatory tools and incentives to improve utility performance and efficiency; and sorting out the roles of the various stakeholders under the new operating scenario. Under the tariff study, key issues such as the need for a rational tariff structure across Soums and a targeted subsidy policy had been identified. Similarly, other remaining areas of concern were still being actively addressed with TA and training at closing. As these initiatives were introduced near the end of project implementation, results were not available for assessment at the time of this ICR.

Extension of Closing Date. The government was keen to complete the National Program, which was well underway and very close to conclusion at the end of 2011. The second restructuring in November 2011 effected reallocation of some IDA savings to provide additional subsidies for about 1,200 SHSs; and an extension of the Grant closing date by six months to June 30, 2012. As expected, the incremental funding and implementation time enabled the GOM to bring the National Program to a very successful conclusion during 2012. That said, when meeting the goal of the National Program by closing became a top priority, some TA activities proposed at a very late stage were sacrificed. This was the result of a conscious decision made to allow the PIU to focus its resources on monitoring the progress of the SHS sub-component. In retrospect, the project's institution building components might have benefitted from an extension of more than six months which would have enabled the PIU to turn its attention to other matters after the rush to meet the physical targets of the National Program was over.

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

M&E Design. The M&E framework was designed to focus on progress towards meeting the PDO and GEO as measured by the outcome and intermediate results indicators; assessment of the impact of rural electrification through beneficiary survey data and analysis; and evaluation of the delivery mechanism of the herders' access component. A mid-term review was also planned to take stock of progress and evolving needs 18-24 months after project launch. One shortcoming of the M&E framework was that there were many outcome and results indicators (at least one per sub-component, for a total of 15). Some of the intermediate results indicators could have been able to shed some light on the progress of the capacity building components but it appeared few of them were regularly tracked and reported, particularly during the initial years when project progress was slow. Achievement of the GEO was estimated and evaluated only at project completion after the various systems had been installed and become operational. In the absence of a feedback loop, it could be argued that their potential benefit to the REAP was limited.

M&E Implementation. The PIU prepared regular annual and quarterly reports on implementation progress. Training for them to effectively conduct the M&E work was provided before project launch.

M&E Utilization. The M&E framework was useful in monitoring implementation progress, signaling issues and prompting the client and the Bank to make adjustments to enhance REAP's ability to realize its objectives. During the initial years, it helped to highlight the slow progress of the smart subsidy program, particularly in contrast to the Government program's swift implementation, and brought about modification of the approach which resulted in the first restructuring. Preparation for the restructuring in 2009 served as the Mid-term Review. After implementation of the sub-component gained momentum, achievement of the PDO and intermediate outcome indicators were regularly monitored and evaluated against the baseline and target values. The same M&E indicators also served to track progress of GOM's National Program which by then was fully overlapping with the project. With the second restructuring, the project was able to help the Government bring the National Program to a successful conclusion in 2012.

2.4 Safeguard and Fiduciary Compliance

Environment: The project was classified as Category "C". As such, it was not expected to and did not pose significant environmental impact.

Procurement: Procurement was organized and carried out by the PIU with oversight from the EA and the Steering Committee under it. Procurement of goods was carried out on the basis of international competitive bidding, shopping and direct contracting. The Bank's oversight included prior and post reviews of procurement and contracting procedures to ascertain that the Procurement Guidelines were followed and the activities were in compliance with the legal documents. During this process issues with documentation and reviews had been identified and subsequently rectified. One notable wrinkle with Bank/Donor financed procurement was related to the first batch of bulk purchase of SHSs. The process experienced a delay of about six months due to a complaint that escalated through the Mongolian legal system all the way to the Supreme Court. The case was ultimately dismissed and the contract award eventually became effective in July 2010. The procurement of the RET systems with GOM's own resources encountered a number of serious problems which took the PIU substantial time and resources to address. They were eventually resolved and all systems had since been operating (Sections 1.9 and 5.2a).

Financial Management: The PIU maintained dedicated accounts for the project and prepared financial statements on a regular basis. Annual audit reports were submitted to the Bank on time and no significant issues had been identified. Financial management supervision and sample reviews identified shortcomings, mostly in the area of documentation deficiencies. These findings were followed up and the problems were resolved. It was concluded that the project's financial management system was adequate and proceeds of the grants were used for their intended purposes.

2.5 Post-completion Operation/Next Phase

The project adopted existing international standards and used them to establish the technical specifications for the SHSs and RETs. The SHSs were inspected and certified to meet stringent quality standards to minimize potential for breakdowns and reputational

risks in a novel market. The establishment and functioning of the SSC network and the introduction of the manufacturers' warranty practice will enhance their sustainability. At completion, most of the SHSs sold had already been in operation and the main parameters for their continued functioning were not expected to change in the foreseeable future. Efforts to ensure proper battery disposal was ongoing at the time of the ICR and a winning solution was expected shortly. The SHSs distributed under the project are expected to continue to operate smoothly. However, it has to be recognized that the itinerant nature of herder families presents significant challenges to the service infrastructure (the SSCs) and the GOM will need to continuously monitor the availability and quality of after-sales service/repairs.

The rehabilitated mini grids and new RETs were either connected to the main grid or handed over to the Aimag utilities as they were judged to be in a better position to meet the technical, budgetary, and staffing requirements to operate and maintain the new systems.. The staff of utilities in charge of the new systems received the necessary training to operate and maintain the facilities. However, the changed scenario has posed new challenges such as rigid tariffs, affordability issues and the lack of ownership. While they would not negatively impact the day-to-day operation of the RETs in the near term, they could potentially hurt long term sustainability of the project (refer to Section 4: Risks). The Aimag utilities may therefore need further assistance for management of SC systems to ensure sustainability

The successful completion of the GOM's National Program was recognized as an important achievement and major development milestone for Mongolia. It provided a solid foundation for the government and its partners to turn their attention to the GOM's next target, namely, universal rural electrification by 2020 under the National Renewable Energy Program.

3. Assessment of Outcomes

3.1 Relevance of Objectives, Design and Implementation

Rating: Satisfactory

The project's PDO was consistent with two of the three strategic objectives of the FY2005-2008 CAS. It was also designed to contribute to three of the five pillars of the Government's Economic Growth Support and Poverty Reduction Strategy of August 2003, around which the CAS was built. Specifically, they were to ensure public sector effectiveness; improve the environment for private sector led development; and enhance rural development and environmentally sustainable development. The GEO was also closely aligned with three of GEF's Strategic Priorities for the Climate Change Focal Area.

While the prevailing CAS remained relevant for REAP throughout the implementation period, its own success was rapidly affected by external events. In particular, it had not

foreseen the speed at which the mining boom would occur, the sudden economic growth that ensued, and the range of new development challenges they brought about. The Bank's strategic focus, understandably, had shifted. Nonetheless, the project is still well aligned with one of the three pillars, namely, to address vulnerability through improved access to services and better service delivery, safety net provision, and improved disaster risk management.

The project adopted a combination of physical components, beneficiary subsidies, and TA that proved effective for it to meet its objectives. The design included innovative features such as the adoption of high international standards for SHSs and RETs; and introduced best practices such as after-sale service and warranties which were legitimate concerns of potential buyers. The project also enabled the establishment of a network of trained and certified SSCs, which were able to buy (in small quantities), distribute, sell and service SHSs and meet the scattered herder population's electrification needs. At appraisal it was envisioned that in time the private dealers would be able to scale up and purchase in bulk; and private operators would be willing and able to take on management of the retrofitted Soum center utilities. Despite all the mitigating measures, development and reliance on the private sector eventually proved to be insurmountable hurdles. Overcoming then required significant modifications to the project approach and implementation plans. It was helpful that the design was flexible enough to accommodate such modifications without a major restructuring. The experience also contributed to some of the lessons learned.

Another innovative feature was the introduction of partial cost recovery for SHSs to leverage additional funds to scale up implementation and enhance ownership. Prior to REAP, SHSs were often provided to herders virtually free of charge under the National Program with funds from bilateral donors. In the cases where small costs were recovered, the funds were absorbed in the GOM budget. Under REAP the herders' cost sharing was about 50 percent, and the recovered funds were channeled back to the project to cover the cost of additional SHSs. This contributed to the project's ability to exceed its herder access targets. A significant copayment by herders quite likely enhanced their sense of ownership.

3.2 Achievement of Project Development Objectives and Global Environment Objectives

Rating: Satisfactory

Achievement of the PDO and GEO were measured against two and one outcome indicators, respectively. At completion, all target value set at appraisal had been surpassed by a significant margin, suggesting that the PDO and GEO had both been achieved in a satisfactory manner as detailed below.

PDO: to increase access to electricity and improve reliability of electricity service among the herder population and in off-grid SCs. In terms of reliable SHSs delivered, the target was to improve coverage to 50 percent of the herder population. At project completion, over 67,000 SHS units had been distributed to herders in 331 Soums. Along with the 33,000 or so units already supplied by GOM prior to the project, a total of over 100,000

units had been provided to herders in 342 Soums. This represented coverage of about 62.5 percent and 34 percent more units sold as compared to the appraisal estimate. The project achievements can be further underlined by looking at the area of indoor lighting in gers: not only has the service been greatly expanded (by a factor of 144 when measured as lumen hours) but the unit costs (US$ per thousand lumen hours) have been reduced by a factor of 94 from a 7.5 to 0.08 when comparing with candles – the most common baseline. Reliability has improved because herders are no longer dependent on buying candles or kerosene in times where money are tight or access to shops restrained.

In terms of number of people served with improved services in off-grid SCs, the target was 16,000 persons. The project, along with the Government's parallel programs, yielded 30 Soums with more reliable and improved service either through grid rehabilitation and main grid connection; or grid rehabilitation and installation of RET systems. At project completion, the total number of beneficiaries in this category was over 18,000 persons. This represented a 15 percent increase over the appraisal estimates. The many new electricity consumers are reaping significant benefits from the new energy source including many productive end-uses.

GEO: to remove barriers to the development and use of RET in grid and off-grid systems and reduce emissions of carbon dioxide (CO_2). The target for REAP was to reduce CO_2 emissions by 9,000 ton per year. At the time of project completion, total reduction from all components combined was estimated to be 11,333 ton per year, or 26 percent about target, for an estimated period of 20 years.

The above impressive achievements notwithstanding, there were shortfalls in the implementation of some of the technical assistance sub-components such as the yet to be completed and implemented tariff reform that would affect the residents of the SCs with improved services. Also, there is limited information on the quality of maintenance of the RETs that were handed over to the Aimag utilities. There is anecdotal evidence to suggest that the reliability of the RET systems leaves room for improvement and that support for the Aimag utilities that operate the Soum center systems needs to be strengthened. These issues, though not captured in the physical achievement focused PDO and GEO outcome indicators, would affect the reliability of power supply and sustainability of REAP. Given these concerns which could present real threats to the sustained attainment of the PDO and GEO over the long term, the overall achievement is rated Satisfactory.

3.3 Efficiency

Rating: Satisfactory

Herder Access. At appraisal three alternative household lighting sources were compared. There was a clear cost effectiveness advantage for using SHS as compared to candles and kerosene lamps.

At project completion the same comparison was made with updated cost figures. The results show that unit costs (measured as US$ per thousand lumen hours) have been

reduced by a factor of 94 (from 7.5 to 0.08) when comparing with candles – the most common baseline and by a factor of 9 when comparing with kerosene lamps.

Soum Center Supply. Financial analysis of a wind-diesel hybrid system was carried out at appraisal since this was then assumed to be the preferred solution. A partial[1] and a full cost recovery scenario required average tariffs of $0.17/kWh and $0.49/kWh respectively. It was concluded that the effective subsidy of $0.32/kWh provided through the project would make the supply generally affordable (about 5 percent of poorest household's income) and was adequate to sustain the operation and maintenance of the system over its life, as well as finance its replacement cost. It was also calculated that a solar-diesel hybrid would require a tariff of $0.80 for full cost recovery leading to an effective subsidy of around $0.55-0.65/kWh depending on the performance of the solar system.

At project completion the wind-diesel hybrid is regarded as a less relevant option because of operational problems in the GoM financed projects, which have not allowed for systematic collection of reliable performance data. All four SC RETs financed by this project are solar-diesel hybrids so a financial analysis has been prepared for this technology set. Calculations using assumptions based on real data from the SCs funded by this project indicate that a 10 percent financial rate of return would require average tariffs $0.90/kWh for full cost recovery whereas break-even at partial cost recovery will be achieved at $0.17/kWh. The implicit subsidy is in other words $0.73 or somewhat higher than assumed at appraisal for this technology. However most of this difference can be accounted for by inflation.[2]

For more details please refer to Annex 3.

3.4 Justification of Overall Outcome and Global Environment Outcome Rating

Rating: Satisfactory

The PDO and GEO remained relevant to Mongolia despite a rapidly transforming rural electrification sector within an even more dramatically changed macro-economic context. In a dynamic operating environment REAP was able to complement, respond, and support the Government's efforts and the resulting achievements in rural electricity access and GHG emission reduction were quite remarkable. The project also supported institutional development and introduced new approaches and standards that facilitated the development of the private sector and local utilities. Despite limited success with the private sector pilots and despite the fact that bringing utility management up to par was still a work-in-progress, the access targets have been met and people's lives have been

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[1] Partial cost recovery assumes that the investment is grant funded and therefore that no capital costs need to be recovered over the tariff. This is emulating the real situation.

[2] Between 2006 and 2012, Mongolia had inflation rates of 30% in 2008-2009 (crisis years) and it has been at around 15% annually since 2010

greatly improved. Precious lessons have been learned that will facilitate future intervention to further deepen the coverage (i.e. making more capacity available to the new consumers) and improve the quality of the electricity access. At closing, the development results were expected to be sustained provided remaining work would in fact be carried out to their successful conclusion. Given the impressive results in improving access, and the risks to sustainability, on balance, overall outcome is rated satisfactory.

3.5 Overarching Themes, Other Outcomes and Impacts

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

At completion, the project enabled an estimated half million people within the herder population to gain access to electricity. Of this total, about 51 percent were women and 37 percent children. The improved services at the SCs not only benefitted year-round residents but also the women and children from herder households as many of them stayed around the SCs during the several harsh winter months (low temperature often below -30C between November and March). The increased use of electrical household appliances such as electric hot pots, ovens and washing machines provided relief to women in particularly since traditionally it was their role to cook and wash for the family (refer to Section 3.6 for more examples).

With almost two thirds of the herders having access to electricity, the project has likely boosted demand for consumer electronics, televisions, satellite dishes, radios, cell phones and other electrical appliances and equipment. Their usage not only improved the herders' quality of life but their having timely access to weather and market information has the power to reduce their vulnerability to natural hazards, facilitate livestock management and give them an edge in marketing their goods. With the country experiencing an economic boom, herder electrification could help ensure that this community, with strongest connection to the country's rich history and culture, would be able to maintain its traditional way of life without being left far behind. To the private dealers and SSCs, the apparent fast growing demands also represented potentials for fresh business opportunities and a commercial market that never existed before.

(b) Institutional Change/Strengthening

Assisting the institutional development of NREC, the agency responsible for the national renewable energy agenda, was an important project component. While the role of the Commission changed over time, and in 2009 it was reestablished as a self-financing state owned enterprise responsible for advancing the market for renewable energy, the appraisal goal to establish a clear organizational and business plan for NREC was still relevant. At the time of project completion, NREC had a clear business plan and structure and was operating on a commercial basis.

The establishment of 50 certified SSCs across the country was a far reaching institutional development under REAP as the network was instrumental in disseminating SHS product information and widening awareness, thus helped the herders make informed choices

with confidence. The after-sale services they provide, within reasonable travel distances from a highly dispersed rural population, also make the SHSs more desirable and affordable. Successful implementation of GOM's National Program and REAP helped nurture a new market mechanism where trained, certified, and private sector operated SSCs and dealers can play an increasingly important role in furthering herder access. The private sector may also benefit from increased business opportunities.

A range of capacity building activities was also conducted to provide support to government officials in different agencies, the SSCs and private dealers, and the PIU. They included technical and management workshops; study tours; and training programs that benefited over 840 participants (refer to Annex 2 for more details).

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

An example of a potential unintended outcome was in the management of used batteries. The REAP sponsored feasibility study demonstrated that a recycling plant would be highly profitable. The business opportunities have already attracted the attention of the private sector. The proposed SHS battery recycling facilities, if implemented, were expected to produce additional positive environmental benefits as it would include the disposal and recycling of other batteries such as those for automobiles, PV systems for hospitals, and telecommunication units.

With funding support from ASTAE, the Bank was able to disseminate information about the results of the project and lessons learned. Branded as "Capturing the Sun in the Land of the Blue Sky – Providing Portable Solar Power to Nomadic Herders in Mongolia" it included an information poster, a documentary video (available on the internet), a paper, a web article and a PowerPoint presentation.

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

Results from a beneficiary survey is presented in Annex 5: Beneficiary Survey Results. The survey is comprised of two parts:

Part A:
A sampling survey among herders in two selected Aimags (out of a total of 21). The survey covered a random selection of around 50% of all the herders that had purchased SHS through the project in the two Aimags – a total of 789 families were interviewed. The result is a quantitative assessment of user satisfaction and social impacts. The survey showed high levels of customer satisfaction among herders: 41.7% were "extremely satisfied" and 51.7% "very satisfied". 70.5% of the herders cited "increased productivity for work" as the key benefit linked with the installation of SHS. Moreover, the survey showed that the vast majority of herders are either likely (52%) or very likely (43.9%) to use SHS in the future and would recommend SHS to others (99.6%).

In addition to improving the herders' productivity, the installation of SHS systems had a positive impact on communication and information access. After the project, more than 90% of the survey population use mobile phones for their communication needs

compared to a pre-project level of near zero. The interviewed herders indicated the SHS system made it easier for them to access information on livestock prices, food and weather conditions thereby enhancing their productivity. While, prior to the installation of SHS systems, herders largely relied on the radio and going in person to the Soum centers for their information-related needs, a new reality sees the TV as the most popular and widely-used source of information.[3]

In general, more than 90% of the interviewed herders state that the SHS have improved the quality of their lives. According to the vast majority of the people interviewed, solar PV systems are a reliable source of electricity that can generate enough output to power the existing appliances in a given household. Finally, herders value electricity as important for their children's education.

Part B:
A rapid appraisal was conducted in three SCs to supplement Part A. Individual heads of households, public administrators, representatives of the Aimag power utility companies, business owners, and public service providers such as educators and medical workers were interviewed. The rapid appraisal showed that all three sites had experienced transformative changes in the past two to three years. While not all of these changes were attributable to REAP, the increased supply of electricity (from an average of four to five hours per day to between 11 to 18 hours a day) had been a critical enabling factor.

At the household level, it was observed that spending on electricity had likely decreased on a per kWh basis and it was also likely that the cost effectiveness of lighting has improved. In the three SCs, most households have refrigerators or freezers, allowing them to keep fresh meat for longer in the warm months and to prepare frozen meat to keep through much of the winter and spring. There is evidence that cooking habits have changed due to the use of electrical appliances, and some have reportedly added more variety to their diets. The added flexibility of using electricity has benefited working women in terms of time savings especially since they continue to do most of the cooking and washing. Having additional hours of supply has enabled the regular use of mobile phones. The increased supply of electricity has freed up time for other activities: residents tend to stay up later and watch television for more hours per day. Subscription satellite TV offerings have also improved significantly. Some residents have capitalized on the additional time to engage in productive activities, such as the teachers using computers to prepare for lessons, baking and selling bread and cakes.

At the community level, daytime supply of electricity has been instrumental to improving the provision of medical care. Some clinics have acquired new medical equipment

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[3] Note that the World Bank also implemented three other projects in rural areas that indirectly benefited from REAP: the Information and Communications Infrastructure Development Project (P092965) aimed at increasing the coverage of ICT services to rural areas by incentivizing private operators; the Sustainable Livelihoods Program 2 (P096439) objective is to enhance livelihood security and sustainability by financing community initiatives and pastoral risk management activities; and the Rural Education and Development project (P096328) aimed to enhance the quality of education by distributing learning materials (including laptops) and training students and teachers in rural areas.

because they no longer have to rely on small diesel generators for power supply. According to the nurses interviewed improved lighting has made it easier to give injections and perform other procedures. Better conditions are also observed in the schools which enroll children of the local population as well as those from herder families and the surrounding baghs. The children no longer use candles for lighting, eliminating a potential fire hazard, and the dorms have all been fitted with compact fluorescent lamps, improving the quality of light. Almost all of the children own mobile phones. Because they are able to use washing machines, hygiene has improved. There is also evidence that the quality and variety of instruction in the classroom has improved. The teachers own laptops that they may use for lesson planning, and the schools have outfitted computer labs to offer courses. In each of the Soums, new entrepreneurs were found, and existing businesses may have expanded their stock of goods for sale.

Positive changes in household and community life have been undercut by recent power disruptions that have occurred at each of the project sites. Apart from inconveniencing households, causing economic losses to businesses, and limiting the ability of institutional users to provide public services, power disruptions have also hurt the confidence of consumers in the reliability of RETs. Several lessons can be distilled from the problems encountered: consumer demand for electricity in the soums increased much more quickly than initially expected and investments in expanding the capacity of the systems may be needed to ensure a continued high level of performance and service delivery. Also, while the Aimag power utility companies remain the best option for managing the off-grid RET systems, they need additional financial and technical support to ensure that they have the capacity to effectively manage the systems, and the flexibility to adjust tariffs to cover costs.

On the consumer side, the ability of soum residents to hold the utility companies accountable has been weakened by the inactivity of the users' associations created under REAP. Without this formal mechanism for consumer representatives to engage directly with the utility companies, communication between provider and users has been poor; consumers do not understand why power disruptions have occurred, and they are concerned that restrictions will continue into the future. Reconstituting the associations and bridging the communication gap is needed to strengthen the management of the systems and improve the responsiveness of the utility companies.

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

Rating: Moderate

Few risks are anticipated with regards to the physical sustainability of the SHSs and RET systems given the relatively simple technologies employed. Critical to the Herders' Access component is the availability of convenient and affordable after sale services by the SSC network. Critical to the SC Electricity Service component's long term sustainability are utility management, tariffs, and proper functioning of the Soum user associations. Issues such as operating at below capacity due to poor spare parts

management and the lack of qualified repair crew had been observed and were being addressed at the time of the ICR. The transfer of the RET systems to the Aimags continues to highlight the need to formulate and adopt a rational tariff policy and an appropriate tariff structure that would be affordable and equitable to the SC consumers while providing incentives for the utilities to operate efficiently and with minimal service interruptions and restrictions. The lack of ownership at both the Aimag utilities and SC consumer levels could potentially put the impact of the project at risk. At the macro level, economic development and government commitment to extend rural electrification remain strong, and consumer demand for more reliable and less diesel dependent supply is expected to continue to grow. In view of the positive macro environment, the absence of major threats to the herders' access component, and the identified risks to the SC electricity service component being manageable, the overall risk that the development outcomes would not be sustained was considered moderate at the time of this assessment.

5. Assessment of Bank and Borrower Performance

5.1 Bank Performance

(a) Bank Performance in Ensuring Quality at Entry

Rating: Satisfactory

As summarized in Sections 1.1 and 2.1, the Bank's support for the project was well aligned with the prevailing CAS and GOM's energy strategy, and complemented several ongoing operations. Their objectives and components of the four partners (IDA, GEF, GON and GOM) were dovetailed and well integrated into the design of the project. During preparation, the Bank team assisted GOM in designing the project to meet the Bank's technical, financial, economic, fiduciary, social and environment standards. It also helped shape the TA and training programs to strengthen the institutional capacity of the relevant government and power sector authorities, the PIU, and other stakeholder organizations. The resulting design was clear and straight forward except for the capacity building elements which involved many organizations in a rapidly changing operating environment.

The PDO and GEO were clearly stated, realistic and important for Mongolia's rural power sector, though the outcome indicators, with emphasis on physical outcomes, could only tell a partial story of actual achievements and shortcomings. The project introduced innovations such as international standards and good practices, private sector involvement in the distribution, sales and service of SHSs, establishment of a SSC network and SC user associations. The appraisal coverage was comprehensive as reflected in the skill mix of the preparation/appraisal teams and PAD. Implementation arrangements and M&E were discussed and agreed in advance. The overall risk of REAP was rightly rated as substantial. The Bank might have been overly optimistic regarding the capacity of the private sector but the built-in back-up arrangement which allowed the flexibility to include bulk procurement of SHS possibly spared the project a major restructuring. Project preparation was relatively fast with Concept review in

February 2006 and Board approval in December, 2006. The cost of preparation, at a little under US$350,000, was acceptable given the complexity of the project. Working relationships with the Borrower, stakeholders and co-financiers were productive and supportive. The Bank's performance in ensuring quality at entry was satisfactory.

(b) Quality of Supervision

Rating: Moderately Satisfactory

Supervision of the project was regular and vigorous during the second half of the implementation period. The rationale for the two restructurings, and the resulting amendments were clearly spelled out, thoroughly discussed and documented. Field supervision teams were by and large appropriately staffed to address and report on implementation issues as they emerge. They covered all aspects of the project including monitoring of physical progress, TA and training activities and compliance with the Bank's fiduciary policies. They also included coordination with donor agency representatives. For bulk procurements, the Bank's office in Beijing provided just-in-time procurement review and support on site. Towards the end of implementation, physical progress was particularly scrutinized to ensure the Government's National Program targets would be met and the problems with the GOM financed RETs would be resolved. Supervision reports were generally comprehensive, candid and focused on the PDO indicators.

While supervision of physical progress was comprehensive and well documented especially after the pace of implementation of the herder's access component accelerated, the same did not seem to apply to the supervision of the TA activities even though activities were frequently tallied. In some instances it was not possible to determine why certain TA activities were never mentioned, and it was often unclear whether the actions were intentional or by default. Compared to the appraisal estimates, actual disbursement on TA activities under the IDA and GEF Grants were about 52 percent and 68 percent respectively. Part of the savings under the IDA Grant was reallocated, but without the benefit of any reallocation, about 16 percent of the GEF Grant had to be cancelled at closing. Closer supervision of the project's TA activities might have enabled some of the cancelled grant funds to be better used.

By comparison, the quality of supervision during the initial years of implementation was more difficult to assess in that the project appeared to have suffered a sluggish start, and at the same time many key supervision documents for that period were unavailable, hampering an understanding of earlier challenges. The gap in early supervision documentation was particularly problematic as task management changed hands around the time when the first restructuring was proposed, and again shortly after the Grants were closed but before preparation of the ICR commenced.

(c) Justification of Rating for Overall Bank Performance

Rating: Satisfactory

During implementation, the Bank repeatedly showed flexibility and willingness to make adjustments (and restructure) either based on evidence on the ground, or in response to the client's requests. While there were moderate shortcomings in early supervision, they did not affect the ultimate achievement of the PDO and GEO as measured by the outcome indictors, nor do they affect the impact of the project in any significant manner. On balance, overall Bank performance is considered satisfactory.

5.2 Borrower Performance

(a) Government Performance

Rating: Satisfactory

At the central level, the former Ministry of Fuel and Energy and NREC both supported the design, PDO and GEO of the project. They also showed strong commitment to rural electrification through the use of RETs, as evidenced by the high Government contribution to the project (about 43.5 percent of total financing). The commitment remained strong after the 2009 government reorganization. GOM's focus on the National Program was a key factor that brought to the Herders' Access component to a very successful conclusion.

In terms of day-to-day implementation, the government's lengthy procedures and review process caused some delays in the internal clearance of the ICB documents, bid evaluation and contract signing. These were later rectified. The Government's own procurement and contracting practices for the intended fast track purchase and installation of eleven RETs (with state budget) highlighted a number of shortcomings: lack of competition, inadequate safeguards, unclear technical specifications, and no pre-shipment inspections. That said, credit should be given to MMRE for taking considerable actions to address these problems, including using REAP for remedial measures. As a result, all SCs were able to benefit from its new RET system at the time of ICR.

While the procurement issues were not insignificant, given the government's relentless corrective actions, and its overwhelming commitment and support to the project which were critical to its success, overall performance of GOM is considered satisfactory.

(b) Implementing Agency or Agencies Performance

Rating: Satisfactory

The PIU was committed to achieving the PDO and GEO. Focus on capacity building was apparent as staff often participated in training activities to enhance their skills in carrying out their management and procurement functions. Several shortcomings were noted during early project implementation, e.g. it had been pointed out that the procurement files were not always complete and some shopping quotes were not documented, also sometimes introduction of changes to the procurement methods were not accompanied by corresponding amendments to the plans. However, the PIU's performance improved over

time after training, TA and technical support from the Bank in standardizing the processes and documentation. Similar issues in financial documentation were also identified and rectified during the implementation period.

(c) Justification of Rating for Overall Borrower Performance

Rating: Satisfactory

As indicated above, ratings for both dimensions are satisfactory. Hence the rating for overall Borrower Performance is satisfactory.

6. Lessons Learned

Transfer of international experience with appropriate adaptations. Carefully selected international experiences are generally transferable, but to be effective they have to be customized to suit local conditions. The pilot for private dealer led sales of SHSs demonstrated that in a sparsely populated area, an emergent private sector with limited resources would not be able to make much headway. After two years of very limited sales by private dealers (about 200 units out of a project total of 50,000), the approach was modified. The resulting public/private partnership for the bulk purchase, distribution and sales of SHSs using existing GOM institutional infrastructure; and the private SSCs and dealers for the retail sale and provision of after-sales service proved effective to scale up implementation and ensure long term sustainability of the project's positive impact. This also nurtured the development of the SSCs and private dealers by allowing them to maintain a foothold in the market while giving them time and space to find their niche.

Flexibility to change based on evidence on the ground. The project was designed to pilot private sector involvement in two areas: dealers for SHSs and operators for Soum utilities. As in the private dealer pilot, the private sector showed little interest in operating the utilities as their ability to take on such tasks was also severely limited by their financial and technical capacities. The implementation experience confirmed that flexibility is paramount when evidence on the ground demonstrated that conditions were not ripe for a pilot to continue or to scale up. The project was restructured twice to meet prevailing needs (refer to Sections 1.8, 1.9, 2.2 and Annex 2). Changing course without losing sight of the project's objectives helps manage risks (both real and reputational) and remove impediments to implementation.

Balance between cost recovery and affordability. The government model in place before REAP was able to distribute SHSs to the herders quickly while bilateral resources were available. However, the Program became stagnant and unsustainable when external funding dried up and the little costs recovered were reabsorbed into the government's budget. There were also issues of ownership (many units were given away virtually free) and lack of after-sale service (many herders could not afford a trip to the capital city to have the units repaired). The approach introduced under REAP illustrated that while affordability of the herder population was limited there was still a strong willingness to pay for good quality and reliable products and services if the consumers were well

informed and after-sale service was accessible to a dispersed population. With a combination of partial cost recovery and smart subsidies (about 50/50) and a dedicated account to recycle the payments from the herders back to the program, REAP was able to leverage the funds to double the coverage. With increased ownership, the units sold also stood a better chance to reach their designed life of twenty years.

Focus needed on institutional aspects of Soum center electrification. The rapid assessment with visits to three SCs showed a clear pattern of institutional deficiencies in the way the Aimag utilities are operating these satellite systems. With a low tariff and high diesel subsidies still in place there is little incentive for the Aimag utility to maintain and repair the SC systems resulting in reduced availability of the RET systems, which threatens the long-term sustainability. There should have been more focus on this issue during supervision and the planned tariff studies to determine affordability and suggest sustainable tariffs for the SCs should have been implemented. Furthermore, the performance of the institutional setup should have been monitored and possible improvements, including early involvement of NREC to assist Soum system operators, suggested prior to the closing of the Grants.

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

(a) Borrower/implementing agencies

Following are highlights of salient points made, issues raised and lessons drawn by GOM and the PIU. Their joint ICR is included in Annex 7.

Project Outcomes. With the Herders' Electricity Access component, GOM was able to meet the goal of the 100,000 Solar Ger Program. This meant more than half of the herder households have gained access, and they are made aware of how electricity can improve their quality of live. This experience will promote the growth of the household renewable energy market. Despite lingering technical problems with the RET systems build under the Soum Center Electricity Service component, household appliance ownership has increased considerably, some residents have been able to start new businesses, conditions in schools and clinics have also improved. The Institutional Capacity Building component helped the national energy agencies make and implement renewable energy policies. The Bank funded systems also provided national experts with best-practice examples. While operators of the renewable energy systems and the staff in the Aimag utilities received some training, more effort would be needed to ensure proper functioning of the systems.

Project Design. In hindsight, certain aspects of the design advocated by the Bank team were not entirely realistic. The Bank argued strenuously that the SHS units should be supplied primarily by private companies. As experience would show, the network of SSCs and private retailers did not form quickly enough. By 2009, the private sector had only sold about 300 SHS units, whereas 40,400 SHS units were bulk-procured, sold, and installed through the Government network of local administrators in 2007 and 2008. This

led GOM to express its concerns to the Bank. The resulting restructuring helped speed up progress and REAP was able to achieve its targets.

*Coordination and Timeliness of Response***.** Implementation of REAP during the first years was not able to keep pace with the GOM's expedited action plans for rural electrification, due in part to policy changes introduced after the start of the project. Coordination between GOM and REAP was relatively weak in the beginning; implementation of the Soum Center RET component did not even commence until after the restructuring. The situation was much improved over time. While the Bank generally responded to requests in a timely and effective manner, "no-objections" sometimes took longer than expected because of the time needed to meet Bank requirements.

Aspects of the project that should have received more focus. Battery recycling – a feasibility study was carried out; however, measures to ensure proper disposal of used SHS batteries should have been introduced earlier to avoid causing damages to the environment. In terms of RET, the Bank could have leveraged its technical expertise and experience to demonstrate other renewable energy technologies besides solar PV, particularly when the Government experienced so much difficulty with wind power systems. While the focus of the project was on off-grid renewable energy, the capacity building component could have better addressed GOM's needs in managing larger on-grid RET systems in the aimags.

Post-project Transition. Building the capacity of NREC and EA was critical in preparing for the post-project transition period. NREC and the PIU will need to work closely with the soum centers and aimag utilities to solve technical problems that arise with the off-grid RET stations. The capacity of the Aimag utilities to maintain the RET systems is still weak, and Soum center consumer associations are inactive. During the transition period, NREC will inspect all of the RET systems installed to determine the cause of the remaining technical problems in the systems that are performing sub-optimally and to identify needed repairs. Additional measures will be needed to improve the management of the systems to ensure a reliable level of service.

Lessons Learned. The most important lesson was in the design and use of economic incentives in the development of the market for household RET. REAP's subsidy program created a cost recovery mechanism that was able to leverage the success of the project. While ger household demand for renewable power solutions has grown, it is unlikely that sales of SHS units by SSCs and private dealers will continue once the subsidy program expires. If the private sector chooses to sell units that are cheaper and lower-quality than the ones distributed under REAP, it may undercut the confidence of ger household consumers in the reliability of SHSs.

The second lesson is on the development of off-grid RETs**.** Consumer demand for electricity and improved services in the project SCs increased much more quickly than expected, and some have already reached or exceeded capacity. In deploying small-scale RET solutions in off-grid SCs, adequate allowance should be made for future capacity expansions.

Maintenance of the RET systems should continue to be strengthened to ensure an optimum level of service. The Aimag utilities have shown little enthusiasm for their assumed role in system O&M and repair because the off-grid systems are seen as lower priority and not profitable. Also, the utilities have little experience with managing off-grid RET systems; and finding spare parts in Mongolia and making repairs is costly. More meaningful interaction and consultation between the utility companies and soum consumers is needed. Reconstituting the user associations could provide a channel for improving communication between supplier and consumers, especially in clarifying how tariffs are set and providing advanced notice for power restrictions.

A lesson learned from GOM's experience with the early wind systems was that the quality of the installed systems may have been improved by strengthening the procedures and requirements for procurement. This could have been done by including specific technical requirements in the contracts and establishing a more rigorous selection process. On the other hand, the high procurement requirements for the larger capacity PV systems effectively created a hurdle for Mongolian companies to participate. Developing a local industry for off-grid RET will improve the O&M systems in rural areas; solidify supply chains for spare parts needed to maintain the systems; and reduce response time.

(b) Cofinanciers

No comments received

(c) Other partners and stakeholders

No comments received

Annex 1. Project Costs and Financing

(a) Project Cost by Component (in US$ Million equivalent)[4]

Project Cost by Component - IDA Portion (in USD Thousand equivalent)								
Components		Appraisal Estimate [1]		Formally Revised Estimate Nov 2011	Variance from Appraisal	ICR Estimate	% of Appraisal Estimate	% of Revised Estimate
Component A: Herders' Electricity Access								
A1	Sales and Services Network Devel.							
A2	Quality Standards and Compliance							
A3	Marketing and Sales/Service Support							
A4a	Smart Subsidy			291	291	291		100%
A4b	Bulk Procurement of SHSs							
Subtotal Component A				**291**	**291**	**291**		100%
Component B: Soum Center Electricity Service								
B1	SC Utility Policy and Regulation	76	80	80		80	100%	100%
B2	SC Capacity Building	152	160	36	(124)	35	22%	98%
B3	Feasibility Studies							
B4	Energy Management Assistance	48	50	50		8	16%	16%
B5	Rehabilitation of SC Power Grids	818	900	877	(23)	877	97%	100%
B6	Renewable or Hybrid Systems	1,909	2,100	1,997	(103)	1,953	93%	98%
Subtotal Component B		**3,003**	**3,290**	**3,040**	**(250)**	**2,953**	90%	97%
Component C: Institutional Capacity Building								
C1	NREC Institutional Development	95	100	100		100	100%	100%
	Project Management, M&E			50	50	47		94%
C2	National Policy and Regulation	105	110	19	(91)	36	33%	188%
	Subtotal Component C	**200**	**210**	**169**	**(41)**	**183**	87%	108%
Total Base Cost		**3,203**						
	Physical Contingencies	136						
	Price Contingencies	160						
Total Project Cost		**3,500**	**3,500**	**3,500**	**0**	**3,427**	**98%**	**98%**

[4] Project costs estimated at appraisal: the first column is base cost (slightly different from PAD due to PAD calculation errors), second column includes physical and price contingencies. The "Percentage of Appraisal" compares value of ICR estimates with the second column of the appraisal estimate. Furthermore 5 percent physical and price contingencies are applied to all investment costs except the smart subsidies

Project Cost by Component - GEF Portion (in USD Thousand equivalent)					
Components		**Appraisal Estimate [1]**		**ICR Estimate**	**% of Appraisal Estimate**
Component A: Herders' Electricity Access					
A1	Sales and Services Network Devel.	95	100	100	100%
A2	Quality Standards and Compliance	190	200	94	47%
A3	Marketing and Sales/Service Support	571	600	566	94%
A4a	Smart Subsidy				
A4b	Bulk Procurement of SHSs				
Subtotal Component A		**857**	**900**	**760**	**84%**
Component B: Soum Center Electricity Service					
B1	SC Utility Policy and Regulation				
B2	SC Capacity Building	190	200	198	99%
B3	Feasibility Studies	381	400	112	28%
B4	Energy Management Assistance				
B5	Rehabilitation of SC Power Grids				
B6	Renewable or Hybrid Systems	1,273	1,400	1,400	100%
Subtotal Component B		**1,844**	**2,000**	**1,710**	**86%**
Component C: Institutional Capacity Building					
C1	NREC Institutional Development				
	Project Management, M&E	390	410	409	100%
C2	National Policy and Regulation	181	190	76	40%
	Subtotal Component C	**571**	**600**	**485**	**81%**
Total Base Cost		**3,273**			
	Physical Contingencies	64			
	Price Contingencies	164			
Total Project Cost		**3,500**	**3,500**	**2,955**	**84%**

Total Project Cost by Component (in USD Thousand equivalent)								
Components		Appraisal Estimate [1]		Formally Revised Estimate Nov 2011	Variance from Apprais.	ICR Estimate	% of Appraisal Estimate	% of Revised Estimate
Component A: Herders' Electricity Access								
A1	Sales and Services Network Devel.	95	100	100		100	100%	100%
A2	Quality Standards and Compliance	190	200	200		94	47%	47%
A3	Marketing and Sales/Service Support	571	600	600		566	94%	94%
A4a	Smart Subsidy	10,700	10,700	7,791	(2,909)	7,791	73%	100%
A4b	Bulk Procurement of SHSs			3,200	3,200	3,200		100%
Subtotal Component A		**11,557**	**11,600**	**11,891**	**291**	**11,751**	101%	99%
Component B: Soum Center Electricity Service								
B1	SC Utility Policy and Regulation	76	80	80		80	100%	100%
B2	SC Capacity Building	343	360	236	(124)	233	65%	99%
B3	Feasibility Studies	381	400	400		112	28%	28%
B4	Energy Management Assistance	48	50	50		8	16%	16%
B5	Rehabilitation of SC Power Grids	818	900	877	(23)	877	97%	100%
B6	Renewable or Hybrid Systems	7,545	8,300	8,197	(103)	8,001	96%	98%
Subtotal Component B		**9,211**	**10,090**	**9,840**	**(250)**	**9,311**	92%	95%
Component C: Institutional Capacity Building								
C1	NREC Institutional Development	190	200	200		200	100%	100%
	Project Management, M&E	676	710	760	50	756	106%	99%
C2	National Policy and Regulation	381	400	309	(91)	212	53%	69%
	Subtotal Component C	**1,248**	**1,310**	**1,269**	**(41)**	**1,168**	89%	92%
Total Base Cost		**22,016**						
	Physical Contingencies	418						
	Price Contingencies	566						
Total Project Cost		**23,000**	**23,000**	**23,000**	**0**	**22,230**	**97%**	**97%**

(b) Financing (in US$ Million Equivalent)

Source of Funds	Type of Financing	Appraisal Estimates	Actual/ Latest Estimates	Percentage of Appraisal
Government of Mongolia	Counterpart Funds in MNT	10.00	10.00	100%
Global Environment Facility (GEF)	Grant	3.50	2.96	84%
IDA	Grant	3.50	3.43	98%
Government of the Netherlands	Grant	6.00	5.85	97%
Total	3,200	23.00	22.23	97%

Annex 2. Outputs by Component

Appraisal Plans		Actual Accomplishments at the Time of ICR and Reasons for Deviation
Component A: Herders' Electricity Access – establishment of rural retail and service network for private and public investments in standalone solar home systems (SHS) and small wind turbine systems		
A1	Facilitate the development of a retail/service network consisting of certified private dealers and about 50 SSCs at Aimag and Soum centers	A network of 50 SSCs was established, covering the sale of SHSs across all 21 Aimags. The privately operated centers were selected, trained and certified under REAP. They played a critical role in providing sales and after-sale services which enhanced the life and proper functioning of the SHSs, consumer electronics and small appliances. A private sector network where the companies self-finance SHSs and claimed the subsidy upon sale to the herders was also established to extend the distribution network further. A herder survey is being conducted to evaluate the impact of the project, herders' satisfaction, and the scope for continuation of the Renewable Energy Program for universal connectivity by 2020.
A2	Introduce product quality standards, compliance and warranty requirements	REAP adopted 15 standards from "Recommendations for small renewable energy and hybrid systems for rural electrification" of the IEC to establish the technical specifications for RETs. The project also adopted the SHS Implementation Standard developed in 2005 under the Bank assisted China Renewable Energy Development Project. The SHSs sold were inspected for quality and certified to meet stringent standards to enable the herders to purchase them with confidence. The RET systems installed and mini grids rehabilitated under the REAP were under factory warranty for the first one to three years.
A3	Organize national and local information campaigns and outreach programs, and develop and distribute catalogs and demonstration equipment to support marketing, sales and services	Information campaigns and outreach programs were organized; catalogs and demonstration equipment to support marketing, sales and services of SHSs were also developed and distributed. The PIU also selected project ideas to strengthen various aspects for the development of the market reach programs and information campaigns to increase herders' awareness. Proposals to compete for funding were submitted by equipment supplier, consulting firm, financial institution, NGO and government agencies.

Appraisal Plans		Actual Accomplishments at the Time of ICR and Reasons for Deviation
A4a	Provide co-financing (smart subsidies) to buy down acquisition cost of 50,000 SHSs to provide incentive for sale by private dealers and enhance affordability of herders	At the time of ICR, 67,224 SHSs had been sold. Of the total, 6,824 (about 10%) were sold through private dealers certified under REAP while the balance were sold through the 50 SSC established under the project and the existing GOM network of Soum administrations following the bulk procurement system of the Government. Sale reached all Aimags and many of the dispersed and remote locations. Most systems were sold to herders with a subsidy of $160 per unit. The bulk of the subsidies were funded by GON, with a small number funded by the Bank (as discussed under the second restructuring). The users paid the difference, sometimes with small loans provided by a network of financial institutions. Target number of SHSs sold was surpassed by almost 35%.
A4b	Component added after the first restructurings (8/5/09) for the bulk purchase of SHSs	$3.2M of GON funds was relocated from A4a to this subcomponent to speed up implementation of SHS sales. The closing date was also extended by six months to accommodate GOM's goal or meeting the target set under the National 100,000 Solar Ger Electrification Program in 2012. At the conclusion of REAP, GOM would have supplied 100,146 SHSs, of which 67,224 units were supplied under the REAP.
		A range of capacity building activities had been conducted to provide support to the GOM officials, SSCs and private dealers. The project also organized technical and management workshops and training for the SSCs to help them expand their markets (e.g. 5-day workshop at the end of 2011, learning trips for herders to expose them to business opportunities). They include training, workshops, and study tours. During the period from September 2009 to June 2012, over 840 participated in 23 such events (i.e. three of the four National Renewable Energy Forums for 130-160 participants each).

Component B: Off-grid Soum center electricity service – Soum utility service reform, local power network rehabilitation, and introduction of renewable or renewable-diesel hybrid power generation systems		
B1	Develop a policy and regulatory framework for off-grid Soum center electricity service operation including a cost effective tariff and billing system, asset and operation management, business planning, and legislation to facilitate private participation	The operational situation underwent substantial changes after project implementation started in that either the newly rehabilitated systems were connected to the main grid or the newly built RET systems were destined to be handed over to the nearest centralized Energy Supply Companies at the Aimag level. [Latest: Ownership of electricity networks and utility services had been transferred from Aimag to Regional State Property Companies. There are also potential changes in the tariff setting authority from the Aimag regulatory committee to the electricity regulatory authority.] A study to promote regulatory and policy framework for renewable energy, including rationalizing tariff setting commenced as of late 2011. Operations of Aimag utilities were reviewed. Key issues were identified and consultant services had been utilized to address them. The consultant's report was discussed with the Bank and the revised report provided a reasonable methodology and recommendations on the establishment of suitable tariffs in various Soums.
B2	Build capacity of Soum centers and enhance community involvement through the creation of SC user associations, SC utilities (including TA and training for their management and business plans)	15 user associations were established for systems not connected to the main grid. The tariff study (B1) enabled the user associations, Soum governments and Aimag utilities to address the pricing policies for the Soum power systems. Operations of Soum utilities were reviewed, some key information was missing, many operational parameters were not monitored on a regular basis, and little analytical work was being carried out. At project completion, these identified issues were still being addressed. In the few Soums where data is available, losses, at less than 10%, and collection, at about 98% were satisfactory.
B3	Develop technical and feasibility studies and bidding documents	All technical and feasibility studies and bidding documents for the configuration and construction of small renewable or hybrid systems and SC mini-grid rehabilitation were completed in accordance with revised plans for rehabilitation as detailed in B5 and B6.
B4	Provide cross-sector TA to Soum-level public institutions on energy management	This TA was not carried out. The reason stated by the PIU was that since the whole soum benefited from the RET systems including public institutions it was not necessary to develop separate TA only for public institutions.
B5	Rehabilitate 30 mini grids in 30 off-grid SCs where user associations and utilities will be established	30 mini grids rehabilitated. After the first 15, the government requested that the remaining 15 dilapidated grids be more substantially rehabilitated or replaced in order to avoid the need for further rehabilitation in the medium term. This was agreed.

B6	Convert existing diesel generation plants to renewable or renewable-diesel hybrid (R/RH) Systems in 20 SCs where the mini grids are rehabilitated	Of the 20 plants selected, GOM connected five to the national grid, leaving 15 for REAP. All 15 RET systems had been installed. The four funded by IDA/GEF/GON (PV systems) were fully commissioned and running satisfactorily. Among the 11 financed by the Government five WT systems experienced major problems which were rectified either by repair or replacement by the time of the ICR. Total capacity of the 15 Soum centers RETs are 1,210 kW solar PV and 790 kW WTSs. Due to demand growth, installed capacity of four systems were augmented to 100/200kW. All 15 systems have either been or are expected to be transferred to Aimag level utility companies.
		[Components B5 and B6 yielded 30 Soums with more reliable and improved service either through grid rehabilitation or installation of RET systems, benefitting 28,138 people.]
Component C: National policy development and institutional strengthening – development of policies and regulations for grid-connected and off-grid renewable energy investments, project management, and monitoring and evaluation.		
C1a	Assist in the institutional development of NREC, the agency responsible for the national renewable energy agenda, through training, business planning, work program development etc.	The role of NREC in the implementation of REAP had changed in that its responsibilities had mostly been transferred to the Energy Authority. Over time it roles evolved and in early 2009 NREC was reestablished as a self-financing state owned enterprise that is responsible for advancing the market for renewable energy, including a major focus in photo-voltaic. As such, the appraisal goal to establish a clear organizational and business plan for NREC was still relevant given the important role it plays in the renewable energy sector. At the time of project completion, NREC had a clear business plan and structure and was operating on a commercial basis, producing equipment, implementing projects and providing technical and engineering services.
C1b	Support project management, monitoring and evaluation	PIU was established and staffed as a condition of effectiveness. Procurement and financial management practices and performance were monitored throughout project implementation. Issues identified in procurement, internal control, documentation and reporting had been resolved.
C2	Assist in the development of a regulatory framework and associated legislation for grid-connected RET systems	Mongolia adopted a Renewable Energy Law in January 11, 2007 which covered the content of this component. As a result, this component, as designed, was no longer needed.

Annex 3. Economic and Financial Analysis

Herder Access. At appraisal three alternative household lighting sources were compared: candles, kerosene lamp and solar home system (SHS). The difficulty in comparing the three alternatives lies in the fact that the quality and quantity of service is very different. Lighting service can be measured by the amount of lumen provided multiplied by the number of hours they are provided – i.e. lumen hours. In the table below the cost per unit of lumen hours is calculated

	At Appraisal			At Completion		
	Candles	Kerosene Lamp	SHS[5]	Candles	Kerosene Lamp	SHS
Consumption/Replacement						
Sticks/year	365			365		
Kerosene (l/year)		40			40	
Wicks (pieces/year)		4			4	
New lamp (every 5 years)		1			1	
New light bulbs (every 2 years)			2			2
New battery (every 2 years)			1			1
PV Module			1			1
Specifications						
Service hours	2.5	400	3,000	2.5	400	3,000
Light output (lum.)	8.0	45	720	8.0	45	720
Daily Usage (hours)	2.5	4	4	2.5	4	4
Lumen hours/year	7,300	65,700	1,051,200	7,300	65,700	1,051,200
Costs						
Candlestick	$0.15			$0.22		
Kerosene lamp		$3.00			$3.5	
SHS			$160.00			$400.00
Kerosene (l)		$0.65			$1.0	
Wick		$1.00			$1.0	
Battery			$50.00			$115.00
Lamp			$3.00			$3.60
Annualized costs ($/year)	55.00	31.00	42.00	79.00	45.00	89.00
Cost per unit of service ($/kLh)	7.53	0.47	0.04	10.82	0.68	0.08

[5] 2x8W CFLs of a 20Wp

The table shows that at appraisal there was a clear cost effectiveness advantage of using SHS as compared to candles and kerosene lamps. At project completion the advantage of SHS is maintained. The results show that unit costs (measured as US$ per thousand lumen hours) have been reduced by a factor of 94 (from 7.5 to 0.08) when comparing with candles – the most common baseline and by a factor of 9 when comparing with kerosene lamps.

Soum Center Supply

At appraisal it was estimated that a wind-diesel hybrid system would require a tariff at $0.49/kWh to achieve full cost recovery. However, taking into account that the investment would be grant funded a partial cost recovery scenario (variable costs only) would require a tariff of $0.17/kWh (see calculations in table below). The resulting subsidy was of the order of $0.32/kWh.

It was also calculated that a solar-diesel hybrid would require a tariff of $0.80 for full cost recovery leading to an effective subsidy of around $0.55-0.65/kWh depending on the performance of the solar system.

At project completion the wind-diesel hybrid is regarded as a less relevant option because of operational problems in the GoM financed projects, which have not allowed for systematic collection of reliable performance data. All four SC RETs financed by this project are solar-diesel hybrids so a financial analysis has been prepared for this technology set.

Calculations are presented for the solar-diesel hybrid in Altai, which is representative of the four SC RETs financed by the project. Altai is chosen because it is the SC utility with the most complete performance data available.

The following are the key assumptions used in the calculations:

(i) The investment in Altai was US$1.8 million in 2009. However, since costs of solar panels have been dramatically reduced during the last three years it is estimated that the same system today would cost US1-1.2 million;
(ii) Total electricity delivered factors in a technical loss of 10 percent in the Altai scenario (this is more accurate than the 15 percent used in the PAD scenario)
(iii) A target internal rate of return of 10 percent is used to determine the partial and full cost recovery tariffs; and
(iv) O&M costs are based on comparative estimates with the values used in the PAD since no information is available for the Altai system. The costs include scheduled overhauls and battery replacements.

The result of the calculation for Altai is presented in the table below:

	Unit	(Altai) Solar-diesel
Total Electricity Delivered	kWh/year	317,848
Costs		
Initial investment[6]	$	(1,800,000)
- O&M	$/year	(53,854)
Revenue Needed		
Partial Cost Recovery	$/year	53,854
Full Cost Recovery	$/year	286,063
Cost Recovery Tariff		
Partial Cost Recovery	$/kWh	0.17
Full Cost Recovery	$/kWh	0.90

The calculations indicate that a 10 percent financial rate of return would require average tariffs $0.90/kWh for full cost recovery whereas break-even at partial cost recovery will be achieved at $0.17/kWh. The implicit subsidy is in other words $0.73 or somewhat higher than assumed at appraisal for this technology. However most of this difference can be accounted for by inflation.

Reduction of Carbon Dioxide

Total reduction in CO_2 emissions was estimated to be 11,333 ton/year, exceeding appraisal target by 2,333 ton/year or about 26% based on

(i) RET systems in SCs: the actual installed capacity and an assumed RET utilization rate of 20%,
(ii) Herder component: the SHS have been assumed to displace kerosene lamps in line with the assumption of the PAD.[7]

[6] Only included in the full cost recovery scenario

[7] In fact SHS have fully replaced kerosene lamps as the preferred source of lighting. Kerosene lamps are no longer commonly used by herders.

Annex 4. Bank Lending and Implementation Support/Supervision Processes

(a) Task Team members

Names	Title	Unit	Responsibility/ Specialty
Lending			
Arturo S. Rivera	Lead Energy Specialist	ECSS2	Task Team Leader
Bernard Baratz	Consultant	MNSEG	Environment
Carla Teresa Sarmiento	Program Assistant	EASIN	Administrative
Carlos Ricardo Escudero	Consultant	LEGLA	Legal
Charles A. Husband	Consultant	ECSS2	Financial Analysis
David I	Sr Financial Management Specialist	EAPFM	Financial Management
Xiaoping Li	Senior Procurement Specialist	AFTPC	Procurement
Ximing Peng	Senior Energy Specialist	EASCS	Operations
Supervision/ICR			
Arturo S. Rivera	Lead Energy Specialist	ECSS2	Task Team Leader
Chrisantha Ratnayake	Consultant	EASIS	Renewable Energy
Cristina Hernandez	Program Assistant	EASWE	Administrative
Dhruva Sahai	Sr Financial Analyst	EASIN	Economist
Dulguun Byambatsoo	Consultant	EACMF	Consultant
Feng Liu	Senior Energy Specialist	SEGES	Economist
Haixia Li	Sr Financial Management Specialist	EAPFM	Financial Management
James A. Reichert	Senior Infrastructure Specialist	EASCS	Operations
Jinan Shi	Senior Procurement Specialist	EAPPR	Procurement
Joanne S. Nickerson	Operations Analyst	EASSD	Implementation Support
Martin M. Serrano	Senior Counsel	LEGES	Legal
Nina Masako Eejima	Senior Counsel	LEGEN	Legal
Nomuutugs Tuvaan	Program Assistant	EASMF	Administrative
Peter Johansen	Senior Energy Specialist	EASWE	Task Team Leader
Robert J. van der Plas	Consultant	EASCS	Renewable Energy
Tumentsogt Tsevegmid	Senior Infrastructure Specialist	EASCS	Operations

(b) Staff Time and Cost

Stage of Project Cycle	Staff Time and Cost (Bank Budget Only)	
	No. of staff weeks	US$ Thousands (including travel and consultant costs)
Lending		
P084766	36.8	202,698
P099321	13.1	73,067
Total:	49.9	275,765
Supervision/ICR		
P084766	13.2	27,576
P099321	61.5	178,005
Total	**74.7**	**205,582**

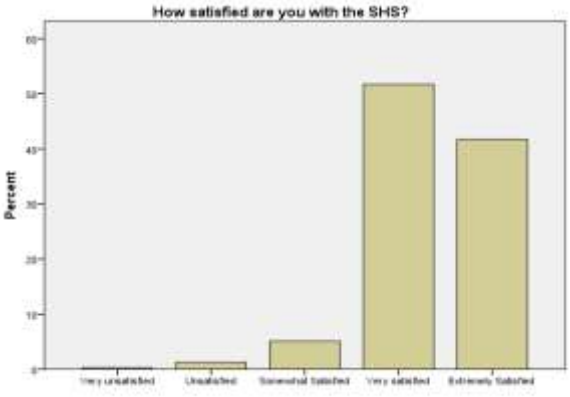
Annex 5. Beneficiary Survey Results

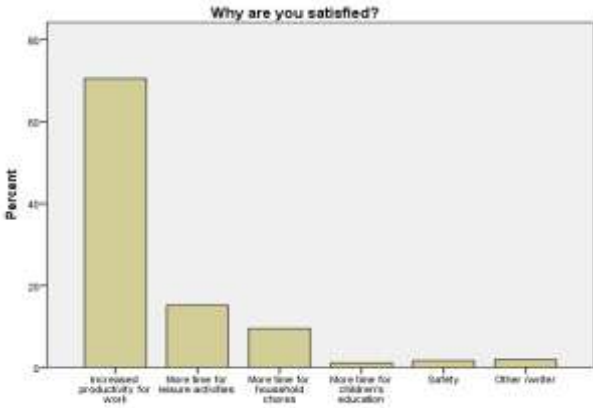
This annex is comprised of two parts: A. a sampling survey among herders in two selected Aimags; and B. a rapid appraisal of residents in Soum Centers

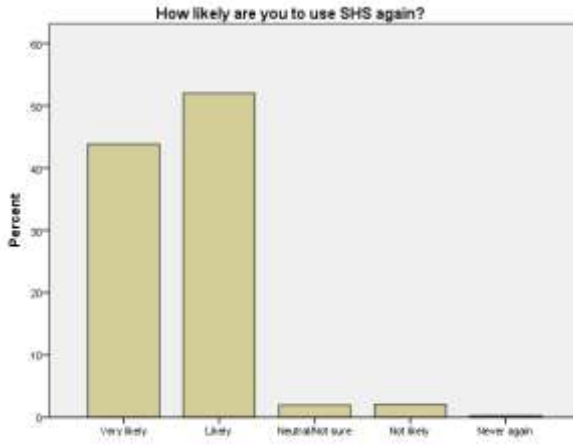
A. Summary of Survey of Herder Electrification

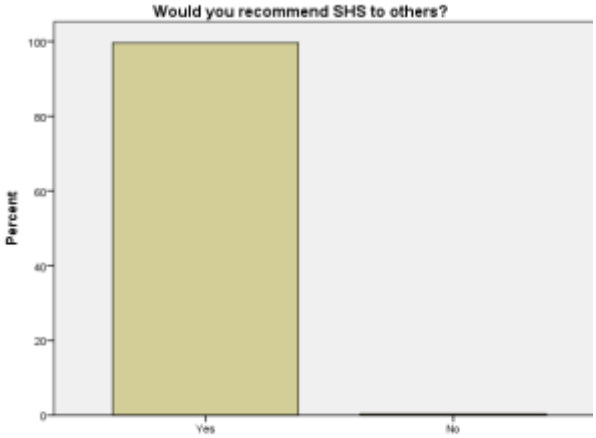
A "Survey of Herder Electrification" was carried out in October 2012 in order to evaluate the impact of the dissemination of SHS to the herder population. The survey consisted of face-to-face interviews with 789 herder households in ten Soums of Khentii and Bayankhongor Aimags. The 789 households were chosen randomly from the total of 1490 herder families that were registered as purchasers of a SHS through the project in those ten Soums. The preliminary analysis of the data collected resulted in a quantitative assessment of the user satisfaction and socio-economic impacts linked with the installation of SHS. Some key results are presented in the following with four main areas of focus, namely: (i) Customer Satisfaction; (ii) Communication; (iii) Access to Information; and (iv) Attitude. In the following pages some of the key results are presented in bar charts showing response percentage of total households interviewed on the y-axis.

- *Customer Satisfaction*

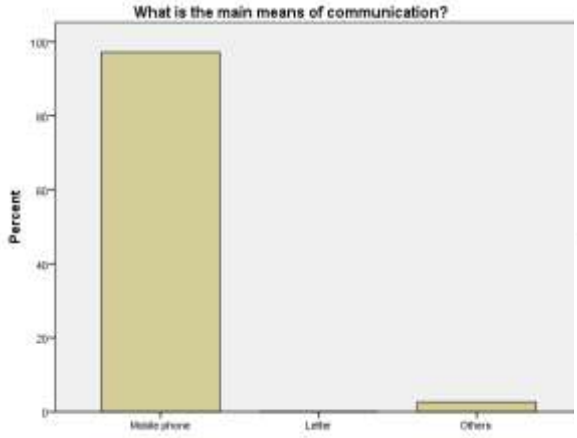


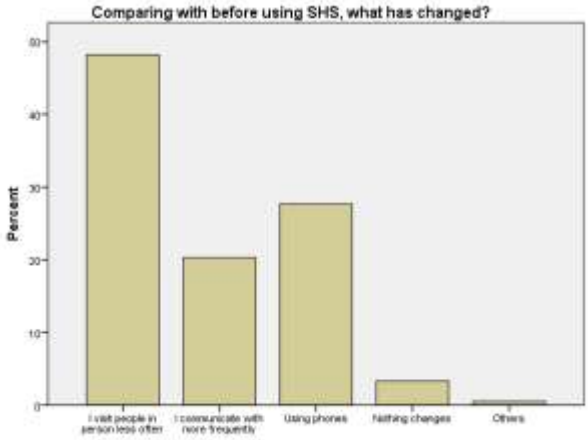


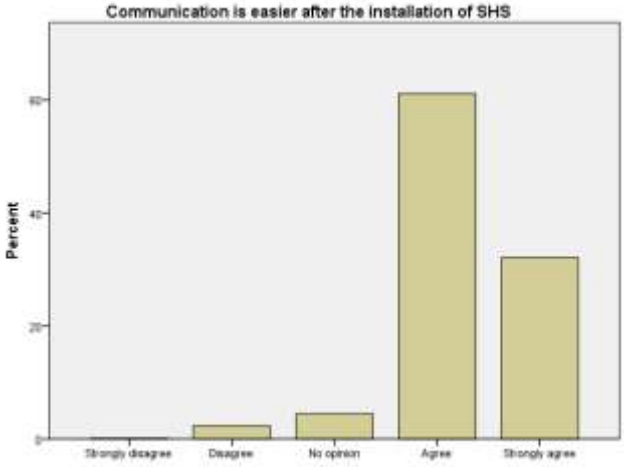




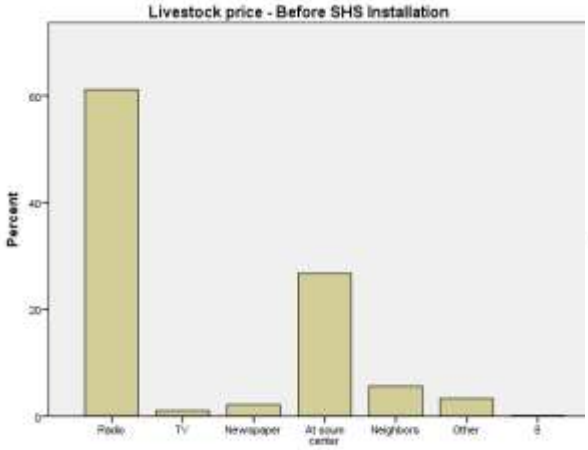
- *Communication*

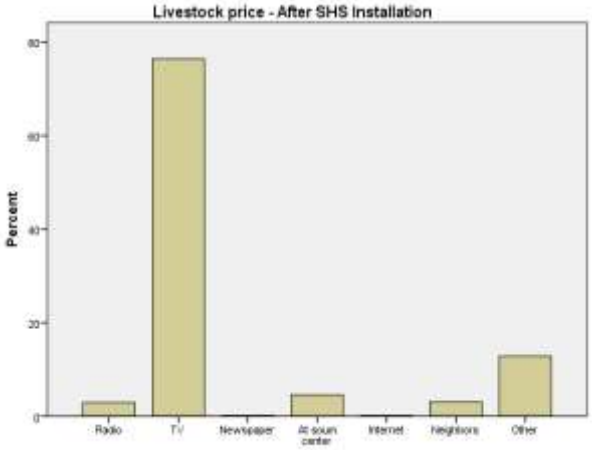


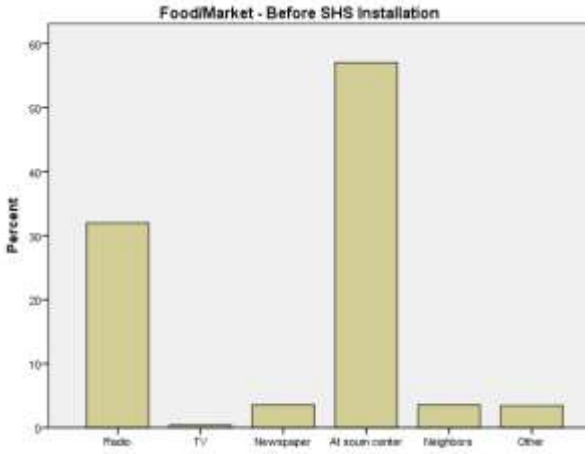


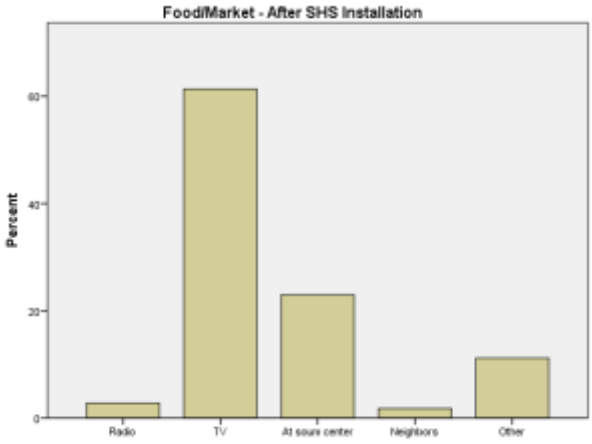


Access to Information

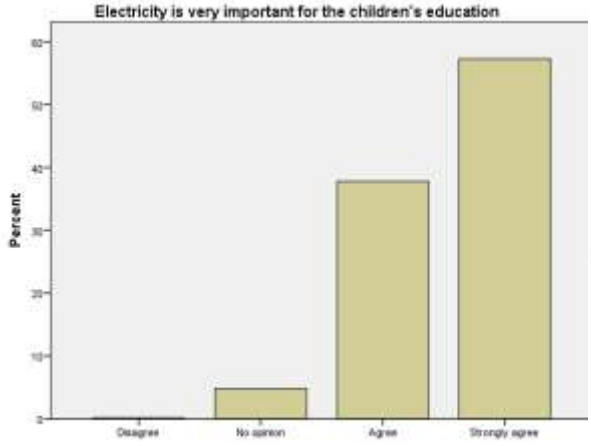


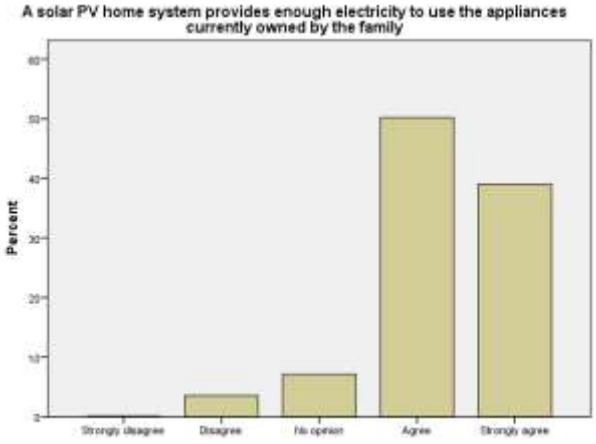


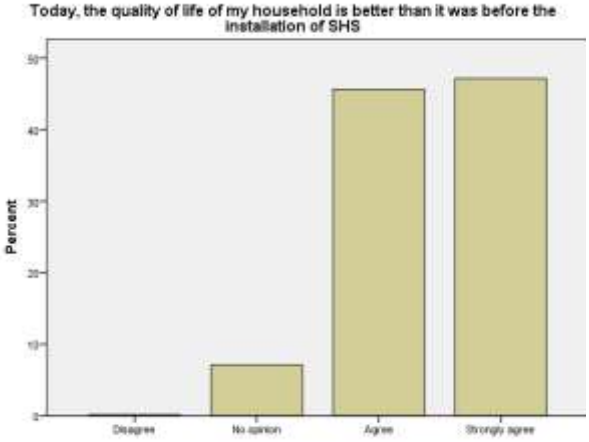


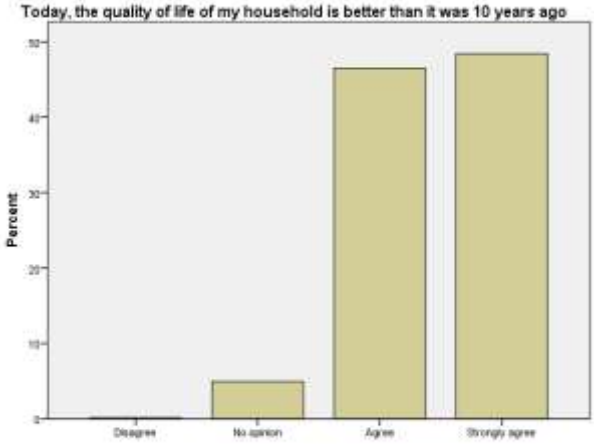


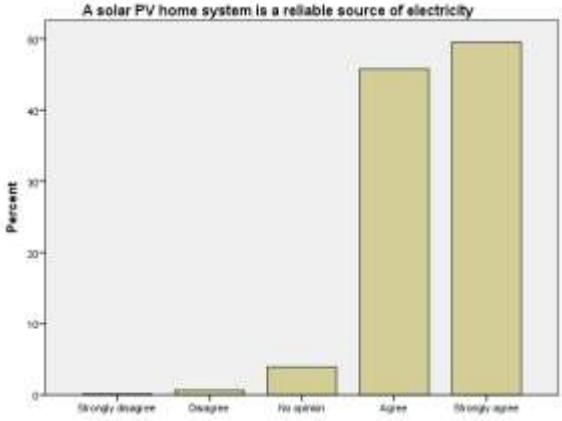
Attitude


Electricity is very important for the children's education
Percent
Disagree
No opinion
Agree
Strongly agree


A solar PV home system provides enough electricity to use the appliances currently owned by the family
Percent
Strongly disagree
Disagree
No opinion
Agree
Strongly agree


Today, the quality of life of my household is better than it was before the installation of SHS
Percent
Disagree
No opinion
Agree
Strongly agree


Today, the quality of life of my household is better than it was 10 years ago
Percent
Disagree
No opinion
Agree
Strongly agree


A solar PV home system is a reliable source of electricity
Percent
Strongly disagree
Disagree
No opinion
Agree
Strongly agree

B. Summary of Rapid Appraisal of Soum Electricity Service Sites

Introduction

A rapid appraisal was conducted In October 2012. Three sites were selected: Mandakh Soum Center in Dornogobi Aimag, Bayantooroi Bag in Gobi-Altai Aimag, and Altai Soum in Gobi-Altai Aimag. They represent two different regions of the country, RETs involving both wind and solar power, at least one site financed by the GOM, and at least one site financed by the World Bank.

In order to assess potential development outcomes at both the household and community level, individual heads of households, public administrators, business owners, and public service providers (educators and medical workers) were interviewed at each site. The team also spoke with representatives of the aimag power utility companies that have assumed ownership of the RET systems. Interviews were semi-structured, following an outline of questions that was adjusted depending on circumstances and relevance to the interviewee. From the 34 interviews, a mix of qualitative and quantitative data was collected. Due to the small sample size and the nature of the appraisal, quantitative findings are only preliminary and must be confirmed with additional research.

Findings

All three sites have experienced transformative changes in the past two to three years. While not all of these changes are attributable to REAP, the increased supply of electricity in the Soums has been a critical enabling factor. Prior to REAP, grid-supplied electricity was provided to consumers in each of the project sites for only four to five hours per day. Since the RET-diesel hybrid systems were installed, average daily service provision has increased to 11 hours in Mandakh, 18 hours in Bayantooroi, and 15 hours in Altai. Development outcomes facilitated by the increased supply of electricity have occurred at both the household and community level.

<u>Household-level Improvements</u>

- ***More cost-effective electricity and lighting services.*** Household spending on electricity has likely decreased on a per kWh basis thanks to REAP. Prior to REAP, consumers in each of the soums paid a flat rate ranging from MNT 5,000 to MNT 13,000 to help offset the cost of buying diesel fuel for the soum generator. Given the limited supply of electricity and low rates of appliance ownership, monthly diesel fees paid by households equaled an effective tariff of MNT 130 to MNT 430 per kWh. Since the RET systems and meters were installed by REAP, households in the three sites have paid a rate of MNT 132 per kWh.[8] At the same time, hours of grid-supplied electricity each day have increased, and households are using more electricity compared to before the project, evidence that REAP has satisfied a latent demand for an undersupplied service.

[8] As of September 2012, the rate set by the Aimag regulators in Gobi-Altai and Dornogobi was MNT 120 plus 10 percent VAT. The rates in Dornogobi were set to increase to MNT 135 plus tax starting in October.

It is also likely that the cost effectiveness of household lighting has improved in at least some of the soums. Prior to REAP, most households used incandescent lamps during the hours of grid-supplied electricity in the evening. During off-grid hours, they either lit candles or powered small DC lamps with SHSs. Many households in Bayantooroi and Altai already owned SHSs prior to REAP while they were quite rare in Mandakh. In the intervening years since REAP, most households have replaced their incandescent lamps with more efficient, brighter compact fluorescent lamps (CFLs), and candle use has decreased. For Mandakh, it was estimated that household spending on lighting has decreased by around 50-60 percent on a cost per lumen hour basis. About 90 percent of these savings were due to decreased candle use and lower electricity costs attributable to REAP; the remainder was from households replacing incandescent lamps with CFLs. Because of the prevalence of SHSs in Bayantooroi and Altai, the difference is likely much smaller there. Determining the welfare effects of such changes in household spending on lighting and electricity was beyond the scope of the rapid appraisal.

- ***Greater convenience in performing household tasks.*** Appliance ownership in each of the soums increased dramatically after the installation of the RET systems. Most households interviewed reported only owning a television and electric iron prior to REAP. Since REAP, they have all acquired a refrigerator or freezer, washing machine, and kitchen appliances such as electric kettles and hot pots. The greater use of appliances has made performing household tasks more convenient. There is evidence that household cooking habits have changed as a result. Some households have reportedly added more variety to their diets, for example, by baking with electric ovens or preparing rice with electric cookers. Even during the winters when households rely on their coal-burning stoves, interviewees say having the option to cook with electricity is helpful if they do not have time to prepare a meal on their stoves. The added flexibility of using electricity has benefited working women in terms of time savings especially, since they continue to do most of the cooking[9] and washing.

- ***Added time for leisure and productive activities.*** Residents all said they feel less rushed in the evenings now, and that the increased supply of electricity has freed up time for other activities. They tend to stay up later now—versus before when most would go to sleep once the diesel generator shut off for the night—and they tend to watch television for more hours per day, indicating more time for leisure. Some have capitalized on the additional time to engage in productive activities, such as the teachers in Bayantooroi and Altai use their computers at night to prepare lessons for the following day, or the entrepreneur in Mandakh who sells bread and cakes that she bakes in the afternoons and evenings after finishing her day job.

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[9] Ironically, the most compelling evidence of the added convenience and flexibility afforded to working women in the soums was the *inconvenience* suffered by these women as a result of the recent power outages.

- ***The ability to refrigerate food.*** Households identified being able to refrigerate food as one of the biggest improvements associated with the increased supply of electricity. Meat is central to the diet of most families in the soums. Prior to REAP, storing meat in the summers was difficult because the limited hours of diesel-supplied power each night were insufficient to operate electric refrigerators or freezers. Today, most households have refrigerators or freezers, allowing them to keep fresh meat for longer in the warm months and to prepare frozen meat to keep through much of the winter and spring (which many said they prefer to dried meat). Households are also able to store dairy and refrigerated foods purchased from soum grocers, such as dumplings or yogurt. While the health benefits of having access to food refrigeration are difficult to assess, several interviewees did say that they felt their diets had improved and that family members experienced fewer stomach problems from spoiled food now.

- ***Expanded access to information and communication.*** Access to information and modern communication has been facilitated by the improved supply of electricity to households. Mobile phone service providers began operating in each of the three project sites after 2009. Prior to that, the only telephone connection was the central line at the post office. Relying on a single line for the entire soum hindered the ability of residents to communicate with people outside. There were long lines; having a private conversation was out of the question; and it was difficult for people outside to call in because the line was constantly occupied. While the cell towers that were installed in the soum centers run on an independent power supply, having additional hours of grid-supplied power has enabled the regular use of mobile phones by residents—especially for larger households with multiple phones and students boarding in the school dormitories—because residents are able to charge their phones throughout the day.

Subscription satellite TV offerings have also improved significantly in the soums. Now, residents can purchase subscription packages of up to 70 channels (as opposed to four a few years ago), including nearly 30 Mongolian language channels. Access to information through television has been enhanced by REAP, especially for people who spend significant amounts of time at home during the days. Elderly interviewees said they have learned about public assistance programs for retirees by watching daytime television, while parents said that their children are now able to watch children's daytime programming. Households without satellite TV are able to watch a handful of channels which are broadcast from the soum telecom office.

Community-level Improvements

- ***Improved public service provision.*** The introduction of a daytime supply of electricity has been instrumental to improving the provision of public services such as medical care. The clinics in Mandakh and Bayantooroi have both acquired a range of new medical equipment, including x-ray machines, oxygen concentrators, and devices for electrotherapy. Prior to REAP, the use of such equipment was hampered because the clinics relied on small diesel generators for power. The generators were run sparingly, and because the soum administration had a limited budget for fuel, shortages were common. Since REAP, the clinic in Bayantooroi has ceased to rely on diesel for power

during the day (shortages are still a problem in Mandakh due to prolonged blackouts). The ability of the clinics to treat patients using modern medical equipment has also benefited from improved lighting, which, according to the nurses interviewed, has made it easier to give injections and perform other procedures.

Improvements in public services were also evidenced by the better conditions seen in the schools in all three sites which enroll children of the local population as well as those from herder families and the surrounding bags. Many of these children board (for example, in Bayantooroi, the dormitory houses more than 110 children, out of a student body of 280). According to the school principals interviewed, conditions in the dorms are much better since REAP. Children no longer use candles for lighting, eliminating a potential fire hazard, and the dorms have all been fitted with compact fluorescent lamps, improving the quality of light. Almost all of the children own mobile phones, which they use to communicate with their families. Because they are able to use washing machines, students can wash their clothes more regularly, and hygiene has improved. There is also evidence that the quality and variety of instruction in the classroom has improved. The teachers in Bayantooroi and Altai all own laptop computers that they may use for lesson planning, and the schools have outfitted computer labs to offer computer courses.

- ***Perceived growth of small businesses.*** Residents interviewed credited REAP with spurring the growth of small businesses.[10] In each of the soums, entrepreneurs were found who started new businesses after REAP, including a bakery, a family hotel, a cinderblock-making workshop, and a snack shop, which relied on power supplied from the soum grid. Existing businesses may have expanded their stock of goods for sale. For example, grocers and dry good stores in each of the soums now sell frozen and refrigerated foods in addition to basic electric appliances such as electric hot pots and kettles. Prior to REAP, demand for such appliances would have been limited, and it was not possible for stores to keep cold foods in stock for long.

Lessons Learned from Recent Disruptions and Recommendations

Positive changes in household and community life have been undercut by recent power disruptions that have occurred at each of the project sites. In Mandakh, problems with the charge controller have left the wind turbines operating at reduced capacity since around May 2012, while the solar PV has been at reduced capacity since mid-October. Because the Dornogobi Aimag Electricity Distribution Company (which assumed ownership of the Mandakh RET-hybrid system in 2011) has refused to operate the hybrid system's diesel generator, service provision in the evenings and mornings has been severely restricted. In Bayantooroi, power to one of the two main grid lines was shut off in late-September 2012 due to de-charged batteries in the system battery bank, and

[10] Due to the limited availability of consumer meter records in the soums, it was not possible to verify whether the number of businesses has actually grown. For example, power meter records for commercial users in Altai show that the number of private businesses with metered grid connections did not increase between May 2011 and September 2012; however, records were not available for 2010 to compare.

restored in late-October. During these three to four weeks, local operators for the Altai-Uliastai Energy System Company (which now owns the systems in both Bayantooroi and Altai) supplied power to the affected part of the bag for around six hours per day by operating the hybrid system's diesel generator. The problem was fixed, and power was restored to the affected area at the time of visit. In Altai, power to one of the three main grid lines was cut for nearly two months between July and August 2012 and then again starting in October. Consumers on the affected grid line include the school, kindergarten, bank, restaurants, shops, and about 40 households. During the prolonged outages, electricity has been supplied to the line for around five hours per day by running the hybrid system's diesel generators.

Apart from inconveniencing households, causing economic losses to businesses, and limiting the ability of institutional users to provide public services, power disruptions have also hurt the confidence of soum consumers in the reliability of RET-supplied electricity. In Mandakh, which has the lowest average for hours of service provided per day among the three sites visited, residents consistently expressed the view that connecting to the central grid would be preferable. While they agreed that the RET system was an obvious improvement over the old diesel generator, they also complained about the unreliability of the electricity supply, and voiced dissatisfaction with not being able to use high wattage appliances such as hot plates for cooking.

Several lessons can be distilled from the problems encountered with the RET systems in three sites. Consumer demand for electricity in the soums increased much more quickly than initially expected. According to the chief engineer of the Altai-Uliastai Energy System Company, demand in Bayantooroi and Altai has already reached or exceed the capacity of the solar stations. In fact, the recent malfunctioning of the systems during the late summer months when electricity use is at its highest may be linked to overloading. Investments in expanding the capacity of the systems may be needed to ensure a continued high level of performance and service delivery. The company has investigated the need for additional capacity, but does not have the capacity to make the investments.

The reluctance of the Dornogobi and Altai-Uliastai power utility companies to take real ownership of the RET systems has been further reinforced by the challenges faced by the companies in maintaining and repairing the systems. Making repairs is costly, and spare parts are difficult to locate in Mongolia. Because the companies are responsible for overseeing much larger centralized grid systems, according to company officials, it is difficult for them to divert scarce resources in sending repair crews to service smaller, more remote consumer centers. Furthermore, the companies lack trained technicians and engineers familiar with off-grid renewable energy systems to make the needed repairs, so they continue to rely on experts at the National Renewable Energy Center.

The companies' willingness to act as owners has also been dulled by the fact that the small-scale renewable power systems are not seen as being profitable. Both the Dornogobi and Altai-Uliastai power utilities have claimed that they are operating the RET-systems at a loss. While neither company would provide data on revenue and O&M costs, in the case of the Altai-Uliastai company at least, it appears the claim is true. For

example, in consumers in Altai Soum were billed a total of MNT 2.625 million for August 2012; however, the company used more than 2,400 liters of diesel fuel to power the Altai generator that month. With the price of diesel around MNT 1,800 per liter, total fuel costs for August were roughly MNT 4.32 million, far greater than revenues. The Dornogobi and Altai-Uliastai companies are unable to raise tariffs to cover operating costs because the tariffs must be set by the aimag regulators. While the aimag power utility companies remain the best option for managing the off-grid renewable energy systems in the soum centers, they will require additional financial and technical support to ensure that they have the capacity to effectively manage the systems, and the flexibility to adjust tariffs to cover costs.

On the consumer side, the ability of soum residents to hold the utility companies accountable for the performance of the RET systems has been weakened by the inactivity of the electricity users' associations. The associations, created as part of REAP, were originally intended to ensure the rights and responsibilities of consumers were adequately represented in decisions related to the management of the RET systems. Associations were lawfully established in each of the 15 soum centers that received RET systems financed by REAP; however, in the soums visited, it was learned that the associations have ceased to function. Without this formal mechanism for consumer representatives to engage directly with the system managers at the utility companies, communication between provider and users has been poor. As a soum representative in Bayantooroi said, consumers do not understand why power disruptions have occurred, and they are concerned that restrictions will continue into the future. Reconstituting the associations and bridging the communication gap is needed to strengthen the management of the systems and improve the responsiveness of the utility companies.

Annex 6. Stakeholder Workshop Report and Results *(if any)*

None

Annex 7: Borrower's ICR and/or Comments on the ICR

The following report summarizes the views of representatives of the Ministry of Finance, Energy Authority, and Ministry of Energy on behalf of the Government of Mongolia on the implementation and completion of the Renewable Energy and Rural Electricity Access Project (REAP), co-financed by the International Development Association (IDA), the Global Environment Facility (GEF), and the Government of the Netherlands (GoN), with funding from the Government of Mongolia.

I. Project Alignment with National Goals and Priorities

The Government of Mongolia views improving access to modern forms of energy as crucial for the development of rural areas. At the start of the twenty-first century, only nine percent of nomadic herder households in the country had electricity. About 80 percent of residents in soum centers were connected to electricity, but more than two-thirds of these settlements relied on power from small diesel generators that only operated a few hours a day. Without an adequate and reliable supply of electricity, rural residents were limited in their ability to receive information and communicate with the outside world, and the delivery of services such as education in rural areas was badly hampered. The need to improve access to electricity was apparent.

The priority of rural electrification was—and continues to be—reflected in the policies of the Government. In 2000, the Government launched a major initiative to provide access to 100,000 herder households in rural areas with access to solar electricity (the "National 100,000 Solar Ger Program," or "100,000 Solar Ger Program"). In 2005, the Mongolian Parliament passed the National Renewable Energy Program (NREP) to provide renewable electricity to all distant soums and settlements for which connecting to the centralized power grid was uneconomical. Under NREP, the Government adopted the near-term objective of electrifying at least 13 soum centers by 2010, and reaffirmed its commitment to achieve the targets for the 100,000 Solar Ger Program.

The objectives of the Renewable Energy and Rural Electricity Access Project (REAP) were thus fully aligned with the Government's policies to expand access to renewable-based energy in rural areas, and instrumental in achieving important national goals.

II. Project Outcomes

REAP was successful in fulfilling its objective of increasing access to electricity and improve reliability of electricity service among the herder population and in off-grid soum centers. REAP has provided access to electricity to nearly a half million herders in some of the most remote parts of the country, as well as improving the supply of electricity to soum center residents.

A. Herders' Electricity Access

REAP successfully expanded herders' access to electricity. The original target for REAP was to distribute 50,000 SHS units to ger households before the end of 2011 (in addition to the 32,922 units supplied by the Government prior to the start of REAP). By November 30, 2011, 54,841 SHS units had been finance and sold under the project, raising the cumulative total of households supplied with SHS units as part of the 100,000 Solar Ger Program to 87,763. To successfully complete the 100,000 Solar Ger Program, the Government requested that REAP be extended to support the sales of additional units. As a result, by the time REAP reached its extended closing date of June 30, 2012, the project had financed and supplied a total of 67,244 SHS units, bringing the cumulative number of herder households provided with SHS units as part of the 100,000 Solar Ger Program to 100,146. Thanks to REAP, the Government of Mongolia achieved and surpassed its target for expanding access of herder households to modern electricity services.

Solar power providing lighting inside a ger (Photo credit: Stephen Bachenheimer/World Bank)

Realizing the goals of the 100,000 Solar Ger Program has benefited Mongolia's herder population, and promoted the development of a market for renewable energy solutions among herder households. More than half of the herder households in Mongolia have gained access to electricity through the use of renewable energy and are now aware of how renewable energy can improve their lives. Herder households with SHSs are more connected to information from the outside world through TV and radio, and able to communicate with mobile phones. They have better lighting in their homes at night in the gers, and rely less on candles. This experience using renewable energy solutions that herders have gained under REAP and the 100,000 Solar Ger Program will be fundamental to growing the market for household use of renewable energy in future years.

B. Soum Center Electricity Service

REAP successfully increased the number of people in off-grid soum centers with access to more reliable electricity services, benefiting more than 18,400 soum residents.

The initial scope of REAP investment activities to improve electricity service in the soum centers entailed: (1) rehabilitating the local mini-grids in 30 soum centers, and (2) converting existing diesel generators to renewable-diesel hybrid systems in about 20 soum centers. Shortly after REAP began, the Government decided to fast-track its plans and increased the budget for rural electrification. In March 2007, Mongolian Parliament adopted Resolution 50, allocating MNT 61.3 billion to connect 50 soum centers to the centralized power grid and MNT 8.7 billion to build renewable energy or renewable energy-diesel hybrid systems to power 10 soum centers.

By the end of 2008, the Government had funded renewable energy systems in 12 soum centers. The bidding and selection process for the contactors to install the renewable energy systems in these 12 soums was completed entirely by the Government. The majority of the systems financed by the Government during the first two years of REAP

were small wind power systems. These systems experienced a range of technical problems, including blade, generator, and electrical system failures. Repairing the systems was difficult as spare parts were not readily available, and travel to the project sites in remote areas was costly. As of 2009, only two of the Government-funded systems were fully-operational; and no REAP-funded systems had been put in place. A lesson learned from this experience was that the quality of the installed systems may have been improved by strengthening the procedures and requirements for procurement. This could have been done by including specific technical requirements in the terms of the contracts and establishing a more rigorous selection process based on the qualifications of the bidding documents submitted by the contractors.

Based on its initial experience, and in light of the invigorated pace of its own plans for rural electrification, the Government requested in 2008 that the scope of REAP investments be narrowed to include a few larger-capacity solar PV stations in a smaller number of soums. In the view of the Government, larger-capacity systems were needed to reduce intermittency and instill greater consumer confidence in the reliability of renewable power supply in the soum centers. The World Bank was responsive to the requested changes, and the project was formally restructured in 2009 so that IDA, GEF, and GoN funds were used to construct solar-diesel hybrid systems in four soum centers, and to rehabilitate the mini-grids in 15 soum centers (including those where the Government had financed renewable power systems). The Government of Mongolia provided funding and oversaw the rehabilitation of the mini-grids in 15 other soum centers initially included in the scope of REAP, and connected these soums the centralized power grid.

By October 2012, the performance of the 15 renewable energy systems constructed during REAP was mostly good. Technical problems continue to be experienced in some soums, including Mandakh and Altai, where consumers have reported power outages and restrictions. Ownership of the systems—along with responsibility for operating, maintaining, and repairing the systems—has been assumed by the aimag power utility companies.

Despite these technical problems, according to residents, the supply of electricity has indeed improved, which has facilitated noticeable changes in the life of the soums. Previously, when electricity was provided for only a few hours a night in the off-grid soum centers, very few households owned any electrical appliances beyond a TV and incandescent bulbs for lighting. Since REAP, appliance ownership in the soums has increased considerably. Many households have acquired refrigerators or freezers and are able to store fresh meat during the springs and summers. With the daytime supply of electricity, residents have been able to start new businesses, conditions in the school dormitories have improved, computers have been introduced into the classroom, clinics are able to use more modern medical equipment, and banking may be done in real-time.

C. Institutional Capacity Building

REAP increased the capacity of the Energy Authority and Ministry of Energy (formerly the Ministry of Fuel and Energy, and Ministry of Mineral Resources and Energy) to make and implement renewable energy policies. Under the program, renewable energy specialists in the National Renewable Energy Center (NREC), Energy Authority and Ministry of Energy took part in trainings, attended conferences, and gained vital on-the-ground experience with renewable energy systems. Several specialists in NREC who initially received trained under the program have since transferred to the Energy Authority, Mongolia's agency for regulating and implementing policies in the energy sector, bringing with them valuable know-how. They worked closely with the REAP project implementing unit (PIU) during the process of installing the four solar-diesel hybrid systems that were funded by REAP (Altai, Bayantooroi bag in Tsogt soum, Dorvoljin, and Urgamal). The REAP-funded systems were overseen closely by the World Bank and provided the NREC and Energy Authority specialists with "best-practice" examples for off-grid renewable energy investments. NREC and the Energy Authority have continued to provide technical support to the aimag utility companies that manage the renewable energy systems installed during REAP. The core of technical experts in NREC and the Energy Authority were able to transfer additional solar generating capacity to some soums by reallocating units from other soums that were connected to the centralized grid.

Beyond NREC and the Energy Authority, the annual Renewable Energy Forums in Mongolia organized under REAP, helped strengthen broader-based support for renewable energy development of Mongolia. The forums were widely attended by representatives of the Mongolian Government, renewable energy companies, universities, and the international donor community.

Additional capacity-building activities were provided to SHS retailers and distributors, the operators of the 15 off-grid renewable energy systems in the soum centers, and the staff in the aimag utility. SHS retailers and distributors who participated in trainings and conferences have formed new connections with other renewable energy companies both in Mongolia and abroad. For example, while attending a conference in Beijing, one of the SHS retailers, Monmar Co., Ltd., a joint venture by the Government of Mongolia and the British company Marlec Ltd., met an international supplier of solar PV technologies. Starting from this initial contact, Monmar formed a lasting relationship with the supplier, and they continue to do business together. The operators of the off-grid renewable energy systems, trainings provided under REAP are now able to perform very basic maintenance on the systems; however, they are not able to perform more complicated repairs, and they continue to rely on the aimag utilities and NREC. Thus, ongoing efforts are needed to build day-to-day capacity for implement renewable energy projects at the local level in rural areas.

III. Project Implementation

A. Preparation

The World Bank team had adequate experience and knowledge for the preparation of the project. The REAP Steering Committee collaborated closely with the Government and the World Bank in the design and preparation of the project.

In hindsight, certain aspects of the project design advocated by the World Bank team during the preparation stage were not entirely realistic. Early on, the World Bank argued strenuously that the SHS units should be supplied primarily by private companies. The Government, on the other hand, was of the opinion that the level of private supply would be inadequate, and favored the use of public procurement to distribute the SHS units. When the project was eventually approved by the World Bank's Board of Directors and the Government, it set out a two-phased approach. Bulk procurement would be used to supply the SHS units in the first few years, but eventually be phased out as private dealers established a large enough customer base to place orders directly with suppliers. As experience would show, the network of private retailers did not form quickly enough or at a scale large enough to entirely supplant procurement and distribution via public administration channels.

B. Timing and timeliness

While the project achieved its objectives, the implementation of REAP during the first years was not able to keep pace with the timetable set for rural electrification in the Government's action plans. This was due in part to policy changes introduced after the start of the project. In 2007, the Government adopted new targets to provide SHS units to 100,000 herder households and constructed renewable power systems in 18 off-grid soum centers by 2009. Coordination between the Government and REAP was relatively weak in the beginning. Because REAP was not adequately integrated into the Government's new plans for rural electrification, the start of project activities in the soum centers was delayed until agreement could be reached on restructuring the project to focus REAP investments on a smaller number of soums.

Although REAP enabled the Government of Mongolia to achieve its target of electrifying 100,000 herder households, the distribution of the SHS units by sales and service centers (SSCs) and private dealers certified under REAP was not scaled up as quickly as originally planned. By September 2009, SSCs and private dealers had only sold about 300 SHS units—in addition to the 40,400 SHS units bulk-procured, sold, and installed through the network of local administrators in 2007 and 2008—and the Government expressed its concerned to the World Bank that REAP would not meet its original target of distributing 50,000 SHS units by the end of 2011. In order to speed up the implementation of REAP, under the mid-term restructuring of the project finalized in August 2009, the Government and the World Bank agreed to reallocate project funds toward a second bulk procurement of 20,000 SHS units. After the mid-term restructuring of the project, progress was much quicker, and REAP was able to achieve its targets.

Thus, the Government and the World Bank were able to remove early obstacles to the implementation of the project.

The project also encountered some unexpected delays, which were either partially or wholly beyond the control of the Government and the World Bank. During the years of the project, Mongolia experienced some of its longest and coldest winters in recent history, which shortened the construction season and delayed work by contractors on some of the soum center systems. Also, after bids were evaluated for the first lot of the second bulk procurement of SHS units in 2009, one of the bidders filed a complaint in Mongolian court to challenge the decision to award the contract to Wuxi Suntech Power Co., Ltd. The court eventually overturned the complaint; however, the contract with Wuxi Suntech Power was suspended for several months during the proceedings.

The World Bank generally responded to requests by the PIU and the Government in a timely and effective manner, though receiving "no-objections" by the World Bank sometimes required more time than the Government expected. The main reason for this is that the Bank would request the PIU or the Government to provide more materials or clarification to fulfill World Bank requirements. Thankfully, no major delays occurred as a result of this. Also, the task team leaders were usually quick in responding when action was urgently required. For example, during the second bulk procurement of SHS units, the task team leader sent a procurement specialist from Beijing to Ulaanbaatar in order to assure that all the requirements for tendering were met and the Bank's no-objection could be expedited. This helped speed up the process and ensured that the SHSs were procured quickly enough to avoid further delays in scaling-up the SHS distribution.

C. Aspects of the project that should have received more focus

Battery recycling. A feasibility study for a battery recycling program was carried out for REAP; however measures to ensure proper disposal of used batteries by herder households with SHS units should have been introduced earlier in the program. It is imperative that a battery buy-back program be put in place soon. Some herder households are purchasing low-quality replacement batteries that must be changed every couple of years. Each of these batteries contains toxic materials that may be released into the environment.

Demonstration of other renewable energy technologies. The World Bank could have seized on REAP as an opportunity to demonstrate other renewable power generation technologies besides solar PV. All of the systems financed and installed by the World Bank were PV-diesel hybrid systems. The Energy Authority and Ministry of Energy already recognized the advantages of PV in the Mongolian countryside; however, the Government experienced difficulties with wind power systems it financed during the first years of the project. Consequently, interest in the use of wind power for small-scale off-grid systems in the soums and bags has declined. The World Bank could have leveraged its technical expertise and experience to install a high-quality wind-diesel or wind-solar-diesel hybrid systems, which would have provided a best-practice example for the Energy

Authority and shed light on why difficulties were experienced during the installation of the first systems.

Integration with on-grid renewable energy. While the focus of the project was on off-grid renewable energy, the GoM also needs more support in managing larger on-grid renewable energy systems in the aimags. The capacity-building component of the project could have better addressed this need.

D. Interaction of project stakeholders (World Bank, PIU, and Government of Mongolia)

REAP was a well-implemented project. The quarterly meetings of the REAP Steering Committee allowed for an adequate level of interaction between the Government and the World Bank at the project level. NREC, the Energy Authority, and the PIU worked closely together on a day-to-day basis throughout the project. (The PIU was housed in the same building as NREC.) This improved coordination in solving technical problems that arose and increased the spillover of knowledge and expertise to Mongolia's renewable energy planners, regulators, and implementers. At the larger policy level, coordination between the Government and the World Bank was weak during the initial implementation phase of the project, when the Government's action plans and the REAP timetable were poorly synched, but improved greatly over time.

E. Post-project transition

Building the capacity of NREC and the Energy Authority was critical in preparing for the post-project transition period. NREC and the PIU will need to work closely with the soum centers and aimag utilities to solve technical problems that arise with the off-grid wind and solar stations. The capacity of the aimag utilities to maintain and repair the soum center renewable energy systems is still weak, and soum center consumer associations are inactive. During the transition period, NREC will inspect all of the renewable power systems installed in the soum centers during REAP to determine the cause of the remaining technical problems in the systems that are performing sub-optimally and to identify needed repairs. Additional measures will be needed to improve the management of the systems to ensure a reliable level of service provision to soum center consumers.

F. Overall assessment of World Bank performance

The overall performance of the World Bank in preparing and implementing the project is rated as **satisfactory**. While initial progress made on the project was slow, the World Bank responded to Government requests for changes to the project, and ensured that the central objective of the project was effectively attained.

G. Overall assessment of Government performance

The overall performance of the Government of Mongolia in preparing and implementing the project is rated as **satisfactory**. The Government placed great priority on achieving the objectives of the project in expanding access to rural populations through the promotion of renewable energy, and demonstrated a high level of project ownership, despite weak coordination in the early stages of project implementation. The PIU was able to effectively negotiate between the project stakeholders in implementing the project, including the World Bank and Government, as well as local administrators, the aimag utility companies, soum mini grid operators, and SCCs and private dealers.

IV. Lessons Learned

A. Development of the market for household renewable energy technologies

The most important lesson learned from the project for the development of the market for household renewable energy technologies in rural Mongolia was in the design and use of economic incentives. Prior to REAP, SHS units for the 100,000 Solar Ger Program were secured through international donations and provided to herder households solely through administrative channels. The design of the subsidy program under REAP created a cost recovery mechanism to buy down the costs of additional SHS units and expand sales, leveraging the success of the project.

While ger household demand for renewable power solutions has grown, and people are interested in acquiring larger systems or expanding the capacity of their existing systems; however, it is unlikely that sales of SHS units by SSCs and private dealers during the last years of REAP will continue once the subsidy program expires. SSCs and private dealers who were interviewed at the close of the project expect sales of SHS units to decline because they will not be able to supply SHS units at the same prices offered during REAP. Several reported that if they do continue to sell SHSs, they will choose to sell units that are cheaper and lower-quality than the ones distributed during REAP. This may undercut the confidence of ger household consumers in the reliability of SHSs.

B. Development of off-grid renewable energy systems in Mongolia

There is significant demand in rural areas for improved electricity services. Consumer demand for electricity in the soum centers in which renewable power were installed increased much more quickly than expected. According to the Altai-Uliastai Energy System Company, the REAP-funded systems in Gobi-Altai and Zarkhan aimags have already reached or exceeded capacity. In deploying small-scale renewable energy solutions in off-grid settlements, adequate allowance should be made for future capacity expansions to be made to the systems as needed.

The maintenance of the renewable energy systems installed in the soum centers should continue to be strengthened to ensure an optimum level of service provision. The aimag utilities have shown relatively little enthusiasm for their assumed role in operating,

maintaining, and repairing the off-grid renewable energy systems. There are several factors contributing to the utilities' reluctance. First, the utilities are mainly responsible centralized grid systems, which serve a larger number of consumers and are given higher priority in allocating limited company resources. Second, compared with centralized grid systems, the utilities have relatively little experience with managing off-grid renewable energy systems. Third, when the renewable energy systems have required repairs, the utility companies have had difficulties locating spare parts in Mongolia, leading to slower response time and dissatisfaction on the part of consumers. Making repairs is costly in terms of travel time and use of resources. Fourth, the small-scale renewable power systems in the soum centers are not seen as being profitable, given maintenance and repair, the continued cost of supplying diesel fuel for the soum generators during periods of intermittent wind or sun, and the inability of the utilities to adjust tariffs without prior approval by the aimag regulator.

With limited technical expertise and financial reporting knowledge in the soums, the aimag utility companies remain the best option for managing the off-grid renewable energy systems; however, a higher level of meaningful interaction and consultation between the utility companies and soum consumers is needed. The soum electricity users' associations that were formed during the project are largely inactive now. Reconstituting the associations could provide a channel for improving communication between the power supplier and consumers in the soums, especially in clarifying how tariffs are set and providing advanced notice for power restrictions enforced during periods of intermittent wind and sun.

Finally, the high bar set by open tender requirements for the PV systems financed by REAP effectively created a hurdle for Mongolian companies to participate. Greater participation by Mongolian companies in renewable energy should be encouraged. Developing a local industry for off-grid renewable energy in Mongolia will improve the operations and maintenance of renewable power systems in rural areas, solidifying supply chains for parts needed to maintain systems and reducing response time.

V. Follow-up Activities

A range of possible follow-up activities exist that could be supported by the World Bank but are not currently being pursued.

First, there is a possibility for the World Bank to support the larger-scale development of renewable energy and to connect renewable energy to existing on-grid power generation sources. For example, in Gobi-Altai, the Government has financed the construction of the 12 MW Tashir hydropower plant. If the hydropower plant could be combined with local solar power generation, this would provide a supply of electricity during the day and allow for the hydropower plant to store more water to run turbines during peak-load periods in the evenings. Developing larger-scale renewable hybrid systems for off-grid power generation in the aimags and soums represents an area for greater involvement by the World Bank, where the Bank's expertise and experience with developing renewable energy resources in other countries would be welcome.

Second, there is a need for expanding access to household food refrigeration through the use of renewable energy. Now that herders have become familiar with the use of solar PV technologies, many are hoping to upgrade to larger systems so that they can power freezers. There are good-quality solar freezers on the market, which have been field tested by Mongolian companies, but the freezers are still far too expensive for most households and cannot be powered by the 50wp and 80wp solar PV panels distributed under REAP. There would be a sizeable market for refrigeration technologies; however, subsidies or other forms of financial support are badly needed to develop this market.

Third, there is the issue of heating and access to hot water in the soums. Small individual boilers currently used in the soums for heating and hot water are inefficient and create pollution. The World Bank could support the use of renewable energy technologies such as solar water heaters, ground source heat pumps, or geothermal energy by schools, kindergartens, and other institutional users in the soums and aimag centers.

Herders assembling a ger along with SHS (Photo credit: Stephen Bachenheimer/World Bank)


Solar power providing lighting inside a ger (Photo credit: Stephen Bachenheimer/World Bank)

Annex 8. Comments of Cofinanciers and Other Partners/Stakeholders

None.

Annex 9. List of Supporting Documents

1. Project Appraisal Document dated November 27, 2006

2. Project legal documents including the IDA Financing Agreement, GEF Grant Agreement, and Netherlands Grant Agreement (2007)

3. Restructuring proposals and resulting Restructuring Papers, letters to the Government of Mongolia and amendments to the legal documents (2009 and 2011)

4. Project file containing records of project preparation and appraisal (prior and up to 2007)

5. Supervision aide-memoires, management letters, and Implementation Status and Results reports (2007-2012)

6. ASTAE Report: Evaluation of Social Impacts of Mongolia Renewable Energy and Rural Electricity Access Project (2012-2013)

7. Country Assistance Strategy for Mongolia for the Period FY 2005-2008

8. Country Partnership Strategy for Mongolia for the Period FY 2013-2017

9. Various published papers:

    - A Study on the Evaluation of Solar Home Systems Viewed by Users

    - Long-term Performance Analysis of PV Modules in the Gobi Desert of Mongolia

    - Capturing the Sun in the Land of the Blue Sky

MAP


MONGOLIA
RENEWABLE ENERGY AND RURAL ELECTRICITY ACCESS PROJECT
SELECTED CITIES AND TOWNS
PROVINCE (AIMAG) CAPITALS
NATIONAL CAPITAL
RIVERS
MAIN ROADS
RAILROADS
PROVINCE (AIMAG) BOUNDARIES
INTERNATIONAL BOUNDARIES
RUSSIAN FEDERATION
CHINA
CHINA
Lake Baikal
MONGOLIA
ULAANBAATAR
UVS
HÖVSGÖL
SELENGE
BAYAN-ÖLGII
ZAVKHAN
BULGAN
KHENTII
DORNOD
KHOVD
ARHANGAI
TÖV
SÜKBAATAR
GOVI-ALTAI
ÖVÖRKHANGAI
DUNDGOV'
BAYANKHONGOR
DORNOGOV'
ÖMNÖGOV'
Hangayn Mts
Altay Mountains
Gobi Desert
0 100 200 300 Kilometers
0 50 100 150 200 Miles
NOVEMBER 2006
IBRD 35154