Ministry of Energy and Mines

Republic of Peru

Master Plan Study
for Rural Electrification
by Renewable Energy
in the Republic of Peru

Volume 1
Master Plan

Final Report

August 2008

Japan International Cooperation Agency

Electric Power Development Co., Ltd.
Nippon Koei Co., Ltd.

PREFACE

In response to a request from the Government of the Republic of Peru, the Government of Japan decided to conduct a study on Master Plan Study for Rural Electrification by Renewable Energy in the Republic of Peru and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Tetsuro TANAKA of Electric Power Development Co., Ltd. (J-POWER), and consisted of J-POWER and Nippon Koei Co., Ltd. between February 2007 and August 2008.

The team held discussions with the officials concerned of the Government of Peru and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Republic of Peru for their close cooperation extended to the study.

August 2008

Seiichi NAGATSUKA,
Deputy Vice President
Japan International Cooperation

August 2008

Mr. Seiichi Nagatsuka
Deputy Vice President
Japan International Cooperation Agency

Letter of Transmittal

We are pleased to submit to you the Final Report on "The Master Plan Study for Rural Electrification by Renewable Energy in the Republic of Peru". Under the contract with your esteemed organization, the Study was conducted by Electric Power Development Co., Ltd. and Nippon Koei Co., Ltd. from February 2007 up to August 2008.

This Final Report compiles a master plan for rural electrification by renewable energy (solar power and mini hydropower) in remote villages difficult of electrification by grid extension scattered mainly in Andes and Amazon areas of Peru. The Master Plan proposes policy propositions on legal/institution, organization, finance, environment and gender issues as well as technical issues of solar power, mini hydropower and transmission/distribution lines regarding promotion of rural electrification. At the same time, a long-term plan was prepared for electrification by renewable energy in unelectrified villages.

It is our sincere hope that this Master Plan will contribute to promotion of rural electrification of Peru and, eventually, to mitigation of poverty and improvement of quality of life of inhabitants of remote villages.

We wish to take this opportunity to express our sincere gratitude to the officials of JICA, the Ministry of Foreign Affairs and the Ministry of Economy, Trade and Industry for their direction and support. We also wish to express our deepest appreciation to the officials of the Ministry of Energy and Mines and other pertinent government organizations of Peru as well as the regional/local governments and village inhabitants where we made visits to conduct our surveys and studies.

Very truly yours,

Tetsuro Tanaka
Team Leader
Master Plan Study for Rural Electrification
by Renewable Energy
in the Republic of Peru

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Map of Peru

Map No. 3838 Rev. 1 UNITED NATIONS
September 2000

Department of Public Information
Cartographic Section

Acronyms/Acrónimos	
ADINELSA	Administration Company of Electrical Infrastructure (Empresa de Administración de Infraestructura Eléctrica)
BCS	Battery Charging Station (Estación de Recargo de Batería)
CERER	Renewable Energy Center for Rural Electrification (Centro de Energías Renovales para Electrificación Rural)
CIRA	Certificate of Non-existence of Archaeological Relics (Certificado de Inexistencia de Restos Arqueológicos)
COES	Committee of Economical Operation of the System (Comité de Operación Económica del Sistema)
CONAM	National Council of Environment (Consejo Nacional del Medio Ambiente)
CTE	Electricity Tariff Commission (Comisión de Tarifas Eléctricas)
DEP	Executive Directorate of Projects (Dirección Ejecutiva de Proyectos)
DGER	General Diretorate of Rural Electrification (Dirección General de Electrificación Rural)
DGAAE	General Directorate of Energetic Environmental Affairs (Dirección General de Asuntos Ambientales Energéticos)
DGE	General Directorate of Electricity (Dirección General de Electricidad)
DIGESA	General Directorate of Environmental Health (Dirección General de Salud Ambiental)
DPR	Directorate of Projects (formerly DEP) (Dirección de Proyectos)
DREM	Regional Directorate of Energy and Mines (Dirección Regional de Energía y Minas)
FONCODES	National Fund of Cooperation for Development (Fondo Nacional de Cooperación para el Desarrollo)
FONER	National Fund for Rural Electrification (Fondo Nacional de Electrificación Rural)
FOSE	Electrical Social Compensation Fund (Fondo de Compensación Social Eléctrica)
F/S	Feasibility Study (Estudio de Factibilidad)
INRENA	National Institute of Natural Resources (Instituto Nacional de Recursos Naturales)
ITDG	Intermediate Technology Development Group (Soluciones Prácticas)

Acronyms/Acrónimos	
JBIC	Japan Bank for International Cooperation (Banco del Japón para Cooperación Internacional)
JICA	Japan International Cooperation Agency (Agencia de Cooperación Internacional del Japón)
MEF	Ministry of Economy and Finance (Ministerio de Economía y Finanzas)
MEM	Ministry of Energy and Mines (Ministerio de Energía y Minas)
MP	Master Plan (Plan Maestro)
OM	Operation and Maintenance (Operación y Mantenimiento)
OSINERGMIN	Supervisory Body of Investment in Energy and Mining (Organismo Supervisor de la Inversión en Energía y Minería)
OPI	Planning and Investment Office (Oficina de Programación e Inversiones)
PERNC	Plan of Non-conventional Renewable Energy (Plan de Energía Renovable Non Convencional)
PNER	National Plan of Rural Electrification (Plan Nacional de Electrificación Rural)
Pre F/S	Prefeasibility Study (Estudio de Prefactibilidad)
PSE	Small Electrical System (Pequeño Sistema Eléctrico)
SENAMHI	National Meteorology and Hydrology Services of Peru (Servicio Nacional de Meterorología e Hidrología del Perú)
SHS	Solar Home System (Sistema Fotovoltaico Domiciliario)
SIER	Information System for Rural Electrification (Sistema de Información de Electrificación Rural)
SNIP	National System of Public Investment (Sistema Nacional de Inversión Pública)
SPERAR	Peruvian Solutions to Rural Electrification in Isolated and Frontier Areas with Renewable Energies (Soluciones Peruanas a Electrificación Rural en las Areas Aisladas y de Frontera con Energías Renovables)
UNDP/GEF	United Nations Development Program/Global Environment Facility (Programa de Naciones Unidas de Desarrollo/ Fondo para el Medio Ambiente Mundial)
VAD	Value Added for Distribution (Valor Agregado de Distribución)

Introduction

Different efforts have been made in different countries for rural electrification in areas difficult to electrify by grid extension. There is, however, no sole solution to that attempt and it is in the process of trial and error to seek for more appropriate ways to the realities of each country.

The Master Plan presented here, as said above, is not the sole solution for Peru but one of the conceivable measures proposed as result of investigations and analysis of various pertinent organizations and some regions of the country by JICA Study Team.

The measures proposed here have a participatory approach combining initiatives of local residents and local governments with institutional support of central government, considering the decentralization of government of the country. Those measures are named as "SPERAR" (**S**oluciones **P**eruanas a **E**lectrificación **R**ural en las **A**reas Aisladas y de Frontera con Energías **R**enovables), as one of the strategies of power supply policy for universal services. Promotion of rural electrification in remote areas requires implementation of various measures in parallel. SPERAR as well should be implemented in parallel with the other measures taken for rural electrification in Peru.

1. Background of the Study

Peru has attained a coefficient of electrification of 78% at national level but there is a large problem of disparity between urban and rural areas. Urban areas has come to 90% of coefficient of electrification, while Amazon and Andes areas stay at 35% where grid extension has not been developed, which brings out various impediments in health and education services, industrial development and other sectors.

Against that background, Peru has been tackling the challenge of rural electrification, preparing rural electrification plan aimed at 91% of coefficient of electrification at national level by 2014 (at the time of S/W for this Study in 2006). It is expected to introduce efficient, small-scale power generation by renewable energies such as solar energy and hydraulic energy of mini/micro size in Amazon and Andes areas where grid extension would require enormous amount of money and time. Meanwhile, the Executive Directorate of Projects (DEP) of the Ministry of Energy and Mines (MEM), the responsible organization for rural electrification, has not prepared concrete strategy regarding management and OM system, tariff system and other necessary measures for electrification by renewable energies.

In order to cope with the above situation, the government of Peru requested assistance for a master plan to promote electrification by renewable energies from Japan. In response to that request, JICA (Japan International Cooperation Agency) conducted a project formation investigation in November 2005 and a preliminary investigation in September 2006, when S/W (Scope of Work of the Study) was signed between MEM and JICA. This Study was conducted based on that S/W.

2. Objective and S/W of the Study for Master Plan

The renewable energies of which the Study has the objective are solar energy and mini/micro hydropower. The Study has purposes of elaboration of a master plan clarifying measures for sustainable rural electrification by those renewable energies and technical transfer of promotion of electrification based on that master plan as well as update of the Master Plan.

To achieve the said objectives, the following studies have been conducted.

(1) Preliminary Investigations

1) Study on data and information to grasp the current situation of electrification
2) Study on renewable energy projects
3) Study on Technical and management aspects of electrification by renewable energies
4) Study on organizational and institutional aspects of rural electrification
5) Study on economic and financial aspects of existing rural electrification systems
6) Site reconnaissance to grasp living conditions and renewable energy potential of rural villages
7) Discussions with organizations relevant with rural electrification
8) Collection of information related with activities by local governments for rural electrification

(2) Elaboration of Master Plan

Based on the above studies, a Master Plan will be elaborated with policy proposals, which will include among others:

1) Guidelines for selection of renewable energy
2) Manual for technical design and sustainable operation and maintenance (OM) of power supply by renewable energies to remote areas
3) Guidelines for capacity building regarding renewable energies for pertinent organizations
4) Guidelines for establishing financial mechanism to promote rural electrification by renewable energies
5) Site reconnaissance and model plan survey
6) Long-term rural electrification plan by renewable energies
7) Study on social and environmental impact by rural electrification by renewable energies

(3) Elaboration of Decentralized Rural Electrification Plan

In order to smoothly implement rural electrification projects in line with the Master Plan, the followings will be conducted, raising awareness of local governments and the general public on rural electrification and renewable energies

1) Elaboration of implementation plan of rural electrification by renewable energies including allocation of roles to be played by local governments and central government
2) Seminar and workshop on rural electrification by renewable energies

3) Elaboration of material (pamphlets, video) to provide basic information of rural electrification by renewable energies

3. Objective Area of Master Plan

The Study will cover those parts of the whole Peru that are difficult of grid extension.

4. Composition of Final Report

The Final Report is composed of: Volume 1 Master Plan, Volume 2 Pre-feasibility studies and Volume 3 Educational material for education and diffusion of rural electrification by renewable energies

Basic Content of Final Report

Volume 1 Master Plan

I. Current Situation of Rural Electrification and Its Problems
- I-1 General Situation of Peru
- I-2 Social and Economic Conditions in Peru
- I-3 Situation of Power Sector
- I-4 Situation of Rural Electrification
- I-5 Situation of Rural Electrification by Renewable Energies
- I-6 Donors' Trend
- I-7 Problems in Execution and Diffusion of Rural Electrification by Renewable Energies
- I-8 Situation and Issues of Socio-economic and Gender Aspects
- I-9 Situation and Issues on Environment

II. Master Plan
- II-1 Plan of Rural Electrification by Renewable Energies
- II-2 Use of Master Plan
- II-3 Environmental and Social Consideration

Volume 2 Field Studies at the Level of Prefeasibility

III. Field Studies at the Level of Prefeasibility
- III-1 Solar Power (San Juan, Puno Region)
- III-2 Solar Power (Tarapoto, Loreto Region)
- III-3 Hydropower (Yerba Buena, Cajamarca Region)
- III-4 Hydropower (Balsa Puerto, Loreto Region)

Volume 3 Education Materials

IV. Education Materials
- IV-1 Materials for Awareness and Education
- IV-2 Manuals

Volume 1 is composed of the following:

(1) Current Situation of Rural Electrification and Its Problems
(2) Master Plan

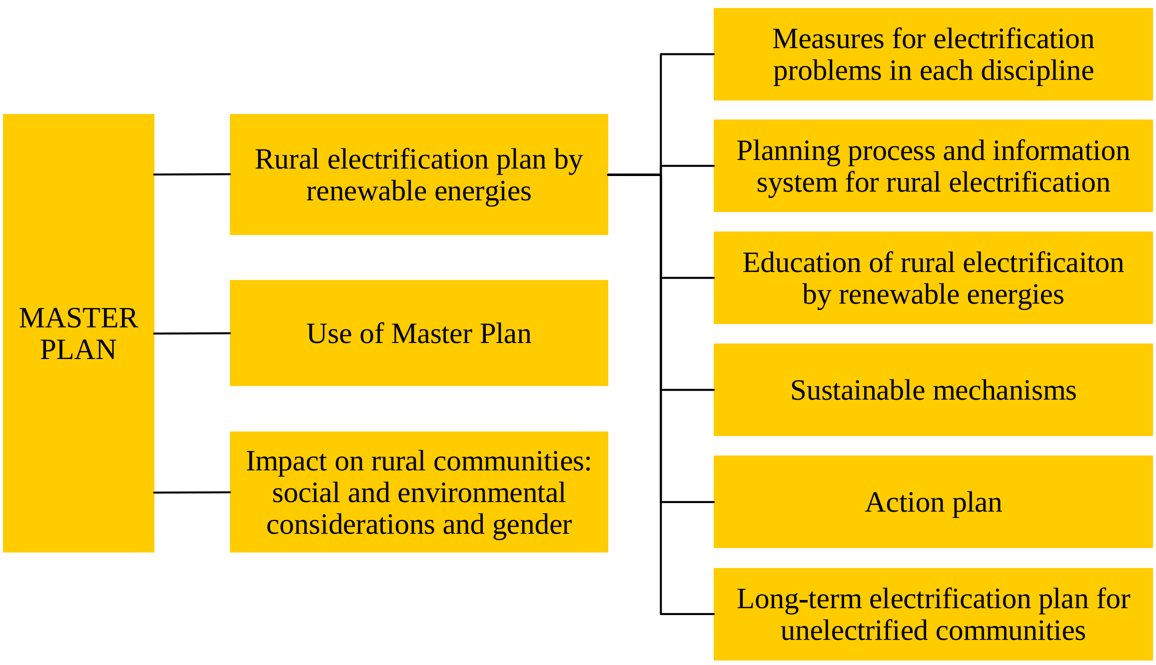
Master Plan is composed of the followings:

1) Rural electrification plan by renewable energies
2) Use of Master Plan
3) Environmental and Social Consideration

1) Rural electrification plan by renewable energies describes in each discipline (legal, organization, finance, solar energy, mini/micro hydropower and transmission/distribution lines) the measures for problems related with execution and diffusion of rural electrification by renewable energies. The following institutional mechanisms are proposed together with an action plan that proposes when and which organization should realize which of those measures.

- Planning process and information system of rural electrification
- Education of rural electrification by renewable energies
- Sustainable mechanism (capacity building and supply chain for OM)

On the condition that the above measures should be implemented by Peruvian side, a long-term plan of rural electrification by renewable energies for the objective communities of the whole country is proposed. This plan also includes identification of objective communities, selection of renewable energy, standard design and costs, model plan of management and financial mechanism, annual fund requirements and priority for electrification.



Volume 2 comprises the results of pre-feasibility studies on two solar energy projects and two mini/micro hydropower projects, including the following:

- Natural conditions
- Socio-economic, environmental and gender conditions
- Power demand and ability to pay
- Selection of renewable energy
- Design and costs
- Management organization
- Tariff setting and financial mechanism
- Economic and financial evaluation
- Impact of electrification

Such parameters as power demand, design, costs, tariff and management organization have been applied to II-1.6 Long-term Rural Electrification Plan.

Volume 3 compiles the manuals for educational material to educate local residents and governments which will be necessary to promote rural electrification by renewable energies.

5. Brief History of Investigations

JICA Study Team conducted the first and second investigations for about 2 weeks in February 2007 and for about 1 month in June and July 2007, respectively. In those investigations, relevant data and information were collected through hearings of the pertinent organizations of rural electrification, whereby the current situation and problems related to rural electrification were grasped. At the same time, preliminary surveys were conducted to select candidate sites for field studies at the level of prefeasibility which were to be conducted in October 2007. In those surveys the Study Team visited the regions of Cajamarca, Puno and Loreto to make hearings and survey of regional governments, villages and concessionary companies of power distribution regarding current situation and future plans of electrification as well as local conditions.

At the time of the first investigation, the Inception Report was submitted to MEM/DPR(DEP) and the Coordinating Committee for the Master Plan Study (composed of representatives from MEM/DPR(DEP), MEM/DGE, MEF, OSINERGMIN and ADINELSA) to explain the approach and methodology of the Study, which was approved by them. And at the time of the second investigation, the Progress Report (1) was submitted describing the current situation and problems regarding rural electrification identified by the Study Team and the basic concepts of the Master Plan and obtained the approval of MEM/DPR(DEP) and the Coordinating Committee.

At the end of the second investigation, a memorandum was signed between MEM/DPR(DEP) and JICA Study Team on July 9, 2007 on the abovementioned basic concepts and the actions to be taken by MEM/DPR(DEP) as counterpart of the Master Plan Study.

For about 1 month in October and November 2007 (50 days for experts in mini/micro hydropower) the third investigation was conducted mainly for site surveys on 2 sites for field study at the level of prefeasibility each for solar power and hydropower. A memorandum was signed between MEM/DPR(DEP) and JICA Study Team on November 13, 2007 regarding the agreed scheme of the Master Plan and the basic content of the Final Report. That memorandum also confirmed that the electrification projects of the selected sites for field study at the level of prefeasibility would be carried out by the own funds of MEM/DPR(DEP).

For three weeks in February 2008, the fourth investigation was conducted. The main purpose of this investigation was to make exchange of opinions with the Peruvian side including the counterpart on the master plan scheme and the prefeasiblity studies of the Study Team. To that effect, the Progress Report (2) was presented to MEM/DPR and the exchange of opinions was done together with the workshop inviting concerned parties.

The fifth and last investigation was carried out in June 2008 and the draft Final Report was submitted to MEM/DPR and the seminar was held inviting the concerned parties. With this all the investigations have been completed.

Volume 1 Master Plan

I. Current Situation of Rural Electrification and Its Problems

I-1 General Situation of Peru

1. Geography

Peru has a national land of about 1,285 thousand km^2 and a population of about 28 million (estimate by INEI in 2005) composed of 52% of mestizo, 32% of indigena, 12% European origin and 4% of other ethnics.

The country is geographically divided in 3 areas: Costa (coastal area), Sierra (mountain area) and Selva (Jungle area), having a great diversity of natural conditions differing from each other area providing diverse natural environment. The surface area of each area is: Costa 11%, Sierra 31% and Selva 58% with the respective population: Costa 49%, Sierra 44% and Selva 7% with nearly 30% of the total population concentrated in Lima, the capital of the country.

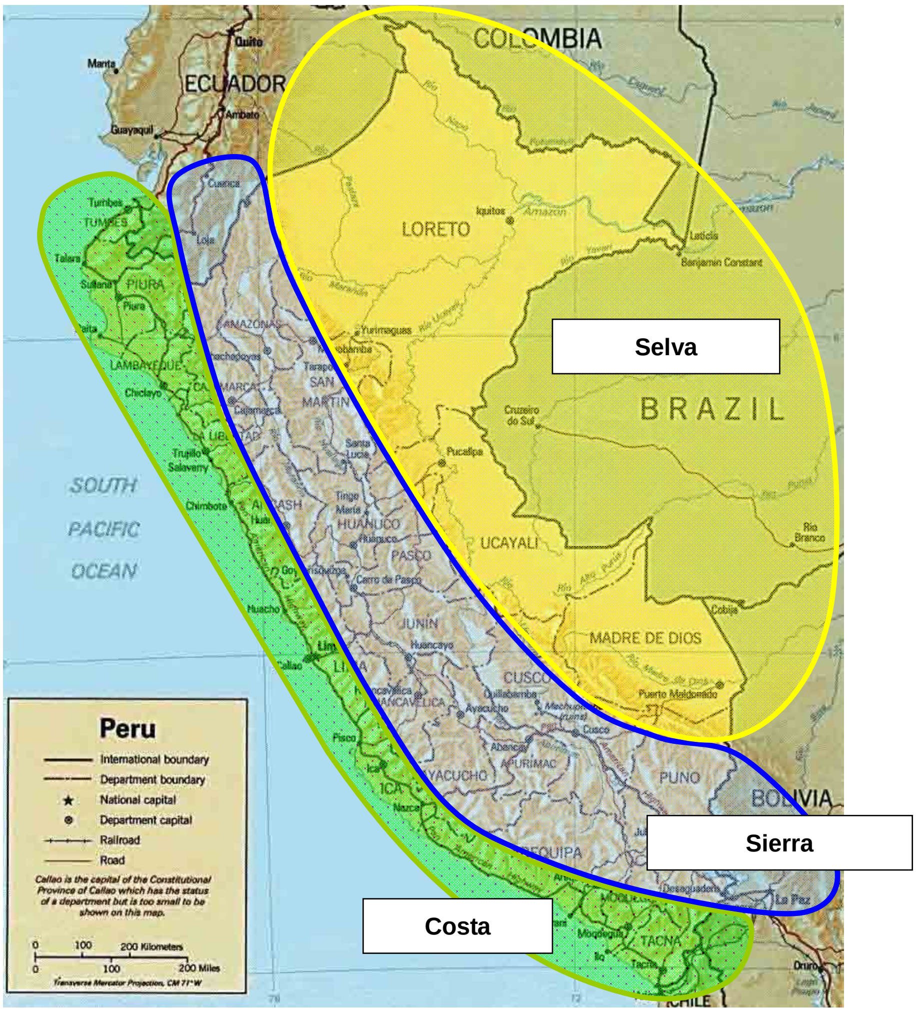


Fig. I-1-1 Geographic Map of Peru

Costa is an elongated area along some 2,600-km long north and south coastline facing the Pacific Ocean, which has arid climate but with fertile soil, so that cotton and sugar canes have been cultivated for exportation since long ago. This area is a flat desert along the coastline and infrastructure such as port, road and electric power has been developed from early times, so that commerce and industries have been advanced and major cities beginning with Lima, the capital, have been prospered.

Sierra is a mountainous area of Andes with little land suited for agriculture but with vast pasture where livestock farming such as llama and alpaca have been conducted. This area is abundant in metallic minerals, so that mining has been developed since early times. However, the geography of the Andes together with fewer densely-populated areas impedes development of infrastructure such as road, water and sewerage, electric power.

Selva comprises forest lands of the east slope of the Andes (Ceja de Selva) and plain fields of the Amazon watershed. The forest lands have fertile soil, suited for agriculture, while Amazon plain is jungle with hot and humid climate, unsuitable for agriculture. A lot of tributaries of the Amazon river forms an intricate river system and hinders traffic, so that transportation depends mainly on boat. Such difficulty in traffic impedes commerce and other trades with other areas. Selva has a vast surface area but provides few inhabitable places and is thinly populated, which has lagging development of infrastructure.

Costa has a concentration of major cities, while Sierra and Selva have small-sized villages scattered. Regarding infrastructure development of each area, the following table shows the development of main infrastructure works in urban and rural areas just for information although the data taken are outdated.

Table I-1-1 New Access to Basic and Social Services 1994-1997

(%)

	Water	Electricity	Sanitation	Outpatient health
Urban	57	72	78	74
Rural	43	28	22	26

Source: LSMS 1994 & 1997 quoted from ‘Does Geography Explain Differences in Economic Growth in Peru?’ by Javier Escobal and Máximo Torero July 2000

The difference in natural conditions and infrastructure development have brought about disparities among areas, making it difficult to improve poverty situation. The table below shows the poverty rate by area.

Table I-1-2 Poverty Rate

(%)

	Sierra	Selva	Costa
Poverty	63.4	56.6	28.7
Extreme Poverty	33.4	21.6	3

Source: INEI 2007

2. Politics

Since shift to civilian rule in 1980, there had been serious problems such as worsened economic conditions and aggravated political and social unrest. Such a situation was calmed by economic reforms and counter-terrorism measures. Macro-economic conditions have been improved since then, while important issues such as job creation, poverty reduction and corruption eradication have not been easy. In 2006 the second government of Garcia started with public commitments of poverty reduction by infrastructure consolidation and job creation along with economic growth.

Learning from experience of economic troubles like hyper-inflation in the first government of Garcia (1985-1990), it is expected that sound economic policy will be implemented. Fiscal policy is aimed for streamlining of public sector, cuts in expenditures by administrative reform and reviewing of expenditures to enhance public investment. Part of that policy is "Shock de Inversión", which is a concentrated investment in infrastructure, advancing rural electrification plan as well.

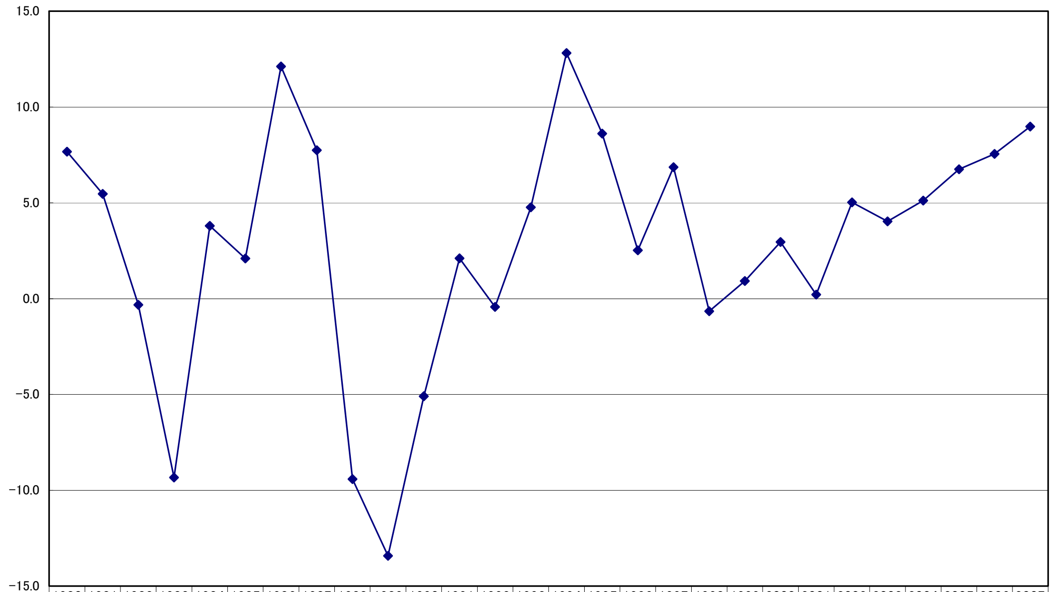
Dissolution of disparities among areas together with poverty reduction is one of the major issues of the current administration. Under the decentralization of government, it is an important point how central and regional/local governments will collaborate for those problems.

3. Economy

(1) Macro Economy

1) Economic Growth

The recent economy of Peru has seen a high pace of growth among Latin American countries under the prudent economic policy such as inflation targeting and fiscal stabilization and in the favorable international economic conditions such as sustained high prices of primary products like minerals. The year 2007 recorded nominal GDP at S/.341,227 million (about 12,284 billion yen: converted with an exchange rate of S/.1=¥36 as of April 2008), translated into S/.12,200 (about 440 thousand yen) of GDP per capita. The growth rate of economy was 9% with respect to the previous year, recording the highest rate in the last 10 years.



	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
GDP Growth Rate	7.7	5.5	−0.3	−9.3	3.8	2.1	12.1	7.7	−9.4	−13.4	−5.1	2.1	−0.4	4.8	12.8	8.6	2.5	6.9	−0.7	0.9	3.0	0.2	5.0	4.0	5.1	6.7	7.6	9.0

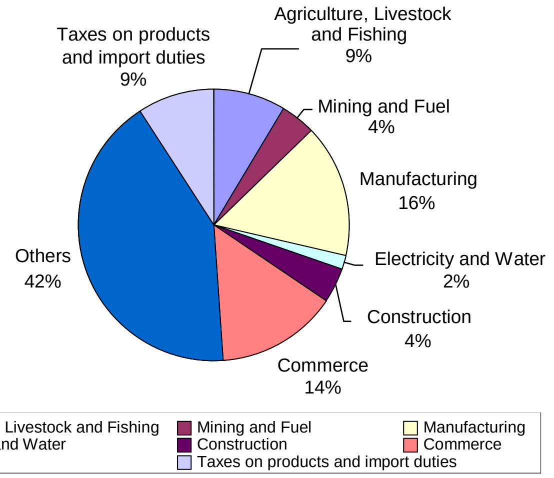
Source: Banco Central de Reserva del Peru

Fig. I-1-2 History of GDP Growth Rate

2) Economic Structure

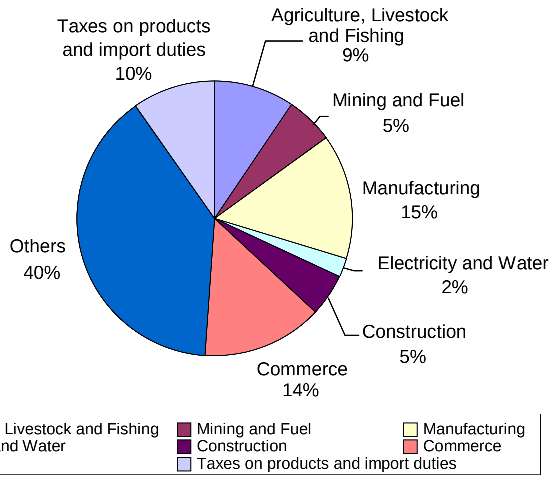
The economic structure has little changed as seen from the component ratio of GDP by industries as of 1990, 2000 and 2007. Mining and construction sectors has expanded by 2% and commercial sector by 1% with respect to 1990, while the other sector has shrunk by 5%.

Seeing GDP from expenditure, the net export (export minus import) recorded 2% as of 1990 and 2000 and increased to 7% as of 2007, showing a considerable growth of international trading sector.



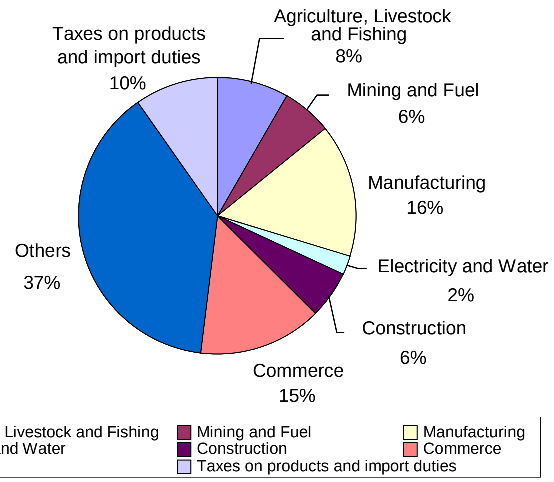
Source: Banco Central de Reserva del Peru

Fig. I-1-3 Component Ratio of GDP by Industries 1990



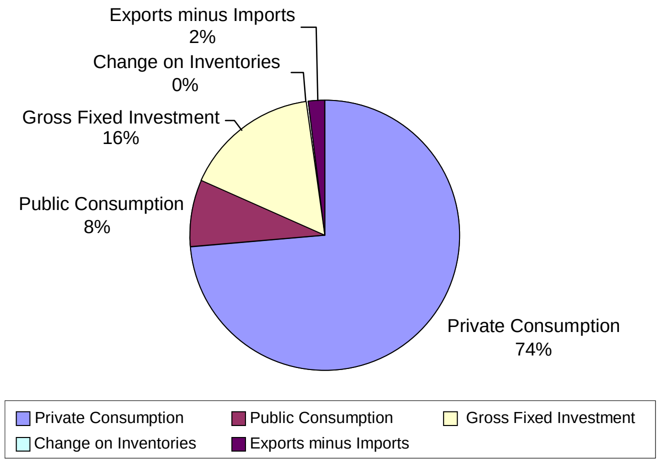
Source: Banco Central de Reserva del Peru

Fig. I-1-4 Component Ratio of GDP by Industries 2000



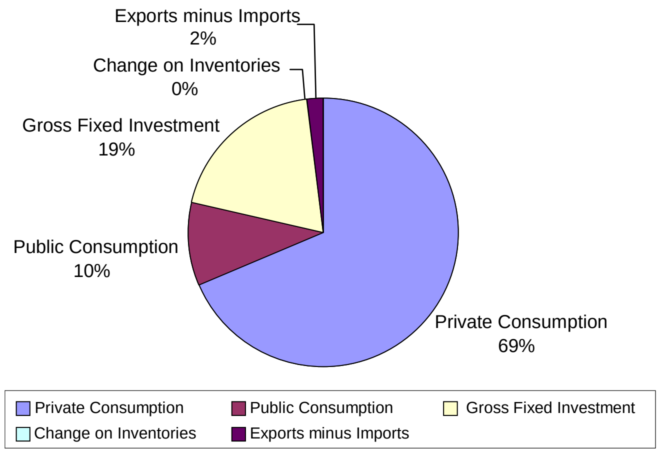
Source: Banco Central de Reserva del Peru

Fig. I-1-5 Component Ratio of GDP by Industries 2007



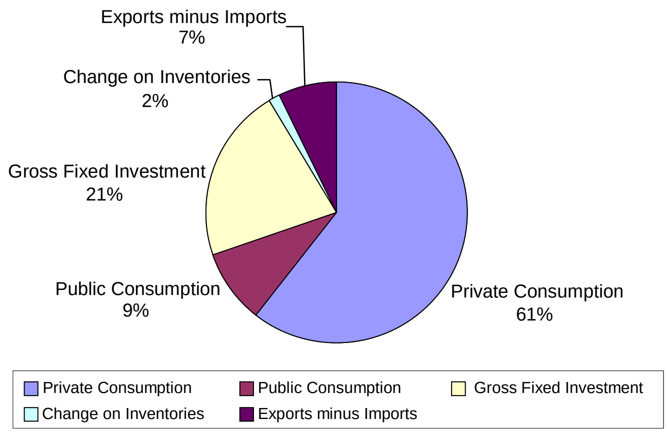
Source: Banco Central de Reserva del Peru

Fig. I-1-6 Component Ratio of GDP by Expenditure 1990



Source: Banco Central de Reserva del Peru

Fig. I-1-7 Component Ratio of GDP by Expenditure 2000

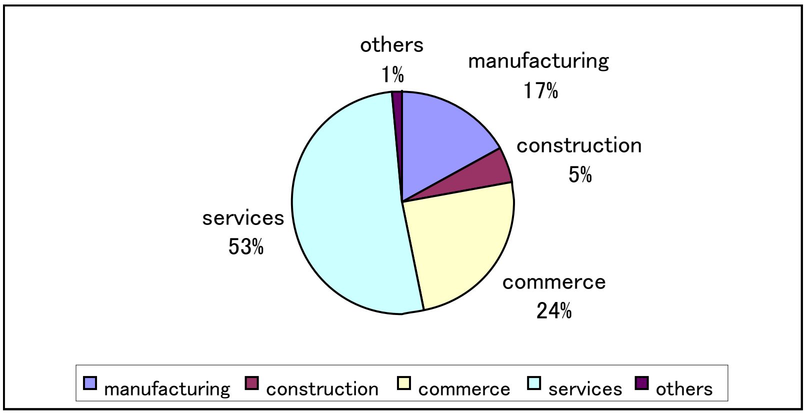


Source: Banco Central de Reserva del Peru

Fig. I-1-8 Component Ratio of GDP by Expenditure 2007

3) Employment

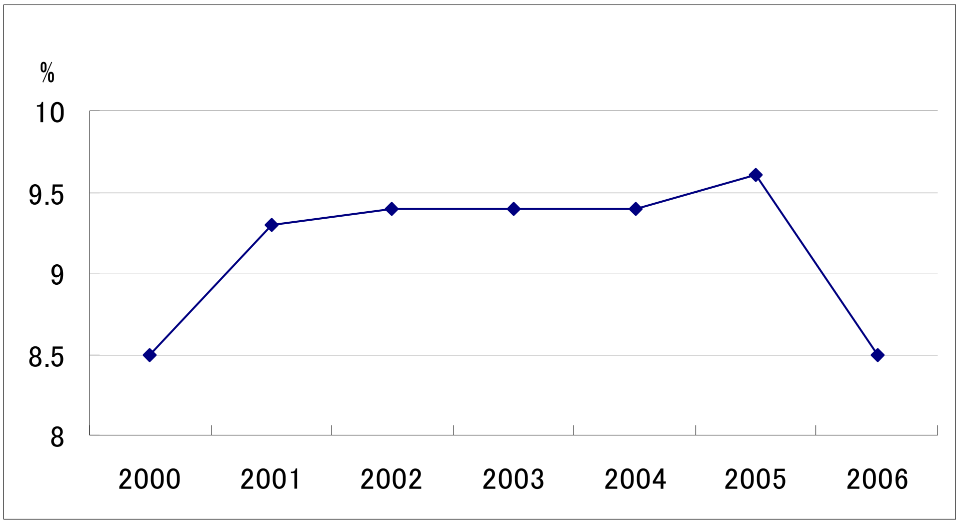
Working population of Metropolitan area of Lima as of 2006 was 4,228 thousand. The Graph below shows the component ratio of employment by industries.



Source: Banco Central de Reserva del Peru

Fig. I-1-9 Component Ratio of Employment by Industries in Lima Metropolitan Area 2006

Unemployment rate, even in the Lima Metropolitan area, has been over 8%. Improvement of employment situation is a serious issue.

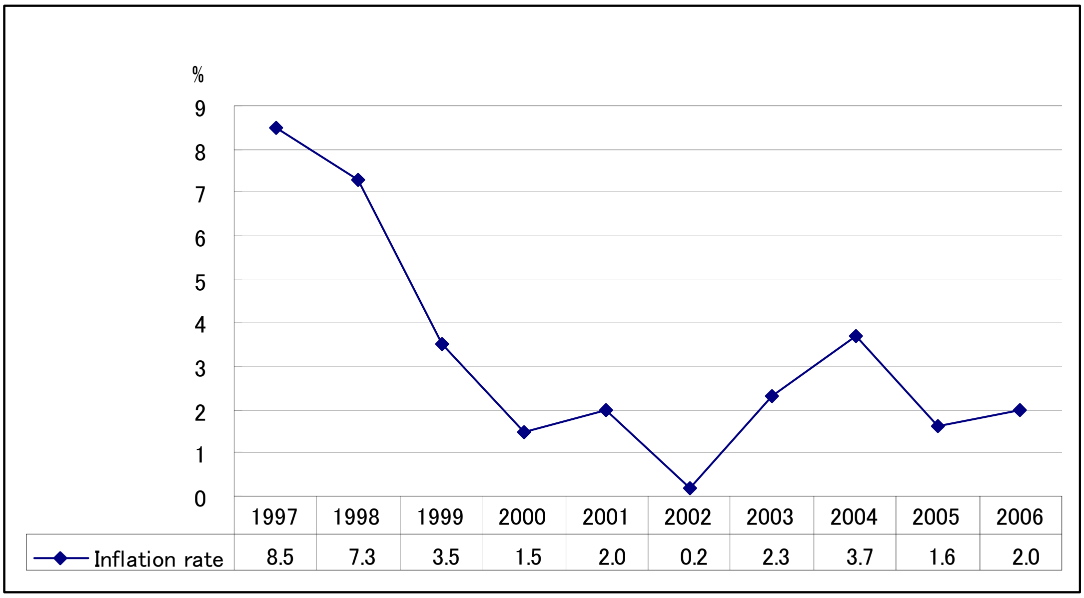


Source: CEPAL

Fig. I-1-10 History of Urban Unemployment Rate

4) Inflation

Economic turmoil of 1980s brought about hyperinflation, reaching 7,479% in 1990. Economic reforms since Fujimori administration in 1990 has suppressed inflation. The recent years saw inflation ranging from 1% to 4% partly due to inflation targeting policy.



Source: CEPAL

Fig. I-1-11 History of Consumer Price Index

(2) International Accounts

1) Balance of Payments

The table below shows balance of payments from 2000 through 2007. The surplus of trade of goods has increased year by year, while excess of imports over exports has been seen in the trade of services, so that the international trade as a whole recorded a surplus since 2004. In the meantime, the income account such as investment income has seen increasing deficit reflecting increase of foreign direct investment. The total of the balance of trade and that of income account was deficit in some years, while current transfers including inter-governmental aid and capital account including private investment increased in such a manner as to compensate the deficit. As a result, foreign exchange reserves has steadily been increasing.

It is to be noted that the public sector of the financial account has been in deficit from 2005, which means that the government of Peru has been making efforts to reduce external debts.

Table I-1-3 Balance of Payments

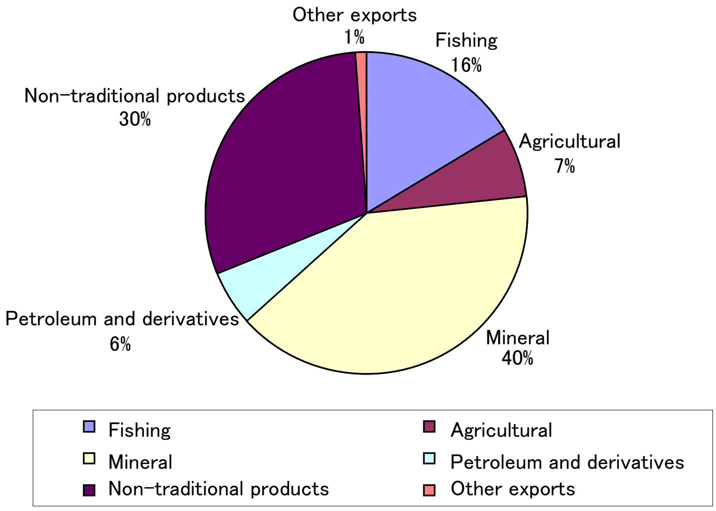
Unit: million US$

	2000	2001	2002	2003	2004	2005	2006	2007
I. CURRENT ACCOUNT BALANCE	**- 1 546**	**- 1 203**	**- 1 110**	**- 949**	**19**	**1 148**	**2 757**	**1 516**
1. Trade balance	- 403	- 179	321	886	3 004	5 286	8 934	8 356
a. Exports	6 955	7 026	7 714	9 091	12 809	17 368	23 800	27 956
b. Imports	- 7 358	- 7 204	- 7 393	- 8 205	- 9 805	- 12 082	- 14 866	- 19 599
2. Services	- 735	- 963	- 994	- 900	- 732	- 834	- 781	- 928
a. Exports	1 555	1 437	1 455	1 716	1 993	2 289	2 647	3 343
b. Imports	- 2 290	- 2 400	- 2 449	- 2 616	- 2 725	- 3 123	- 3 428	- 4 270
3. Investment income	- 1 410	- 1 101	- 1 457	- 2 144	- 3 686	- 5 076	- 7 581	- 8 408
a. Private sector	- 896	- 550	- 746	- 1 275	- 2 715	- 4 211	- 6 901	- 7 989
b. Public sector	- 513	- 551	- 711	- 869	- 970	- 865	- 679	- 419
4. Current transfers	1 001	1 040	1 019	1 209	1 433	1 772	2 185	2 495
II. FINANCIAL ACCOUNT	**1 023**	**1 544**	**1 800**	**672**	**2 154**	**141**	**708**	**8 275**
1. Private sector	1 481	983	1 538	- 105	937	1 818	2 075	9 605
2. Public sector	277	372	1 056	630	988	- 1 441	- 738	- 2 473
3. Short-term capital	- 735	189	- 794	147	230	- 236	- 628	1 143
III. EXCEPTIONAL FINANCING	**- 58**	**- 1**	**14**	**64**	**26**	**100**	**27**	**67**
IV. NET ERRORS AND OMISSIONS	**388**	**110**	**130**	**689**	**151**	**239**	**- 738**	**- 203**
V. BCRP NET INTERNATIONAL RESERVES FLOV (V = I + II + III + IV)	**- 193**	**450**	**833**	**477**	**2 351**	**1 628**	**2 753**	**9 654**

Source: Banco Central de Reserva del Peru

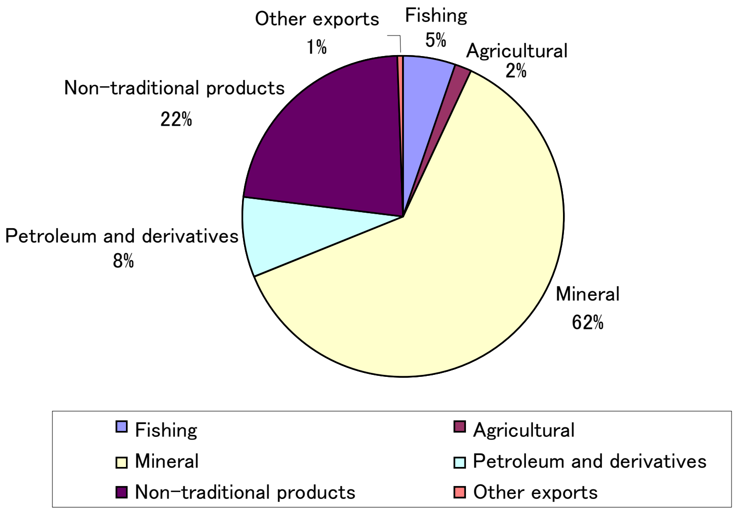
2) International Trade

As seen from the table below, the export of the country has conventionally been dependent on primary products, especially mineral. This fact means that the balance of payments depends largely on not only the quantity of the products but also the international prices. The recent years have seen favorable increase in export of copper and gold among the minerals. In the some latest years, the export amount has considerably increased, tripled with respect to that of 10 years ago. Such an increase of mineral export has led to the expanse of surplus since 2002.



Source: Banco Central de Reserva del Peru

Fig. I-1-12 Component Ratio of Export 1997

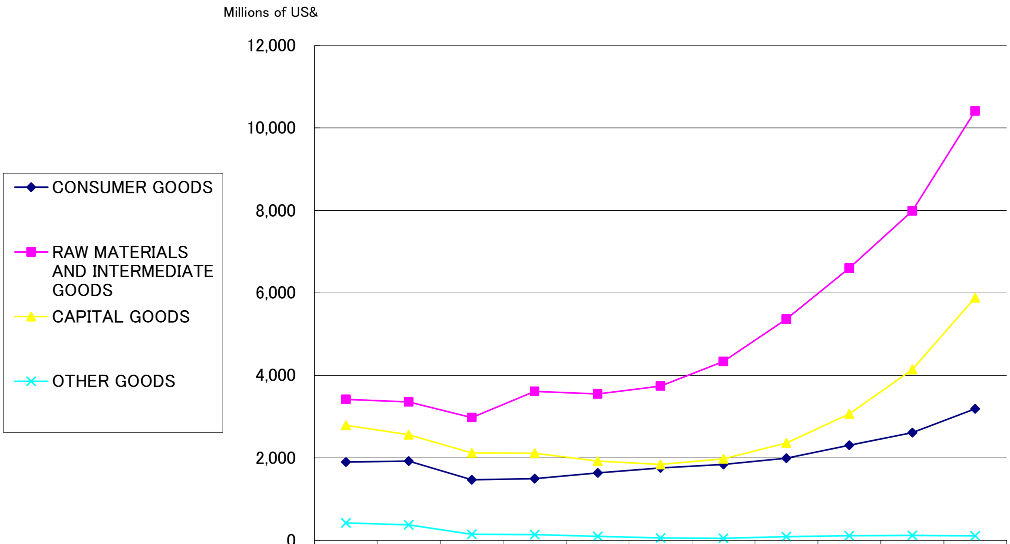


Source: Banco Central de Reserva del Peru

Fig. I-1-13 Component Ratio of Export 2007

Free Trade Agreement (FTA) with the United States, the most important trade partner, was ratified in its Congress, so that further trade expansion is expected and, at the same time, it is an important issue to strengthen the competitiveness of the country’s domestic industry.

Seeing the import items, the increase of capital goods and raw materials and intermediate goods has been considerable, showing that domestic mining and manufacturing has been active.



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
CONSUMER GOODS	1 900	1 922	1 468	1 494	1 635	1 754	1 841	1 995	2 308	2 611	3 191
RAW MATERIALS AND INTERMEDIATE GOODS	3 422	3 360	2 980	3 611	3 551	3 740	4 340	5 364	6 600	7 987	10 416
CAPITAL GOODS	2 791	2 562	2 117	2 114	1 921	1 842	1 974	2 361	3 064	4 145	5 885
OTHER GOODS	422	375	146	139	97	56	49	85	110	122	106

Source: Banco Central de Reserva del Peru

Fig. I-1-14 History of Import Amounts

(3) Public Finance

Garcia Administration has made public commitments that fiscal deficit of the public sector is to be suppressed to 1% of GDP or under and the inflation rate to 2.5%. Table I-1-4 shows that the primary balance has turned in surplus from 2003 and the overall balance in black from 2006, evidencing a steady progress to balanced budget. The turn into the black of the overall balance since 2006 has advanced repayment of public debts, especially foreign debts. Table I-1-5 shows the outstanding balance of public debts.

Revenues recorded a considerable increase in income taxes and value-added taxes, showing active economic situation.

In the meantime, in the expenditures, the transfers of the current expenditure, especially revenue share with local governments, and the capital expenditure have increased. One of the important issues of the current government is to revise the expenditures and to streamline the public sector to reduce the expenditure. In order to accelerate development of infrastructure making use of the limited financial resources, an investment program called "Shock de Inversion" is being carried out. Another issue is to promote rural industries. The increase in the transfer and capital expenditure seen above reflects such policies.

Table I-1-4 Fiscal Balance of Central Government (ratio to GDP)

	2000	2001	2002	2003 1/	2004 1/	2005 1/	2006 1/	2007 1/
I. CURRENT REVENUES	**14.9**	**14.3**	**14.3**	**14.8**	**14.9**	**15.7**	**17.3**	**17.9**
II. NON-FINANCIAL EXPENDITURE	**15.8**	**15.1**	**14.6**	**14.7**	**14.4**	**14.7**	**14.2**	**14.6**
1. Current expenditure	12.9	12.9	12.7	12.8	12.5	12.8	12.2	12.5
2. Capital expenditure	2.8	2.2	2.0	1.9	1.8	1.9	2.0	2.2
III. CAPITAL REVENUES 2/	**0.3**	**0.2**	**0.2**	**0.2**	**0.1**	**0.1**	**0.1**	**0.1**
IV. PRIMARY BALANCE	**-0.6**	**-0.6**	**-0.2**	**0.2**	**0.6**	**1.1**	**3.2**	**3.4**
V. INTEREST PAYMENTS	**2.2**	**2.1**	**2.0**	**2.0**	**1.8**	**1.8**	**1.8**	**1.6**
VI. OVERALL BALANCE	**-2.8**	**-2.8**	**-2.1**	**-1.7**	**-1.3**	**-0.7**	**1.4**	**1.8**
VII. NET FINANCING (1+2+3)	**2.8**	**2.8**	**2.1**	**1.7**	**1.3**	**0.7**	**-1.4**	**-1.8**
1. External	1.1	1.1	2.0	1.6	1.6	-1.2	-0.6	-2.0
2. Domestic	0.9	1.1	-0.6	0.1	-0.5	1.8	-0.9	0.1
3. Privatization	0.8	0.6	0.8	0.1	0.2	0.1	0.1	0.1

1/ Preliminary.
2/ Net of payments to the American International Group y and the Perú-Alemania Agreement.

Source: Banco Central de Reserva del Peru

Table I-1-5 Outstanding Balance of Public Debts

	Millions of US$			Percentage of GDP		
	2004	2005	2006	2004	2005	2006
PUBLIC DEBT	**30,905**	**29,968**	**30,484**	**44.4**	**37.7**	**32.6**
I. FOREIGN PUBLIC DEBT 2/	**24,466**	**22,279**	**21,972**	**35.1**	**28.1**	**23.5**
CREDITS	17,522	13,886	13,580	25.1	17.5	14.5
Multilateral Organizations	7,875	7,983	7,843	11.3	10.1	8.4
Paris Club	8,508	5,696	5,629	12.2	7.2	6.0
Suppliers	1,070	158	73	1.5	0.2	0.1
Commercial Banks	4	1	1	0.0	0.0	0.0
Latin America	42	33	25	0.1	0.0	0.0
Eastern European Countries 3/	23	16	9	0.0	0.0	0.0
BONDS	6,944	8,393	8,392	10.0	10.6	9.0
II. DOMESTIC PUBLIC DEBT	**6,439**	**7,688**	**8,512**	**9.2**	**9.7**	**9.1**
1. LONG TERM	**5,812**	**6,896**	**7,597**	**8.3**	**8.7**	**8.1**
CREDITS FROM BANCO DE LA NACION	929	890	774	1.3	1.1	0.8
1. Central Government	871	857	772	1.2	1.1	0.8
2. Local Government	58	33	2	0.1	0.0	0.0
TREASURY BONDS	4,884	6,006	6,809	7.0	7.6	7.3
1. BCRP Capitalization Bonds	12	0	0	0.0	0.0	0.0
2. Financial System Support Bonds	637	222	224	0.9	0.3	0.2
3. Debt Exchange Bonds 4/	152	122	91	0.2	0.2	0.1
4. Sovereign Bonds	1,149	2,951	3,699	1.6	3.7	4.0
5. Caja de Pensiones Militar-Policial Bonds	34	34	0	0.0	0.0	0.0
6. Pension Recognition Bonds	2,899	2,677	2,795	4.2	3.4	3.0
LIMA MUNICIPALITY BONDS	0	0	14	0.0	0.0	0.0
2. SHORT TERM	**627**	**793**	**915**	**0.9**	**1.0**	**1.0**
TREASURY BILLS	0	0	0	0.0	0.0	0.0
CREDITS FROM BANCO DE LA NACION 5/	265	139	0	0.4	0.2	0.0
FLOATING DEBT	362	654	915	0.5	0.8	1.0

1/ The external debt includes medium and long term debt of COFIDE, excludes loans to balance of payments.
2/ Former Soviet Union countries. Includes the People's Republic of China.
3/ D.U. N° 068-99.
4/ Includes Public Treasury overdrafts in the Banco de la Nacion and credit to the Instituto Nacional de Defensa Civil.
Source: MEF, Banco de la Nacion, ONP, and COFIDE.

Source: Banco Central de Reserva del Peru Memoria 2006

Table I-1-6 Current Revenues of Central Government

	2000	2001	2002	2003 1/	2004 1/	2006 1/	2007 1/
							Millions of Nuevos Soles
I. TAX REVENUE	**22 769**	**23 541**	**24 062**	**27 405**	**31 144**	**45 485**	**52 454**
1. Income tax	5 130	5 630	6 011	7 971	9 026	18 414	22 847
2. Property tax	0	0	0	0	0	0	0
3. Export tax	0	0	0	0	0	0	0
4. Import tax	2 921	2 786	2 483	2 550	2 744	2 847	2 198
5. Value-added tax (IGV)	12 013	11 815	12 613	14 110	16 206	21 517	25 258
-Domestic	7 007	6 866	7 501	8 459	9 526	11 982	13 586
-Imports	5 007	4 949	5 113	5 651	6 680	9 535	11 672
6. Excise tax (ISC)	3 424	3 561	4 184	4 525	4 468	4 042	4 291
-Fuel	2 120	2 321	3 003	3 285	3 177	2 399	2 419
-Others	1 304	1 241	1 181	1 240	1 292	1 643	1 872
7. Other tax revenue	2 053	2 602	1 738	1 414	2 162	3 369	3 848
8. Tax refund	-2 772	-2 853	-2 968	-3 165	-3 462	-4 704	-5 989
II. NON-TAX REVENUE	**4 935**	**3 518**	**4 498**	**4 163**	**4 238**	**7 229**	**8 659**
III. TOTAL (I+ II)	**27 705**	**27 059**	**28 559**	**31 568**	**35 381**	**52 715**	**61 113**

1/ Preliminary.

Source: Banco Central de Reserva del Peru

Table I-1-7 Current Expenditures of Central Government

	2000	2001	2002	2003 1/	2004 1/	2005 1/	2006 1/	2007 1/
								Millions of Nuevos Soles
I. NON-FINANCIAL EXPENDITURE	**29 360**	**28 580**	**29 241**	**31 451**	**34 165**	**38 468**	**43 260**	**49 962**
1. Current expenditure	**24 101**	**24 349**	**25 285**	**27 371**	**29 870**	**33 577**	**37 252**	**42 613**
a. Wages and salaries	8 190	8 228	8 922	9 669	10 509	11 593	12 553	13 020
b. Goods and services	7 161	7 424	6 873	7 338	8 219	8 960	10 192	10 994
c. Transfers	8 750	8 697	9 490	10 364	11 142	13 024	14 506	18 599
2. Capital expenditure	**5 259**	**4 231**	**3 956**	**4 080**	**4 295**	**4 891**	**6 008**	**7 349**
a. Gross capital formation	4 762	3 668	3 435	3 513	3 822	4 458	4 779	6 000
b. Others	497	563	521	567	473	433	1 229	1 350
II. INTEREST PAYMENTS	**4 077**	**4 060**	**3 953**	**4 191**	**4 381**	**4 794**	**5 413**	**5 525**
1. Domestic debt	543	466	485	469	460	657	1 117	1 279
2. External debt	3 534	3 594	3 469	3 722	3 921	4 138	4 297	4 247
III. TOTAL (I+II)	**33 437**	**32 640**	**33 194**	**35 642**	**38 547**	**43 263**	**48 673**	**55 488**

1/ Preliminary.

Source: Banco Central de Reserva del Peru

I-2 Social and Economic Conditions in Peru

1. Social and Economic Conditions

(1) Overview

Peru are composed of three geographical regions: an arid coastal region (costa), the inland Andes mountainous region (sierra) and tropical plain of the Amazon River bordering Colombian and Brazil (selva). Peru's economy and culture reflect this varied geography. The object of this master plan study is sierra and selva regions.

Peruvian geographer Javier Pulgar Vidal proposed to divide Peru into eight environmental divisions[1].

Map of Peru

Source: Wikipedia

Fig. I-2-1 Vegetation of Peru

- *Chara* or *Chala* (coast): coastal area up to about 500 meters above sea level, characterized by very low precipitation and desertification. Rather high humidity and low temperature. Quechuan term '*chara*' means the condition that cloud hangs low over mountains.
- *a* (hot valley): western slope of the Andes from 300 meters to 500 meters above sea level, characterized by much sunshine, dry climate and high daily temperature difference. This area is also found at eastern slope of the Andes from 1,000 meters to 2,300 meters above sea level where precipitation is much higher than the western slope.
- *Quichua* (warm valley): valleys and basins situated from 2,300 meters to 3,500 meters above sea level characterized by warm climate and moderate inclination, which is the most populated area in Peru and many cities, such as Cusco and Cajamarca, were constructed.
- *Suni* (chilly upland): from the upper limit of Quichua up to about 4,000 meters above sea level, characterized by cold temperature and limit of cultivation in Andean mountainous area. Suni means high altitude in Quechua.

1 Pulgar Vidal, Javier "Geografia del Perú : llas Ocho Regiones de Per", Lima, Editorial Universo S.A.; cited to Tomoeda, Hiroyasu, 1986, "Ox and Condor", Tokyo.

- *Puna* (cold highland): area above 4,000 meter above sea level, characterized by cold temperature (annual average temperature is 0-7°C.) and by grass land vegetation where animal husbandry is main subsistence activity.
- Janka (snowy mountain): 4,800 meters and over above sea level that is the lower limit of snow and glacier, characterized by very poor vegetation and high mountains covered by snow and glacier. It has been the object of belief of Andean people.
- *Rupa rupa* or *lupa lupa* (hot): hilly area on the eastern slope of the Andes from 400 meters to 1,000 meters above sea level characterized by tropical rain forest and high precipitation.
- *Omgua*: riverine plain of the upper Amazon below 400 meters above sea level, characterized by tropical rain forest and high precipitation.

The country is, according to the Regionalization Law (2002), divided into 24 regions (departments). Regions are sub-divided into 194 provinces that consist of 1,831 districts.

Abundant mineral resources are found in the mountainous areas, and Peru's coastal waters provide excellent fishing grounds. However, overdependence on minerals and metals subjects the economy to fluctuations in world prices, and a lack of infrastructure deters trade and investment. After several years of inconsistent economic performance, the Peruvian economy grew by more than 4% per year during the period 2002-06, with a stable exchange rate and low inflation. Growth jumped to 7.5% in 2007, driven by higher world prices for minerals and metals. Peru is ranked among medium-income fast developing countries by the World Bank.

Table I-2-1 Basic Social and Economic Indicators of Peru

Area[*1]:	Total:	1,285,220 km^2	GNI in Atlas method (2006)[*3]		
	Land:	1.28 million km^2		GNI:	US$82.7 billion
	Water:	5,220 km^2		GNI capita:	US$2,929.0
Population[*1] (21 Oct. 2007):		28,220,764	GDP (2006)[*3]:		US$93.3 billion
Annual population growth rate			GDP annual growth rate (2006)[*3]:		8.0%
	(average 1993-2007)[*1]:	1.6%	GDP composition by industry (2006)[*3]		
Life expectancy at birth[*2] (2007 est.)				Primary:	6.6%
	Total:	70.14 years		Secondary:	33.8%
	Male:	68.33 years		Tertiary:	59.6%
	Female:	72.04 years	Population below national poverty line[*4](2004)		
Literacy rate[*2] (2004 est.)				National:	51.6%
	Total:	87.7%		Urban:	40.3%
	Male:	93.5%		Rural:	72.5%
	Female:	82.1%	Human development (2005)[*5]		
				HDI:	0.773
				Rank:	87
				(medium human development country)	

Note: GNI=Gross National Income, the sum of value added by all residents producers plus any product taxes (less subsidies) being not included in the valuation of output plus net receipts of primary income from abroad.
The national poverty line of Peru is defined in 2001 by ENAHO (*Encuesta Nacional de Hogares* = National household investigation) as three caloric norms different by area; such as, 2,232 calories/person/day in metropolitan

Lima, 2,194 calories/person/day in the costa and the urban selva, and 2,133 calories/person/day in the rural sierra and the rural selva.

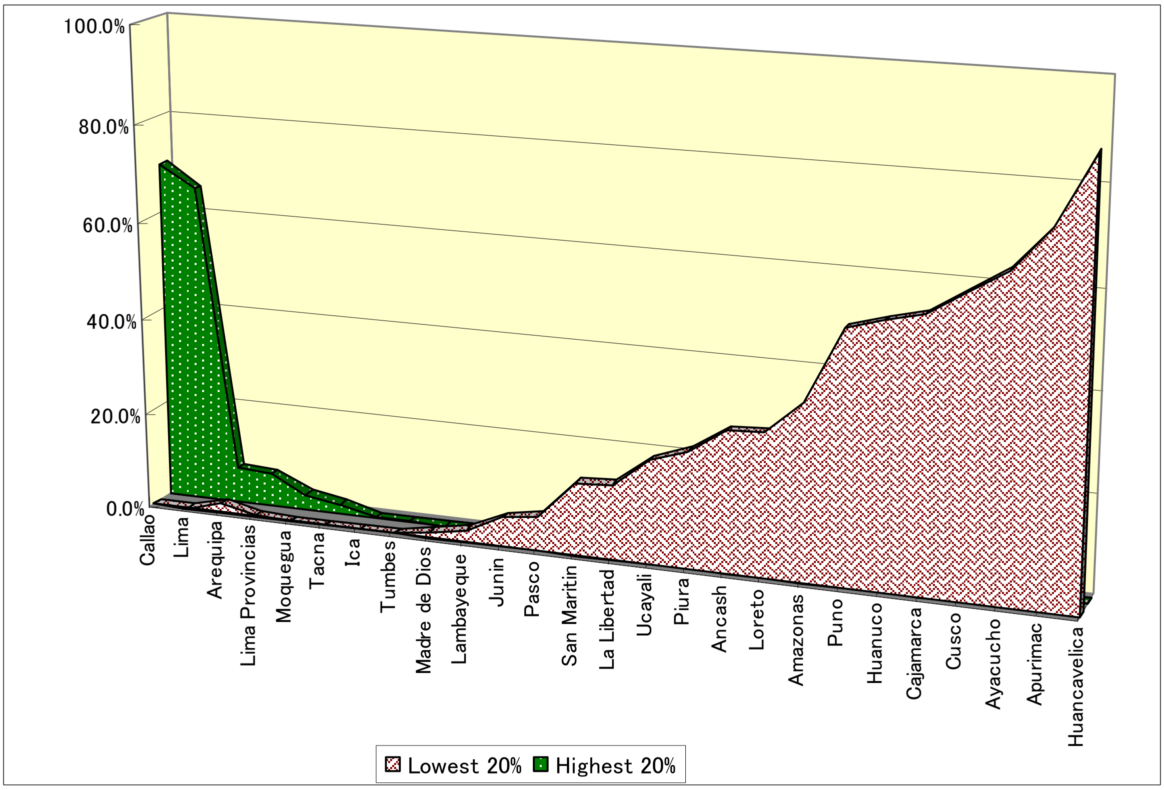
Source: *1 = The first report of the 2007 National Census (INEI)
*2 = The World Factbook (CIA)
*3 = Peru Data Profile (The World Bank)
*4 = Peru at a glance (The World Bank)
*5 = Human Development Report 2007/2008 (UNDP)

Despite the recent strong macroeconomic performance, underemployment and poverty have stayed persistently high. The poverty level measured by the calorie-base criterion and the percent of population below the poverty line shows that there is a remarkable difference between urban and rural zone.

Human development index (HDI) in Peru is 0.773, weaker than 0.803, the average of Latin Americas and Caribbean countries, and Peru ranks as 87th in the world. Table I-2-1 shows the basic social and economic information in Peru.

(2) Human Development and Poverty

The Human Development Report of Peru shows that the HDI is unevenly distributed in the districts within the country.



Source: JICA study team, 2008, based on the UNDP "Human development Report Peru 2005"

Fig. I-2-2 Percentage of Population Ranked Lowest and Highest 20% of HDI by Region

Inhabitants being ranked the highest 20% of HDI in Peru occupy approximately 70% of population of Callao and Lima regions and 7% of population of Arequipa and Lima Provincias, that is, capital city and metropolitan areas, while no inhabitants are ranked that quintile in 20 regions. On the contrary, people being ranked the lowest 20% of HDI in Peru lives in Andean and Selva regions, especially more than 80% of inhabitants of Huancavelica and Apurimac, 70% of population of Ayacucho and Cusco, all of which are regions in the Andean mountains, are included in the lowest 20% of HDI (refer to Fig. I-2-2).

2. Communities with Electrification and without Electrification

Through the field survey in 2007, the JICA study team found that the percentage of electrification is higher than that of MEM (2005). This discrepancy might be because MEM has not completely updated the data of 1993 National Census, the latest released census at moment, which included household electrification. During these years since 1993, many regional and local governments have implemented electrification projects by their own budget without informing to the MEM. The government of Peru executed national census on 21st October 2007 that includes household electrification.

As INEI, the government organization in charge of the national census, was processing and analyzing the data in May 2008, the data of household electrification was not available at the time of preparation of this report.

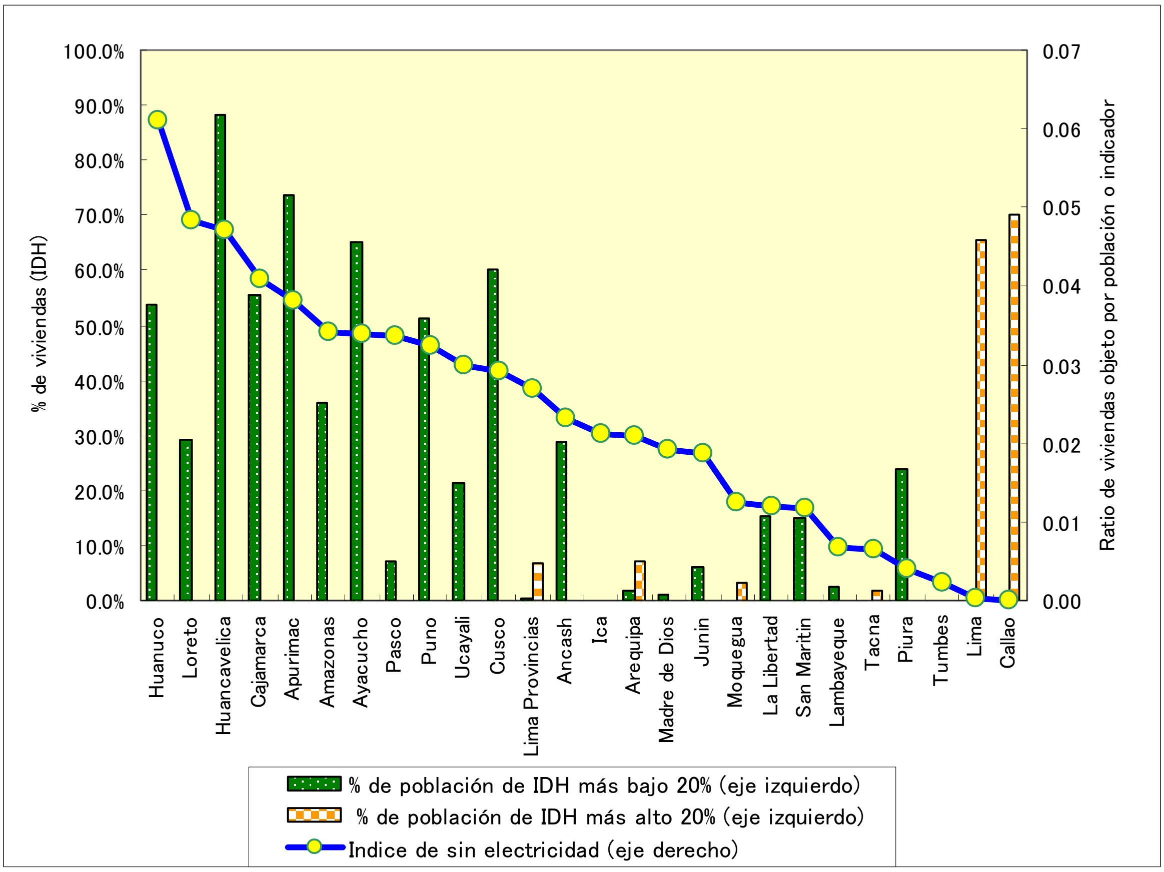
In February 2008, MEM prepared the list 'Pueblos' including 'localidades (communities) without electricity' and 'localidades being object of mini/micro hydropower plan'. The JICA study team formulates the master plan based on this list. The said list shows that 33,701 communities with 361,847 households do not have electricity or plan of electrification. If communities with 10 or more households (appropriate number of households for electrification project) are chosen, 11,348 communities with 280,018 households will be the target of electrification by solar power or mini/micro hydropower.

It needs to be noted that the number of communities who really have neither facility nor plan of electricity might be less than the above mentioned figure, because it may include localidades with facility or plan of electricity that local governments implement by their own budget but do not report it to the central government. As it is the first step of a project to understand the number of non-electrified community, it is recommended to MEM to take initiative and leadership over the regional offices to exchange communication with local governments about the latest information and give appropriate support.

It is not possible to calculate the percentage of the non-electrified households in any administration unit because the National Census does not mention the number of houses or households. The JICA study team tried to estimate a figure indicating the ratio of non-electrified houses/households based on the (inaccurate) supposition that the number of household members is the same in entire Peru; they calculated the ratio of number of the target households to the population as index of electrification need. It does not directly reflect the ratio of electricity need, but might be said as approximation.

Huanuco is estimated at the highest index or regarded to have the highest electricity need (if it is supposed that five persons live in a household, percentage of the target population is 30.5%). The second highest is Loreto and the third is Huancavelica (24.1% and 23.6% respectively with the same supposition). On the other hand, the index is 0 in Callao and almost 0 in Lima City.

When compared with HDI distribution, the need (or demand) of electricity by renewable energy is stronger in lower social development areas. For example, Huancavelica has the highest % of population classified as the lower 20% HDI and, on thither hand, in Callao and Lima, more than 60% of population is classified at the highest 20% of HDI. The index at regional level correlates with the percentage of the lowest 20% population of HDI in Peru (2005) with high coefficient 0.7186 (refer to Fig. I-2-3.)



Note: Indice de sin electricidad is the number of households contained in the lists of MEM "Localidades sin proyecto = communities without project" and "Plan maestro – mini hydrocentral = Master Plan – mini hydropower" divided by population in 2005. It includes the communities where concession has been set.

Source: JICA study team, 2008

Fig. I-2-3 Relation of the Ratio of Target Population to the Regional Population (Index) with HDI

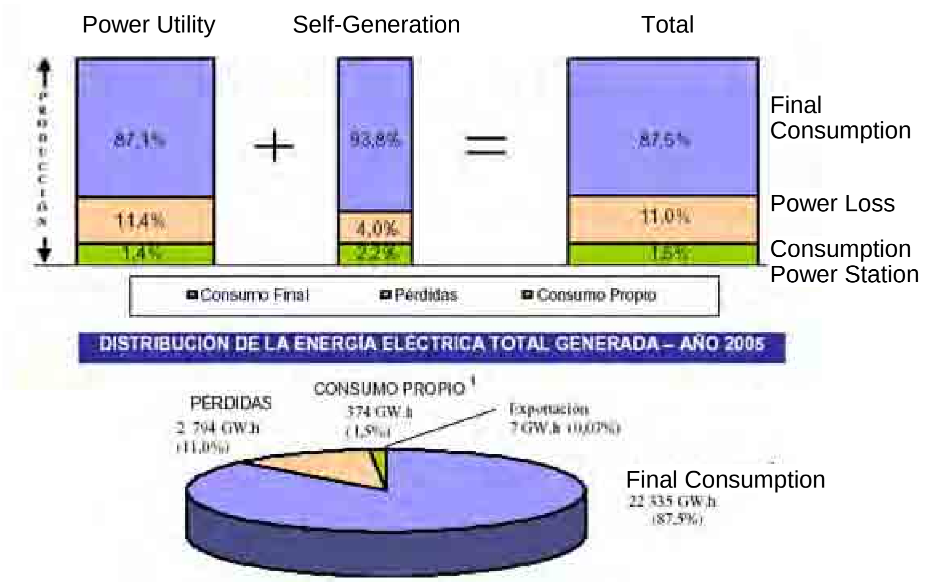
I-3 Situation of Power Sector

1. Power Sector Overview

In 1992, the Peruvian government enacted the “Electric Power Concession Law” that allows for privatization of the electricity sector and promotes competition and efficiency within the industry. Under the new law, Peru privatized the majority of its electricity sector, but there was some protest from organized labor and rural areas, which prevented the government from achieving full privatization.

The largest generating company in Peru is Electroperu, majority-owned by the Peruvian government, which operates the Mantaro (1,008 MW) hydropower complex. According to Peru's Ministry of Energy and Mines, the largest private electricity producers in the country is Edegel, Edelnor and Edelsur (Luz der Sur), which was separated and privatized from Electrolima.

In 2005, total generating power is 25,500 GWh (including self generation 7%), 1.5% of them are consumed in power station and 11% is power loss. For fuel type, 70% is from hydro and 30% is from thermal power generation. The remaining portion is from small wind-powered turbines. Referring to the demand and supply, total power consumption is 22,300 GWh and the consumption per person is 800 kWh/year corresponding to the total generating power of 25,500 GWh. While Peru has maintained GDP growth at the rate of 10% per year from 2001 to 2004, the power consumption has been growing at 15.3% per year as well.

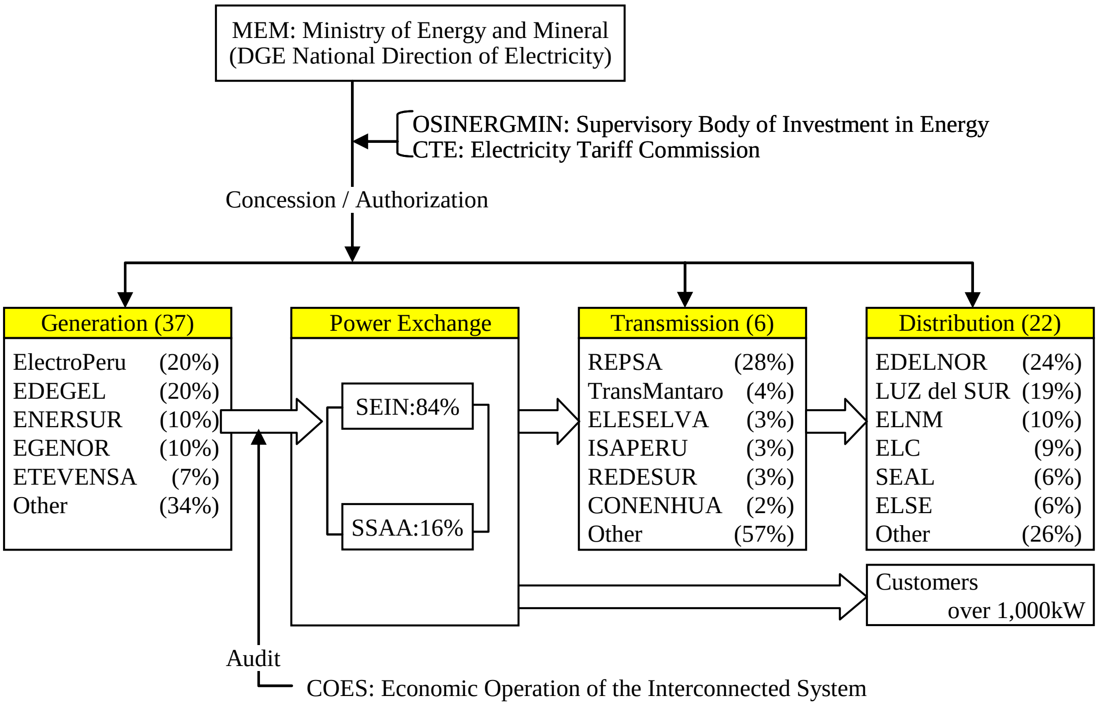


Source: Statistical Yearbook 2005 of Ministry of Energy and Mines

Fig. I-3-1 Power Balance in 2005

The structure of power supply is shown in Fig. I-3-2, generating companies supply power to 22 distribution companies or customers that demand more than 1,000 kW through two different power systems SEIN and SSAA. Generating companies have the right to access transmission lines and pay transmission service prices that are regulated by the government.

The companies operating electric power supply business should have concession and authorization from Ministry of Energy and Mines. The organization CTE of OSINERGMIN regulates the power tariff and transmission service tariff. COES is a neutral organization that regulates fair power trading, the security of energy and proper dispatching.



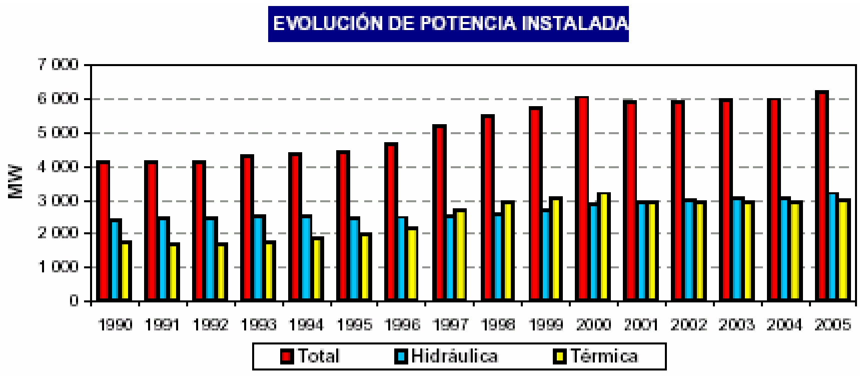
Source: JICA Study Team

Fig. I-3-2 Organization of Electric Power Industry in Peru

2. Generation Business and Wholesale Market

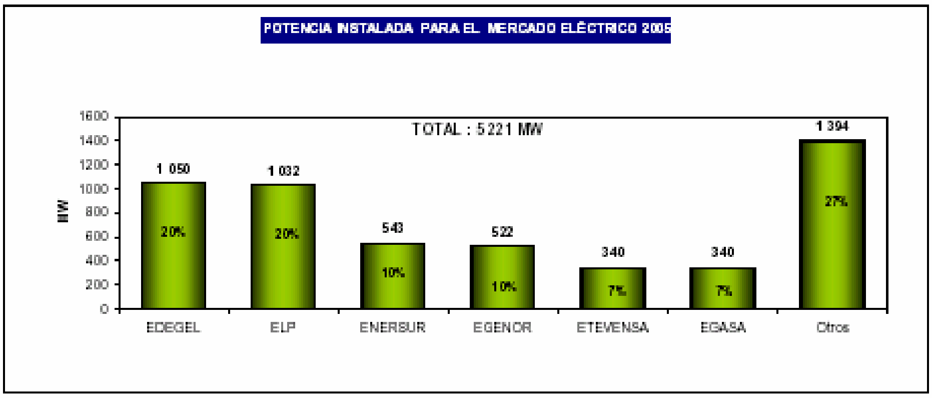
In 2005, Peru had 6.2 GW of installed generating capacity, which is approximately 40% greater than 10 years ago.

It generated 25.5 billion kWh of electric power while consuming 20.7 billion kWh. Even though installed capacity is evenly divided between hydro and thermal power, 70% of Peru's total electricity supply is generated by hydro facilities. Thermal plants supply the rest of the power and there are small wind turbines that generate a minimal amount of power.



Source: Statistical Yearbook 2005 of Ministry of Energy and Mines

Fig. I-3-3 Evolution of Installed Capacity



Source: Statistical Yearbook 2005 of Ministry of Energy and Mines

Fig. I-3-4 Installed Capacity by Company

After restructuring and privatization of the electric power industry, a large portion of Peru's power sector remains in the hand of government. The largest hydroelectric facility in the country is the Mantaro Complex in southern Peru, operated by the state-owned company Electroperu. It and EDEGEL, the second largest power company dominates 40% of the power production in Peru.

Competition was introduced in the wholesale power market, and 37 generators joined the market to exchange its power. The wholesale market operator decides the least cost generating unit price and dispatch the most economic power. They can supply power to distribution companies or large customers with capacity more than 1,000 kW. COES or Economic Operation of the Interconnected System operate and control the economic and fair power trading in wholesale market.

3. Transmissions and Distribution

There are two transmission systems named SEIN and SSAA. 97% of power is exchanged through SEIN. Six transmission companies and 22 distribution companies own power lines throughout Peru with voltages from 220-33 kV for transmission and generally under 30 kV for distribution.

Peru has two main power transmission grids, one covering the north and center parts of the country and the other in the south. An interconnector, owned and operated by Hydro-Quebec International, runs between the two along the Pacific coast. The largest transmission company in Peru is the Colombia-based ISA Group, which controls over half of the transmission grid in the country through its subsidiaries Red de Energia del Peru and Interconexion Electrica ISA Peru. Smaller companies, many of which are state-owned, control the remainder of the grid. Investment in Peru's transmission grid has been greater than the actual demand; therefore there is an excess of spare capacity.

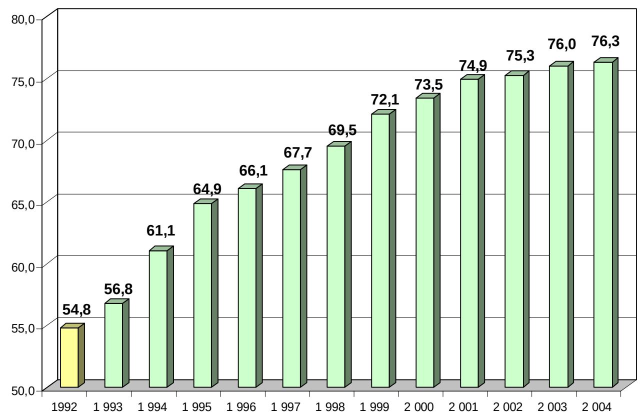
Electrolima, the largest electricity distributor in Peru was separated into 2 private distributors. One is Edelnor, a subsidiary of Endesa, it supplies power to northern areas of Lima. The other is Edelsur (Luz del Sur), the PSEG Global/Sempra owns a majority share of this company. Luz del Sur operates in southern Lima. Smaller state owned distribution companies supply power in the rural areas.

Source: Statistical Yearbook 2005 of Ministry of Energy and Mines

Fig. I-3-5 Main Transmission and Distribution Companies

4. Rural Electrification

The disparity in electrification rates between the urban and rural areas is extreme; electrification in Lima and other large cities is over 90%, while in the Andes and Amazon basin regions, it remains only 30-40%. The government has begun to offer financial incentives to spread electricity service to rural areas. In 1993, the Peruvian government proposed the "National Electrification Plan" to improve the low rates of electrification in the regions.



Source: Statistical Yearbook 2005 of Ministry of Energy and Mines

Fig. I-3-6 Rural Electrification Rate

In addition, transmission and distribution line extensions for rural areas has been funded by JBIC (Electric Frontier Expansion Project) This plan is to expand the 60 kV local transmission lines and 23 kV distribution lines.

The electrification rate in 2005 is 78.8%. However, Peru remains ambitious and has set a target goal of 91% by 2014 according to the National Project for Rural Electrification 2005–2014, MEM/DPR(DEP).

To achieve this goal, the government is considering implementation methods not only related to grid expansion but also mini/micro hydro and PV system renewable energy development in remote areas.

5. Tariff System

Consumers in Peru is classified generally into the large users over 1,000 kW and those under 1,000 kW. While the contract prices for the large users are deregulated, the tariff is regulated for the latter users. In this paragraph, the latter is referred. OSINERGMIN is in charge of tariff setting, and supervises the generation, transmission and distribution. The tariff for the retail consists of the busbar price (generation tariff + transmission tariff) and distribution tariff called "VAD (Value Added for Distribution)".

The tariff level in Peru of 10.34 ¢/kWh is considered high compared to those of neighbor countries: the lowest 4.14c/kWh in Argentine and the highest 13.03 ¢/kWh in Ecuador.

For the residential consumers, the subsidy called "FOSE (Fondo de Conpensacion Social Electrica)" is applied under the certain condition. By this system, for the consumption under 100 kW per month, the tariff is reduced. And conversely, consumption above 100 kW per month pays a surcharge in proportion to energy consumption above 100 kWh/month to finance the subsidy. As above, FOSE is one of the cross-subsidy mechanism among different consumers. 62% of all residential clients at national level benefit from FOSE. Lima consumers are the major contributors to this subsidy. The condition and the level is shown in the following table.

Table I-3-1 Conditions for FOSE Applications

Users	Sector	Tariff reduction for consumers ≤ 30 kWh/m (% of energy charge)	Tariff reduction for consumers > 30 kWh/m up to 100 kWh/m (kWh/m)
Interconnected System	Urban	25	7.5
	Urban-rural&Rural	50	15
Isolated Systems	Urban	50	15
	Urban-rural&Rural	62.5	18.75

I-4 Situation of Rural Electrification

I-4.1 Law and Institution[2]

The 10-year national plan for rural electrification (PNER) for 2006-2015 aims at 93.1% of national electrification rate as of 2015 as political goal, whereby poverty reduction and betterment of life in rural areas is intended. As a measure for that policy, legal and institutional preparations are being made.

The most important laws directly related to rural electrification by renewable energy are the following two laws:

- Ley General de Electrificación Rural (General Law on Rural Electrification) (Ley No. 28749 published on 30 May 2006) (hereinafter called “General Law”): Its regulation (hereinafter called “General Regulation”) was published on 2 May 2007.
- Ley de Promoción y Utilización de Recursos Energéticos Renovables No Convencionales en Zonas Rurales, Aisladas y de Frontera del País (Law on Promotion and Utilization of Non-conventional Renewable Energy Resources in Rural, Isolated and Frontier Zones of the Country) (Ley No. 28546 published on 16 June 2005) (hereinafter called “Promotion Law”): A working document for its regulation (hereinafter called “Promotion Regulation”) was available at the time of the survey of February 2007 and the regulation was slated for publication at an early date and has not yet been published upto the present.

Besides the above laws, the following laws related with power industry have to be considered in relation to the promotion of rural electrification.

- Ley de Concesiones Eléctricas (Law on Power Utility Concession) (Decreto Ley No. 25844 published on 19 November 1992): Law regulating power industry.
- Ley Marco de los Organismos Reguladores de la Inversión Privada (Law of Framework on Regulatory Organizations for Private Investment) (Ley No. 27332 published on 29 July 2000): Law creating OSINERG (now reorganized as OSINERGMIN) as regulatory body for investment on energy sector. It has such functions as supervision for fulfillment of legal, contractual and technical obligations, regulation for tariff and dispute settlement between companies and consumers.
- Ley que crea Fondo de Compensación Social Eléctrica (Law creating Electrical Social Compensation Fund (FOSE)) (Ley No. 27510 published on 28 August 2001): This law creates cross subsidization for poverty group with small amounts of power consumption.

---

[2] Based on the information obtained during the first investigation on February 2007.

Furthermore, the following laws should be considered in that the above-mentioned laws refer to them as laws to be observed.

- Ley que crea el Sistema Nacional de Inversión Pública (Law creating the public investment system (SNIP)) (Ley No. 27293 published on 28 June 2000): This law regulates public funds for efficient investment.
- Promoción de las Inversiones Privadas en la Infraestructura de Servicios Públicos (Decree to promote private investments in infrastructure of public services) (Decreto Ley No. 758 published on 13 November 1991)
- Reglamento de Protección Ambiental en las Actividades Eléctricas (Regulation for environment protection in power business activities) (Decree No. 29-94-EM published on 8 June 1994)

Besides the above-mentioned laws, there are laws relating to decentralization toward region and local governments, which should be considered in allocation of functions in rural electrification promotion. There are also technical regulations related to electric power facilities, which should be considered in that it is necessary to see how those regulations will be applied to electrical system by renewable energy.

The schematic diagram below shows the perspective of the policy and relevant laws and the relevant government organizations.

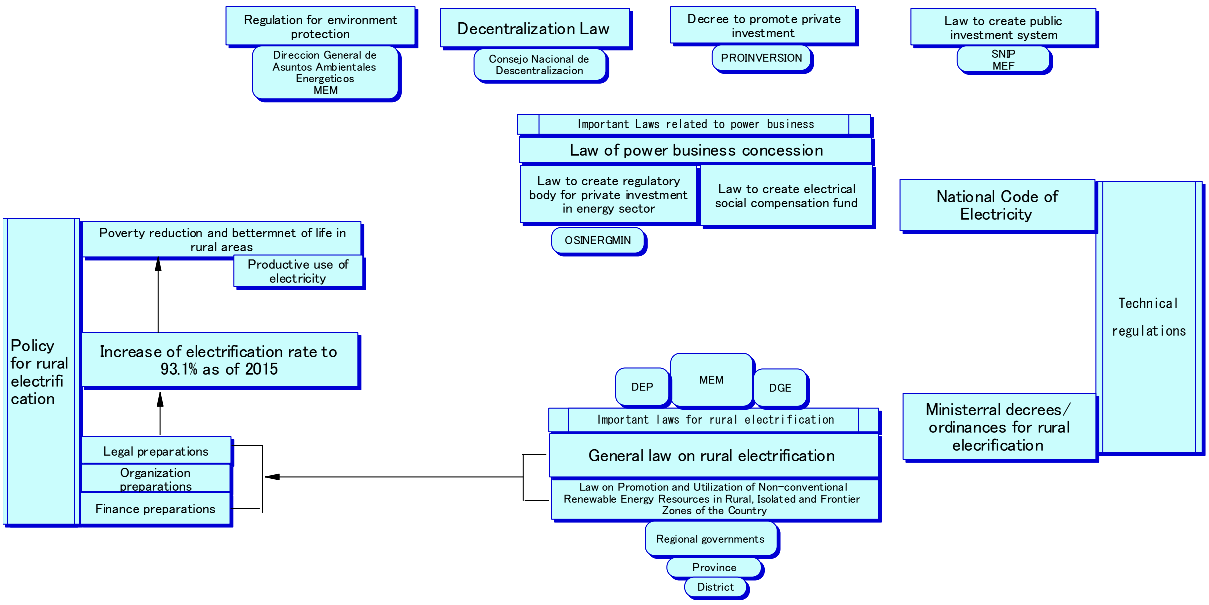


Fig. I-4.1-1 Diagram of Relevant Legal System and Organizations for Rural Electrification

This report will mainly discuss the two laws directly related to rural electrification and their regulations with respect to purposes, institutions, functions of the relevant organizations and financing sources.

1. Purposes

"General Law" considers rural electrification to be nationally necessary public services and aims for: (1) sustainable socio-economic development, (2) improvement of quality of life of inhabitants, (3) fight against poverty and (4) prevention of migration into metropolitan areas.

On the other hand, "Promotion Law" aims for promotion of rural electrification by non-conventional renewable energy (solar, wind, biomass, geothermal, peaking hydraulic, tidal and small-scale hydraulic) and improvement of quality of life of rural inhabitants. "Promotion Regulation" enumerates the following purposes:

1) Increase of electrification rate;
2) Promotion of sustainable management of rural electrification projects by renewable energy;
3) Improvement of quality of life of rural inhabitants through sustainable socio-economic development by means of rural electrification;
4) Promotion of sustainable use of renewable energy;
5) Promotion of investigation of the most appropriate technology according to realities of the areas;
6) Identification of non-conventional renewable energy and prioritization; and,
7) Up-date of record of potential sites for electrification.

The said two laws have the common purposes: poverty reduction and improvement of quality of life by increase of electrification rate. By those laws, "General Law" sets a legal framework for rural electrification and its regulation sets norms related to planning, investigation, evaluation, construction, transfer and operation and maintenance for rural electrification. Meanwhile, "Promotion Regulation" sets criteria and norms to be applied to planning, design, construction, tariff, grant of rural electrical concession and operation and maintenance for electrification projects with renewable energy in rural, isolated and frontier areas included in "Plan of Non-conventional Renewable Energy (PERNC)".

2. Scope of Application

"General Law" defines rural electrical systems as those qualified by MEM as electrical distribution system of preferential social interest, while "General Regulation" defines them as all electrical facilities for power supply to rural, isolated and frontier areas including domestic connections with any type of measuring apparatus as well as distribution and transmission network and generation facilities. OSINERGMIN shall classify each rural electrical system according to "Typical Distribution Sectors" established by DGE.

Moreover, rural electrical systems shall satisfy the following criteria in 10-year national rural electrification plan (PNER).

- Technical criteria: Comply with technical norms and quality in such a form as to satisfy 20-year forecast demand.

- Social criteria: Benefit/cost ratio more than 1 in social evaluation for 20 years considering shadow prices.
- Economic criteria: Economic evaluation shall be made considering market prices of all cost components and income resulting from tariff collection from users and contribution from FOSE.

It is stipulated that for each project of rural electrical system located in those zones where it is not technically and economically feasible to supply electricity from existing power grids, preferential evaluation shall be made on use of renewable energy such as mini-hydroelectric, biomass, wind, solar and geothermal energies.

On the other hand, "Promotion Law" shall apply to non-conventional renewable energy to be developed in rural, isolated and frontier areas and defines non-conventional renewable energy as permanent energy sources and renewable natural resources comprising the following:

- Solar, wind, biomass, geothermal, peaking hydroelectric, tidal and mini-hydroelectric energies

"Promotion Regulation" shall apply to electrification projects with renewable energy in rural, isolated and frontier areas included in "Plan of Non-conventional Renewable Energy (PERNC), which shall be governed by the following principles:

- Technical appropriateness and diversity: Rural electrification projects by renewable energy shall be oriented toward efficient use of the most appropriate resources, considering characteristics of supply and consumption of each rural, isolated and frontier zones, facilitating use of economically viable alternatives and assuring reliable power supply at least cost.
- Access: Facilitate the inhabitants in rural, isolated and frontier areas enjoying access to electricity services through "Plan of non-conventional renewable energy (PERNC).
- Sustainable development: Rural electrification projects by renewable energy shall be inclined to economic and social well-being of rural inhabitants without depleting natural resources nor deteriorating the environment and the right of future generations to utilize for their proper needs.
- Complementarity: Development of rural electrification projects is positioned as coordinated action with regional and local governments and aimed to common purposes of improvement of quality of life of rural inhabitants through efficient provision of public services.

Rural, isolated and frontier zones are defined as follows:

- Rural zones: Area inhabited by people with low purchasing power, of which the economic activities are of a small scale basically destined to self-consumption and where electrification is not financially attractive to private sector but brings large socio-economic impacts. This area includes inhabitants in isolated and frontier zones.
- Isolated localities: Inhabited centers in unfavorable locations in terms of access and distant from conventional electrical system where electrification is not financially attractive to private sector but brings large socio-economic impacts.

- Frontier zones: Inhabited centers geographically located in the limit of Peruvian territory, where electrification is not financially attractive to private sector but brings large, socio-economic and strategic impacts.

3. Institution/Regime

(1) Rural Electrical Concession

"General Law" creates special regime of rural electrical concession to incorporate incentives for private investment in rural electrification, which shall be granted by DGE. "General Regulation" requires rural electrical concession for one or more of the following activities:

- Power generation embedded in distribution network with renewable energy and non-renewable energy;
- Power transmission affecting national property and/or requiring usufructuary right; and,
- Power distribution with characteristics of public service of electricity.

"General Law" provides that right holders of rural electrical concession are benefited with the regime provided for by Decretos Supremos No. 662 & 757, Estabilidad Jurídica a las Inversiones Extranjeras mediante el reconocimiento de ciertas garantías (Juridical stability for foreign investment through acknowledgement of certain guarantees) and Ley marco para el crecimiento de la inversión privada (Law of framework for increase of private investment), respectively, whereby any investment, whether private or foreign, shall be treated equally in free market.

"General Regulation" provides that rural electrical concessionaire shall have the rights to execute rural electrical systems, to obtain necessary usufructuary right and to obtain subsidy and the obligation of developing electrical business. Acquisition of rural electrical concession requires presentation to DGE of the following data and requisites:

- Identity and domicile of applicant;
- Descriptive texts and drawings of the Project;
- Construction schedule;
- Project budget;
- Specification of required usufructuary rights;
- Delimitation of concession zone; and,
- Sworn declaration of environment impact

"Promotion Law" also provides that the special regime of rural electrical concession to be granted by DGE shall be applied to rural electrical projects, while "Promotion Regulation" provides for rural electrical concession entitling the right holder to develop electrical activities included in the Plan of Non-conventional Renewable Energy (PERNC), applying to rural electrification the norms and procedures for usufructuary right included in "Electrical Concession Law" and its regulation as well as other legal and technical norms.

Application for rural electrical concession requires the following data and requisites:

- Authorization of use of natural resources for construction if applicable;
- Technical sheet which includes single-line diagram, geographical diagram of load and project cost estimate;
- Preliminary construction schedule;
- Sworn declaration of conservation of environment and cultural heritage of the nation;
- Plan of Abandon and Elimination of Environment Liabilities
- Specification of the required usufructuary rights;
- Delimitation of the concession zone with coordinates UTM (PSAD56) and model form of power supply contract if the project includes distribution activities;
- Drawings at a scale of 1:100,000

(2) Usufructuary Rights

"General Law" provides that its regulation shall provide for usufructuary rights and that MEM shall compensate damages arising from the imposition of usufructuary rights. "General Regulation" provides that usufructuary rights are for public utility and preferential public interest and shall be imposed by DGE. Use of public property shall not cause payment of compensation but damage to them shall be compensated. The usufructuary rights include the following:

- Water channel, reservoir, and hydroelectric facilities;
- Electrical duct for transformation substations, transmission lines and distribution network;
- Possession of indispensable private property for installation of distribution substations for public service of electricity;
- Telecommunications system;
- Right-of-way to construct access road; and,
- Transit for custody, conservation and repair of the works and installations.

(3) Transfer

"General Law" provides that MEM shall donate rural electrical systems which have been or are executed by them to preferably state-owned concessionary companies of power distribution or to ADINELSA as the case may be. Also included are those companies which are in the process of private investment promotion for purposes of administration, operation and maintenance of rural electrical systems. It is also provided that MEM may donate electromechanical materials and equipment to regional and local governments.

"General Regulation" provides for transfer which comprises rural electrical systems as a whole or their composing assets including installations, works, usufructuary rights, equipment, materials, studies and others included in rural electrical systems, in the following manner:

- Rural electrical systems executed by DEP shall be transferred free-of-charge to state-owned concessionaire companies of power distribution or ADINELSA;
- Donation of electro-mechanical materials and equipment requires MEM through DEP to conclude an agreement with regional and local governments and to have the state-owned concessionaire companies in charge of administration, operation and maintenance verify the correct execution of the works at the expense of the regional and local governments according to the technical norms of rural electrification; and,
- With respect to rural electrification systems financed and executed by regional and local governments, a contract of free-of-charge operation and maintenance for 30 years at the minimum with state-owned concessionaire companies of power distribution or ADINELSA.

"Promotion Regulation" provides that the works resulting from the execution of the Plan of Non-conventional Renewable Energy (PERNC) shall be transferred by MEM free-of-charge to distribution concessionaire or ADINELSA, enabling the latter to conclude a contract of operation and maintenance with distribution concessionaire or other companies considering the most convenient administration model. MEM may donate its-owned equipment and materials for the execution of rural electrification projects with renewable energy to distribution concessionaire, ADINELSA or regional/local governments.

(4) National Plan of Rural Electrification (PNER)

"General Law" requires MEM to prepare a 10-year long plan consolidating regional/local development plans, expansion programs of concessionaire companies of power distribution, private initiatives and programs or projects of the national government. The projects composing PNER shall be subject to technical and economical evaluation to guarantee social profitability and administrative, operational and financial sustainability in the long term. To that effect, MEM shall coordinate with regional/local governments and other entities, providing technical capacity building according to legislation for decentralization.

"General Regulation" provides that PNER shall be 10-year long planning comprising politics, objectives, strategies, methodologies, and list of projects and financing sources for purposes of consistent and prioritized development of rural electrification. It also defines PNER as instrument of linkage for the action by the state and for the private investors who require subsidy to execute rural electrical systems. The purposes of PNER are specified as follows:

- Expand power supply frontier through the execution of rural electrical systems using appropriate technologies to optimize the cost in order to maximize the access to power supply service of the inhabitants of rural, isolated and frontier areas;
- Propose the execution of rural electrical systems of sustainable operation;

- Promote sustainable socio-economic development in rural, isolated and frontier areas through rural electrification in order to improve the quality of life of the inhabitants, fomenting the promotion of use of productive use of energy; and,
- Foment the utilization of renewable energy in distributed generating systems embedded in distribution network.

MEM, through DEP, shall be in charge of formulation of PNER, which shall be updated annually in accordance with the sector policy of the Energy and Mines sector, taking into account regional/local development plans as well as the initiatives of entities, programs, projects, institutions and private investors.

The criteria for priority to be qualified in PNER shall be based on the policy of rural electrification and shall be as follows:

- The lower electrification rate of the province;
- The higher index of poverty in the area where the project is located;
- The smaller proportion of subsidy required for domestic connection of the project;
- The larger number of new domestic connections per unit of investment amount; and,
- Utilization of such renewable energy as mini-hydraulic, biomass, wind, solar and geothermal complying with evaluation for priority in those rural electrical systems that are located in areas where power supply from existing power grid is not technically and economically feasible.

The short-term plan shall be prepared beside the long-term plan. "General Law" provides for a short-term plan including the projects to be developed in the corresponding fiscal year by the central government, regional/local governments and private initiatives as well as programs or projects resulting from agreements of foreign donation or finance for rural electrification in rural, isolated and frontier zones of the country.

"General Regulation" provides for the short-term plan as resulting from the long-term plan and requires the short-term plan to be approved annually and to include the list of projects declared viable by the Public Investment National System (SNIP) and the geographical location, investment amount, budget, goals and identity of the developer of the projects to be developed in the corresponding fiscal year in rural, isolated and frontier zones.

The short-term plan shall contain the following at the minimum:

- List of the rural electrical systems to be executed in the fiscal year (distribution generation embedded in distribution network, transmission and distribution);
- Project location and number of the beneficiaries;
- Investment amount and financing sources;
- Estimated date of commencement and completion of the works; and,
- Identity of the executing entity of rural electrical systems.

"Promotion Law" requires the preparation of Plan of Non-conventional Renewable Energy (PERNC) consistent with regional plans of non-conventional renewable energy. That plan shall include such projects as to improve the quality of life of the inhabitants in rural, isolated and frontier zones and DEP shall establish the criteria for priority.

"Promotion Regulation" provides that regional/local governments shall submit proposals through Regional Direction of Energy and Mines (Dirección Regional de Energía y Minas: DREM), who shall send them to DREM within 10 days. The proposals may be submitted through the year and shall be prioritized by technical, economical and social evaluation by DEP to be incorporated into PERNC of the succeeding year.

In order to be incorporated into PERNC, rural electrification projects shall be subject to evaluation to determine priority and social profitability. DEP shall apply priority factors in function of technical, economical and socio-economic criteria, taking into account the intervention of beneficiary social actors, the interaction level of the inhabitants with the projects, the future development plans and the use of electricity in productive activities.

PERNC shall include the following at the minimum:

- List of rural electrification projects with renewable energy which will be executed in the respective fiscal period;
- Estimated date of commencement and completion of the works;
- Location of the projects and number of the beneficiaries; and,
- Investment amount and financing sources.

The rural electrification projects included in PERNC which have been submitted by regional/local governments may be executed by DEP.

(5) Coordination with Relevant Entities

"General Law" provides that DEP shall coordinate with regional/local governments, concessionaire companies of power distribution, rural electrification companies and other entities and programs of the national government related to the execution of works of rural electrification and their administration, operation and maintenance. "General Regulation" provides for Coordination Committee of Rural Electrification composed of the following 8 members:

1) Vice-minister of Energy of MEM, who shall chair the Committee;
2) Director of DEP, who shall act as technical secretary;
3) Director General of DGE
4) A representative from OSINERGMIN
5) A representative from concessionaire companies of power distribution designated by FONAFE (Fondo Nacional de Financiamiento de la Actividad Empresarial del Estado)

6) A representative designated by the Presidency of the Council of Ministers (Presidencia del Consejo de Ministros)
7) President of the management board of ADINELSA
8) A representative from the executing unit No. 003 (Unidad Ejecutora No. 003) FONER

The functions of the Committee are as follows:

- Coordinate opportunely with other sectors of the state in charge of the promotion of rural sector, regional/local governments and national and foreign private companies to complement the implementation of projects of common interest; and,
- Serve to assist DEP in the development of the functions assigned by “General Law” and “General Regulation”, channeling the information of other sectors which promote socio-economic development of the rural sector.

“Promotion Law” provides that MEM shall, in coordination with regional/local governments, implement mechanisms and actions for development of projects of investigation of non-conventional renewable energy.

(6) Decentralization

“General Law” provides that the national government, regional/local governments, concessionaire companies of power distribution, rural electrification companies, public or private, and other private investors (with the smaller percentage of subsidy) may participate in the execution of works of rural electrical systems. The regional/local governments may take part directly or in coordination with DEP.

“General Regulation” provides that in order to attain effective decentralization in the preparation of plans and projects and the execution of works for rural electrification, MEM through its executing units shall develop, in coordination with the presidency of the council of ministers, capacity building and technical assistance to strengthen the management capacity of regional and local governments. The relevant budget may be financed by DEP and/or regional/local governments. That capacity building shall conform to the annual programs of integrated capacity building.

(7) Promotion of Private Investment in Rural Electrification

“General Law” provides that PROINVERSION shall administer the processes of promotion of private investment and shall coordinate with MEM and regional/local governments with regard to procedures, manners, criteria of eligibility and other characteristics.

“General Regulation” provides that DGE shall prepare the budget for promotion of private investment. The objectives of promotion of private investment are the following activities related to rural electrification:

- Elaboration of studies for development of rural electrical systems;
- Integrated development of rural electrical systems, which include study, execution of works and operation and maintenance; and,

- Operation and maintenance of the rural electrical systems of ADINELSA or transfer thereof.

The promotion of private investment takes the following manners:

- Tender;
- Private initiative; and,
- Other manners included in the norms in effect.

PROINVERSION shall coordinate tenders with MEM and regional/local governments to follow the priority list established in PNER except for private initiatives with priority. Regional/local governments may be in charge of tenders of studies for development of rural electrical systems.

The subsidy for promotion of private investment shall be destined to the following finances:

- Preparation of project studies (Those who take the initiative of the project shall bear at least 70% of the study cost);
- Acquisition of equipment and materials required for rural electrical systems; and,
- Construction of rural electrical systems.

"Promotion Regulation" provides that PROINVERSION shall be in charge of the administration of the process of promotion of private investment in rural electrical concessions and shall coordinate with the following entities:

- DEP (to provide the project portfolio to be included in the promotion of private investment and to extend technical assistance)
- Regional and local governments; and,
- ADINELSA (in the case that the process of promotion of private investment includes rural electrical concessions of ADINELSA)

PROINVERSION shall, in coordination with DEP and regional/local governments, establish mechanisms for promotion and offer of the projects included in PERNC.

Award of the tender shall be given to the tenderer with the most viable proposal in technical and economical terms. The determination of the award shall be made according to the evaluation system set forth in the tender documents, taking into account the smaller percentage of subsidies from the state, the larger commitment of investment and the lower power tariff.

(8) Power Tariff

"General Regulation" provides for the maximum power tariff to be determined by OSINERGMIN, stipulating that the tariff for rural electrical service shall allow the economical sustainability of rural electrification and the continuance of the service to the users. The prices at the level of generation, at the bus bar of isolated systems and VAD (Value Added of Distribution) for rural electrification shall be determined in accordance with the Law of Electrical Concession and its related regulations and considering the special norms set forth in the “General Regulation” within the framework of “General Law”.

“Promotion Law” provides that electrical systems with non-conventional renewable energy shall have special tariff regime appropriate to the rural, isolated and frontier zones of the country.

“Promotion Regulation” provides that OSINERGMIN shall determine the special tariff for rural electrical systems with renewable energy, taking the following into account.

- Corresponding Typical Sector of Distribution;
- Application of the benefits included in the law creating FOSE (No. 27510);
- Socio-economic study of the inhabitants;
- Type of technology;
- Capacity and hours of supplied energy; and,
- Seasonal variation in economy of the inhabitants.

(9) Technical Norms

“General Law” provides that rural electrical systems shall have specific norms of design and construction appropriate to rural, isolated and frontier zones of the country and that DGE shall adapt the National Code of Electricity and emit the corresponding norms of design and construction at the proposal of DEP, regional/local governments, entities of the national government in charge of the execution of works, concessionaire companies of distribution and specialists in that respect. With regard to the projects by renewable energy, they shall be governed by their proper norms.

“General Regulation” provides that the development of projects and the execution of works for rural electrical systems as well as their operation and maintenance shall comply with the specific norms of design and construction, the National Code of Electricity, the standards for quality of rural electrical service and other norms applicable to rural electrification.

As for the quality of power supply, “General Law” provides that rural electrical systems shall have technical norms for quality emitted by DGE, while “General Regulation” provides that application of the norms for quality shall consider different rural realities without increasing investment and operation cost and with standards for quality consistent with rural tariff.

“Promotion Law” provides that electrical systems by non-conventional renewable energy shall have such norms of design and construction as are appropriate to the rural, isolated and frontier zones of the country, while “Promotion Regulation” provides that they shall have such special norms for design, construction, operation and maintenance and installation as are approved by DGE.

DEP shall determine the most convenient administration model for renewable energy projects taking the following into account:

- Guarantee for sustainability of the systems for the period;
- Use of the most appropriate technology for the zone of project implementation;

- Tariff system conforming to the socio-economic reality of the inhabitants; and,
- Fulfillment of the procedures of technical, economic and administrative supervision of the installations.

The second complementary disposition of "Promotion Regulation" provides that the administration of the projects executed by use of solar energy shall be governed by the contracts between DEP and the administrators of the installations.

(10) Environmental Protection

"General Law" provides that in order to execute any works, a sworn declaration of environmental impact shall be submitted to the competent authority of MEM in accordance with the norms for environment in effect. "General Regulation" provides that only the transmission facilities composing rural electrical systems shall have environmental impact study, which shall be submitted only to General Direction of Energy Environmental Affairs (DGAAE).

"Promotion Regulation" provides that, in order to commence their activities, the holders of rural electrical concession shall submit a sworn declaration of conservation of environment and cultural heritage of the nation and a plan of abandon and elimination of environment liabilities.

4. Financial Source

"General Law" provides for financial sources for rural electrification as follows, which shall be used for the execution of projects, works and subsidy to local tariff as well as promotion of private investment and may not be used to cover the cost of operation and maintenance:

1) Transfer from Public Treasure;
2) External finance;
3) Sanctions imposed by OSINERGMIN;
4) Up to 25% of financial resources resulting from privatization of power companies;
5) 4% of the profit of the companies of generation, transmission and distribution;
6) Contributions or donations from natural or juridical persons, national or foreign;
7) Financial resources from agreements with regional/local governments for execution of works of rural electrification;
8) Contribution from the users through bill collection;
9) Outstanding amount of contributions for legal functions of DGE; and,
10) Other sources.

1% of the above financial resources shall be used for education and capacity building of consumers in rural zones including programs of development of productive use of electrification and renewable energy. In the meantime, "General Regulation" provides that the funds required for education and capacity building of rural users shall be budgeted by MEM and those funds shall be used directly by its executing units or through specialized consultants selected by them.

The table below shows the functions of relevant organizations of the central government.

Table I-4.1-1 Roles of Governmental Organizations for Rural Electrification

(LG: General Law, RG: General Regulation, LP: Promotion Law, RP: Promotion Regulation)

Regime \ Org.	MEM	DEP	DGE	DGAAE	OSINERGMIN	SNIP	PRO INVERSION
General	(LG) Qualification of rural electrical system (RP) Promotion, guidance and execution of renewable energy (RG) Promotion of use of renewable energy with participation of universities, companies and specialized entities	(LG) in charge of rural electrification (LP) Participation in investigation project for renewable energy together with regional/local governments	(RG) Establishment of typical sector of distribution (LG) Establishment of norms for commercial operation of rural electrical systems		(RG) Categorization of typical sector of distribution for rural electrical systems		
Rural Electrical Concession			(L/RG&L/RP) Grant of rural electrical concession				
Usufructuary rights	(LG) Compensation of imposition of Usufructuary rights		(RG) Imposition of Usufructuary rights				
Transfer	(L/RG&RP) Transfer of rural electrical systems executed by DEP to state-owned distribution companies or ADINELSA (LG/) Able to transfer the electromechanical equipment and materials to regional governments	(RG) Conclusion of agreement for transfer of donated equipment and materials with regional/local governments (RP) Donation of the equipment and materials to concessionaire companies of distribution or ADINELSA or regional/local governments					
National Rural Electrification Plan (PNER)	(L/RG) Preparation of PNER	(RG) Preparation of PNER				(RG) Approval of projects listed in Short-term Plan	
Plan of Non-conventional Renewable Energy (PERNC)	(LG) Preparation of Short-term Plan	(LG) Capacity building according to norms for decentralization (L/RG) Preparation of Short-term Plan (RP) Establishment of priority criteria for PERNC (RP) Project evaluation for preparation of PERNC (RP) Able to execute projects of PERNC proposed by regional/local governments					

Org. / Regime	MEM	DEP	DGE	DGAAE	OSINERGMIN	SNIP	PRO INVERSION
		(RG) Administration of Information System of Rural Electrification					
Decentralization		(L/RG) Able to participate in coordination with regional/local governments (RG) Strengthen administrative capacity of regional/local governments					
Promotion of private investment	(LG) Coordination with regional/local governments		(RG) Budgeting (RG) Decision of tendering by PROINVERSION				(LG) Administration of process of promotion of private investment
Power tariff					(RG) Fix the maximum of rural tariff (RP) Fix the power tariff for renewable energy		
Technical norms			(LG) Establishment of special norms (RP) Approval of special norms for electrical systems with renewable energy				
Environmental protection			(RP) Sworn declaration of conservation of environment and cultural heritage and plan of abandon and elimination of environment obligations	(L/RG) Acceptance of environmental impact study and sworn declaration of environmental impact			
Finance		(RG) Administration of financial resources for rural electrification	(RG) Budgeting for education and capacity building of rural users				

I-4.2 Organization

Various organizations have been engaged for rural electrification. Major organizations in the central government are: Ministry of Energy and Mines (MEM), Ministry of Education, Ministry of Public Health, ADINELSA, FONCODES, and PRONAMACHCS, while in the local administration, the regional governments were involved. Others include power supply companies and NGOs. Following table shows those related with their major roles.

Among these, the main organization is the Ministry of Energy and Mines (MEM), the policy making body. MEM plans energy policy and implements it, and therefore the electrification is achieved mainly with MEM, based on the electrification plan formed by them.

Table I-4.2-1 Organizations Related to Rural Electrification

Organizations	Major role in rural electrification
Ministry of Energy and Mines (MEM)	The main responsible ministry for energy supply at central government level
Ministry of Education	Electrification of schools
Ministry of Public Health	Electrification of health posts
ADINELSA	Operation and maintenance of not profitable projects implemented by the government.
FONCODES	Electrification requested by the poor level villages
PRONAMACHCS	Electrification of agricultural villages
Regional governments	The main responsible body at regional level
Power supply companies	Electrification based on extension of existing grids
NGO	Electrification using the funds from government or international organizations, etc.

1. Ministry of Energy and Mines (MEM)

The Ministry of Energy and Mines (MEM) is the main ministry responsible for energy supply. MEM undertakes energy policy, establishes electrification plan and implements the electrification. The organization chart is shown in the following figure.

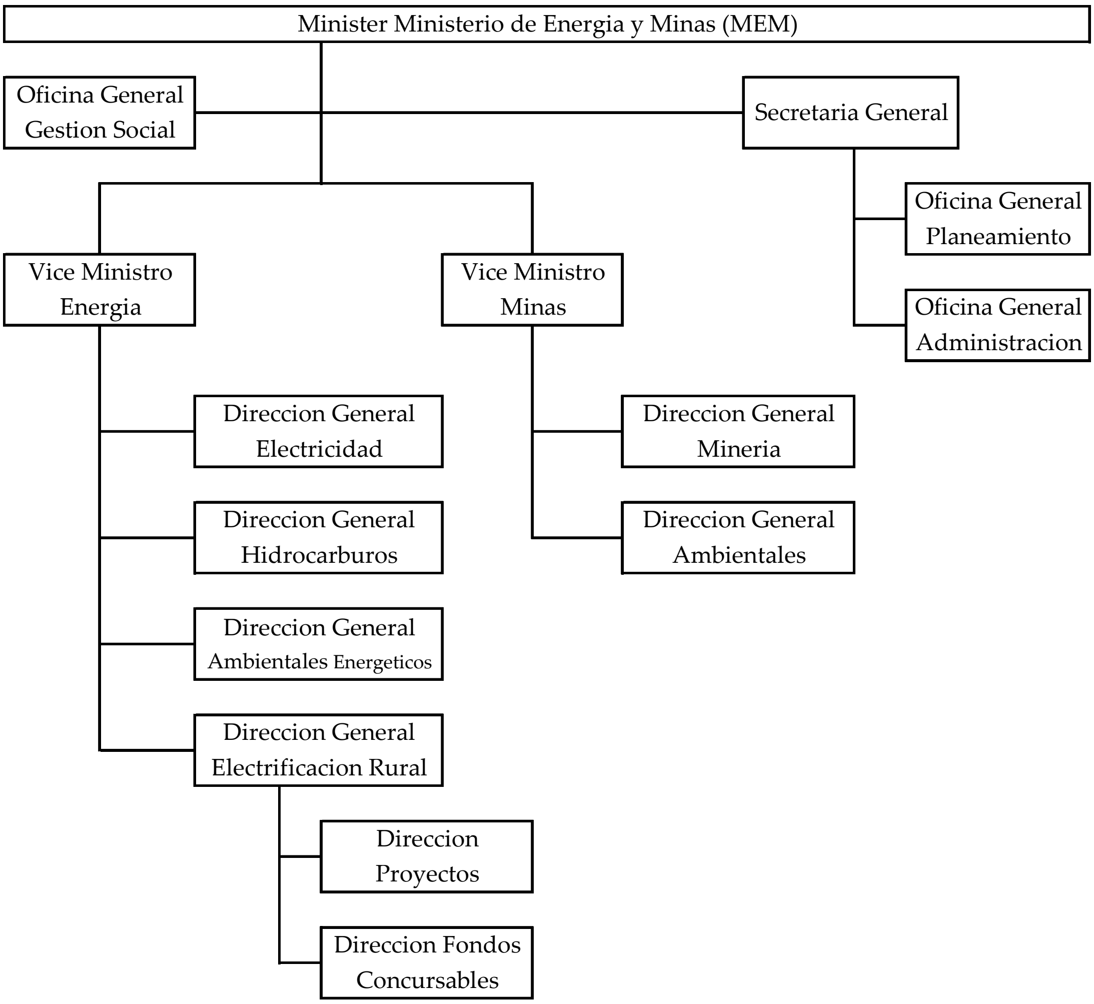


Fig. I-4.2-1 Organization Chart of the Ministry of Energy and Mines (MEM)

2. Direccion General de Electrificacion Rural – Direccion de Proyectos (DPR)

MEM has several departments including Direccion General de Electricidad, or Direccion General de Hydrocarburos. Among them, the main responsible entity for rural electrification is the Direccion General de Electrificacion Rural (DGER). Although this DGER is a new organization created on May 5, 2007, the two organizations which consist DGER are the existing bureaus. One is Direccion de Proyectos (DPR) which was formerly Direccion Ejecutiva de Proyectos (DEP), and the other is Direccion de Fondos Concursables (DFC) which was formerly Fondo Nacional de Electrificacion Rural (FONER). DGER is today the sole responsible agency for rural electrification through on-grid and off-grid system. Among these two organizations of DGER, the actual responsible agency for the public projects on the rural electrification is Direccion de Proyectos (DPR). DPR plans and implements the electrification projects where power supplying companies do not undertake the electrification. In other words, DPR is a so-called project implementing unit (PIU) and executing agency from planning to implementation of rural electrification.

The budget of DGER for FY 2008 is 560 million Nuevo Soles. Out of these, the majority (73%) is for Direccion de Proyectos (DPR) with the amount of 411 million Nuevos Soles. 391 million Nuevos Soles is to be used for investment work. The budget for DPR for 2008 has been increased by 60% from FY 2007.

In FY2007, DPR, or former DEP has 313 million Nuevo soles comprising of 257 million soles current budget and 56 million soles of special budget. In this budget, the extension of grid and 3 mini hydropower stations will be constructed. However, renewable energy is not included.

All projects to be implemented by DPR must be under Plan Nacional de Electrificacion Rural (PNER). This national plan PNER is reviewed every year, and this is the result of bundling all the projects under Plan Regional de Electrificacion Rural (PRER) which is formed by every regional government.

The regional plan PRER must be based on the Plan Local de Electrificacion Rural (PLER) which is formed by each municipality which is based on individual projects. However, the municipalities (more specifically distritos) amounting to more than 1,830 across the country, do not have such an ability to formulate projects and PLER respectively. Therefore, as a matter of fact, public hearings of Meza de Concertacion is done in each municipality and PLER is based on the requests obtained in such hearings. The basic flow up to formulation of PNER is shown in the following figure.

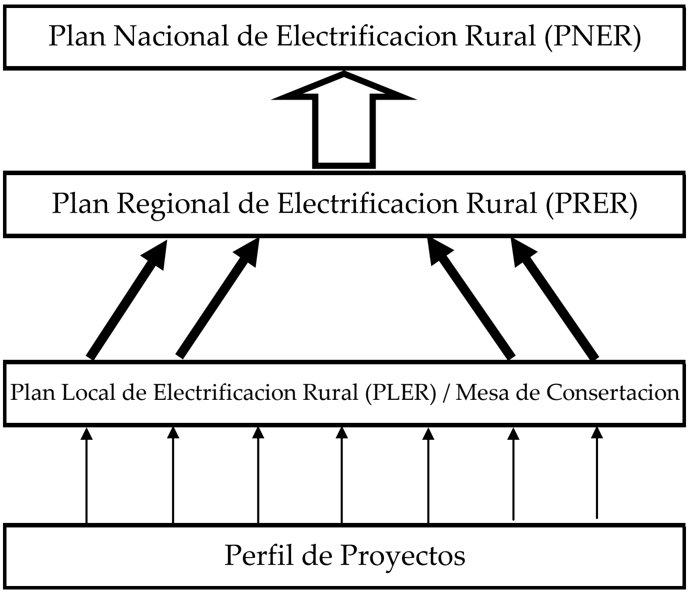


Fig. I-4.2-2 Flow of Requests

Electrification by renewable energy has been also implemented. For example, a project has been implemented using the funds of UNDP-GEF. As a part of it, in Phase II, 4,200 solar home systems (SHS) have been set up, and 22 PV sets have been installed for schools and health posts. In the case of SHS of this Project, DPR has selected the villages to be targeted, and as a contractor, the PV set supplier has planned where actually SHS were going to be set up, and assumed installation, and maintenance of next 2 years together with provision of training to villagers for operation and maintenance. This means that it is a full-turn-key type (llave a mano) contract with full package in a certain way. The property right of the SHS will be transferred to ADINELSA.

For further installation of SHS, "Masivo" type is considered. This method is similar to UNDP-GEF Project. DPR will hire consultant and they will survey and will make a kind of long list which includes candidate of villages of a region, and determine the number of households to be covered by SHS. The contractor, who will assume the procurement of SHS system and its installation, will make a so-called short list which will include the actual villages to be covered, and then decide which houses to be targeted and actually install the system. DPR plans to have Projects Masivo 1, 2 and 3, and Masivo 1 has already obtained the approval of SNIP for its "Perfil".

3. Direccion de Fondos Conursables (DFC)

MEM has another division which enhances rural electrification, which is called Direccion de Fondos Concursables (DFC). This bureau is formerly Fondo Nacional de Electrificacion Rural (FONER). DFC/FONER started its operation since July 2006, with the fund of the World Bank. It aims to enhance private sector initiative for electrification by providing subsidy to lower the investment risk where the cost is higher and not feasible. Therefore, DFC provides subsidies to the projects requested from power supply companies that are in principle extending existing grids. The completed projects do not always have to be operated and maintained by those companies themselves, and the service can be subcontracted.

The conditions or eligibilities of the DFC are; the electrification area should be out of concession areas of the applicants, the applicants should bear 10% of total cost, the minimum level of FIRR is 12% and EIRR 11% respectively (The estimated cost should be reduced taking into account the subsidy), the maximum subsidy is US$800 per connection and minimum number of connection is 1,000. As such restrictions are strict; the electrification can be realized basically by extension of grids.

Table I-4.2-2 Conditions Applied for DFC/FONER Applied Projects

Items	Contents
Basic implementing agency	Power supply companies
Area to be implemented	Out of concession areas
Cost share of implementing agencies	10%
FIRR	Minimum 12%
EIRR	Minimum 11%
New connection	Minimum 1,000 connections
Maximum subsidy	US$800 /per connection

At the first call for projects, 11 projects were approved out of 13 projects presented. Although OPI of MEM approved the evaluation result, considering the amount of investment, it was decided that SNIP is going to be applied and DGPM of MEF is now examining the projects.

The second call will be closed on April 20, and it is expected to have 20 projects (as of February 2007).

4. Ministry of Education

Ministry of Education provides electrification utilizing renewable energy for schools located in the areas where access are not easy. For instance, in 1999, wireless communication facilities and radio transmission systems were installed in 72 schools and 130 solar panels were installed. Through these wireless and radio communication systems, the remote areas and Lima are connected and remote education is implemented.

5. Ministry of Public Health

Ministry of Public Health provides electrification utilizing renewable energy for power supply systems in health posts. In 1998 the Ministry installed cooling system in 50 places and lighting system in 200 places. Similarly, in 2000 the Ministry installed 168 places. Furthermore, in 2006, 400 places were targeted to replace the batteries.

6. ADINELSA

ADINELSA is a public entity who owns the rural electrification projects with non-feasibility and transferred after completion from DPR or FONCODES, etc. In other words, ADINELSA owns non-feasible projects in order to keep the power supply companies with good financial and operating condition. Actual operation and maintenance of ADINELSA's facilities including monthly charges collection are subcontracted to distritos or municipalities depending on the situation.

As for renewable energy, operation and maintenance of 1,300 SHS by PVs in 7 regions are under ADINELSA. For example, in the regions of Pasco, Ayacucho, Selva, Pucalpa, and Madre de Dios, the projects transferred from DPR are now under responsibility of ADINELSA. As for mini/micro hydropower generation projects, 20 systems are operated and maintained under the responsibility of ADINELSA.

7. FONCODES[3], PRONAMACHCS

FONCODES is a central government institution for providing small infrastructures based on the peoples request and needs. The areas are limited to the poorest 2 quintiles of the poverty map made by themselves. The projects include economic infrastructures of roads and power, and social infrastructures of schools and health posts. The size of the project should be smaller than 300,000 soles.

As for electrification, FONCODES has implemented electrification system with battery charging station type, mainly in Iquitos and Pucalpa. The areas are targeted where grid extension will not going to reach. However such electrification data has not been fed back to MEM.

FONCODES has traditionally worked on the basis of direct request from people, however, due to decentralization process; the requests are obtained through municipalities today. Thus the planning and formulation of such requests is made by the municipalities, and the streamlining among electrification policy, plan and actual investment is improved. In the case of solar PV project, the size of project is between 80,000 soles to 12,500 soles and cost share by people is 10%

PRONAMACHCS is a central government institution whose mission is to assist improvement of agriculture infrastructure, and as a part of it, small electrification system has been implemented. However as the main business is to provide agriculture infrastructure, electrification is not active. It has a record of installation of 50 kW micro hydropower generation system.

[3] As of May 2, 2007, The Government decided to dismantle FONCODES. However, as of March 22, 2008, The Government decided to keep it remained. Therefore, still FONCODES will function under the Ministry of Women and Social Development (MINDES).

8. Regional Government, Municipalities

Regional governments and municipalities sometimes implement electrification independently from MEM's electrification plan. For example, from 1996 to 1997, in the Proyecto Especial Rio Putymayo, regional government provided PV systems in 300 places with grant scheme. In 2006, in the Proyecto Binacional Peru Colombia, regional government provided 300 PV systems in 300 places. It is said that such electrification has been done for the election purposes, and MEM may not know some of the projects.

As for financial resources, CANON, Sobre CANON (Petroleo y Gasifero), and Regalia de Mineria are available for regional governments and municipalities. These funds are established by channeling back the local tax revenue from mining entities etc. to local municipalities. The funds are mainly distributed to regional governments and they can utilize these funds independently, but it is reported that some unused amount exist, therefore electrification can be implemented utilizing such funds. Districts and provinces which obtain CANON can also utilize these funds independently just like regional governments, consequently some of them implement electrification without relying on the National Rural Electrification Plan (PNER).

As these funds are controlled by regional governments, districts or provinces, which do not have CANON, need approval from the regions in the case that they need to utilize. As for the project preparation, CANON can be utilized. However, CANON can only provide its 5% to such studies; therefore, it has some limitation to apply the fund.

9. Power Supply Companies

Power supply companies are providing projects at the frontiers of electrification. Grid extension is the basic approach. Mini/micro hydropower is also adopted where grid is not available. For example, in 4 companies under Distriluz, 52 projects of mini/micro hydropower plants with the range of 75 kW to 3,000 kW are installed and operated.

10. NGO

The most active and advanced NGO is ITDG. In renewable energy sector ITDG actively intervenes. With the loan from BID, ITDG provides financial assistance to mini/micro hydropower projects. The revolving fund amounted to US$700,000 in 1994 and US$900,000 in 2005 respectively. In 2005, 47 projects are approved and 31 projects are under implementation. In addition, a training center is established in Cajamarca and training is provided internationally. Furthermore, sustainable power supply system is set up in Ecuador. There is no such active NGO other than ITDG.

I-4.3 Finance

Undertakings for Rural Electrification in Peru are implemented by MEM, as well as FONCODES, Power Distribution Companies, Regional/Local governments, and NGOs.

General Law of Rural Electrification (Law No. 28749) was published in May 2006, substituting the Law of Rural Electrification and of Isolated and Frontier Localities (Law No. 27744). The Article 7 of the new Rural Electrification Law specifies the following financial resources for promotion of rural electrification.

1) Transfers from the Public Treasury;
2) Sources of external financing;
3) One hundred percent (100%) of the amount of sanctions imposed by the OSINERGMIN to the companies having a concession or an authorization to develop electrical activities;
4) Up to twenty five percent (25%) of the resources obtained from the privatization of electric companies of the Energy and Mining Sector;
5) Four percent (4%) of the profits of the generating, transmitting and distributing companies of the electrical subsector, which will be applied against the Income Tax. For the case of the concessionaire companies in hydropower generation, the previously mentioned percentage will be applied without this affecting the percentage established in Law No. 27506, Law of CANON;
6) The contributions, assignments, donations, legacies or transfers for any title, coming from natural or juridical, national or foreign persons;
7) The resources obtained based on execution agreements for rural electrification works with regional and local governments;
8) The contribution of the electricity user, of 2/1,000 of 1 UIT*) per MWh billed;
9) The surplus of the contribution established in literal g) of Article 31 of Law No. 25844, Electrical Concession Law, collected annually by the General Electrical Directorate of the MEM for its normative functions, and which will not be used in that fiscal year by that office; and
10) Others which will be assigned.

*) Note: UIT (Unidad Impositiva Tributaria): corresponding to 1 UIT= S./3,450 (corresponding to some US$1,000) as of January 2007.

It should be pointed out that these are fund for rural electrification in general. They are used for renewable energy projects, as well as for grid extension projects. At this moment, without a master plan, it is not possible for DPR to distribute rationally the budget for renewable energy projects. This means that they are limited to the foreign financial assistance and its contributing amount such as GEF. Amounts of financial resources by the law are estimated here, based on the past trend

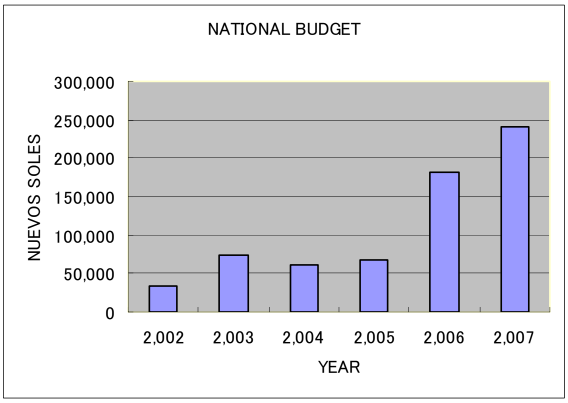
Table I-4.3-1 Amounts of Financial Resources by the Law

(unit: 1,000 Nuevos Soles)

	2002	2003	2004	2005	2006	2007
1) National Budget	34,774	74,892	61,224	68,342	182,309	240,460
2) Foreign credit	131,774	169,447	120,924	85,364	33,890	15,607
3) Penalty by OSINERGMIN	1,780	2,080	4,884	3,956	5,423	n/a
4) Privatization fund	0	0	0	0	0	0
5) Profit of electric utilities	53,168	64,000	68,864	65,855	54,679	n/a
6) Grant aid / donation	16,184	43,683	2,857	3,161	3,184	741
7) Fund by rural electrification contract	n/a	n/a	n/a	n/a	n/a	n/a
8) Contribution by electricity users	117,212	122,652	131,029	140,712	151,572	n/a
9) Surplus amount	17,000	17,000	17,000	17,000	17,000	n/a
10) Others	n/a	n/a	n/a	n/a	n/a	n/a
Total	**371,892**	**493,754**	**406,782**	**384,391**	**448,058**	**485,483**

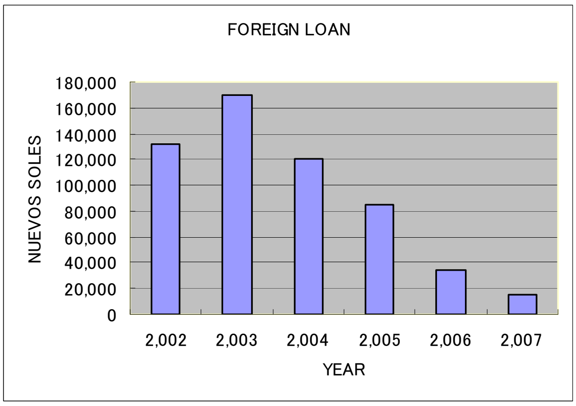
Next, stability as resource is examined from a viewpoint of financial scale.

1) National budget



National budget had been distributed at a range of 60 to 70 million Soles: 182,309,000 Soles was given in 2006 and 240,460,000 in 2007. This sudden increase was due to the "shock de inversiones" introduced to activate economy by President Garcia. It is not clear if such a huge amount continues to be distributed in the future.

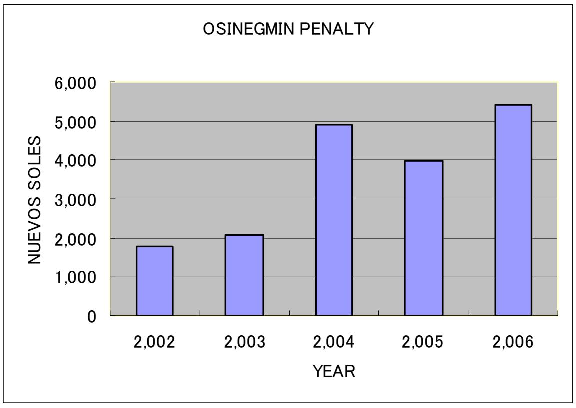
2) Foreign loan



The amount has been decreasing annually since 2003, with the largest amount being 169,477 thousand Soles. The reason is that the large-scale loan is limited to the PAFE (1997 and 1999) and GEF projects, and PAFE is in the last stage with the final disbursement dates being February 2008 for PAFE I and December 2006 for PAFE II.

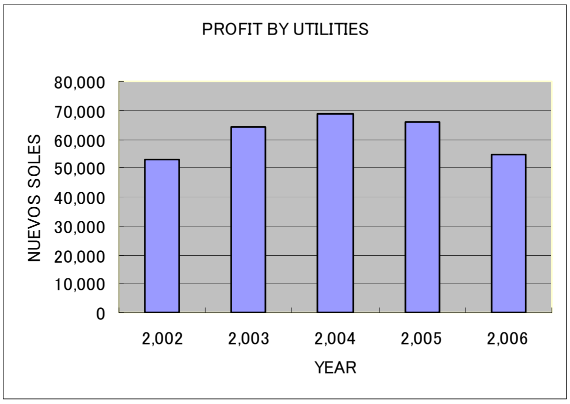
At this moment another Yen Credit for PAFE III is under negotiation, but the amount is expected to be half of the past project (US$50 million), therefore, it is not possible to recover the former level only with this project.

3) Penalty by OSINERGMIN



The amount of the penalty is not so much but constant fund around 2,000 to 5,000 thousand Soles can be expected. The number of penalty was increased from 8 (in 2000) to 137 (in 2006), however, the penalty amount is not proportional to such numbers, because there are minor violations.

4) Privatization fund

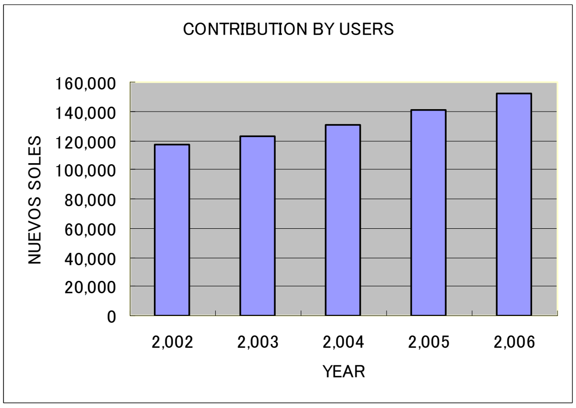


Due to little progress in privatization process of public electric utilities, it is not probable to have any income for privatization in a short term, however, a large amount can be expected temporarily in the future in case of realizing a privatization.

5) Profit of electric utilities

Stable amount of 60 thousand Soles can be assured, but the amount is not so large, and will not be expected to increase greatly in the future.

6) Contribution by electricity users



Constant increase of the amount is recorded and this can be regarded as an important source for rural electrification.

7) Surplus

A fixed amount of 17,000 thousand Soles is annually estimated.

The following table includes those financial resources used for rural electrification by each organization during the past five years.

Table I-4.3-2 Financial Sources for Rural Electrification

Organization	Financial resources	Remarks
MEM/DPR	Ordinary resources Own budget External credit Counter fund Trust fund Bilateral fund Privatization fund Grant aid Technical assistance	including Shock JBIC, etc. Japan, Germany, Italy Las Bambas Peru-Ecuador Luxemburg, USAID
MEM/DFC	Ordinary resources External credit	 World Bank
FONCODES	Ordinary resources External credit	 JBIC, IDB
INADE	Ordinary resources	
Distribution companies	External credit Own budget	World Bank
Regional/Local government	Ordinary resources CANON	
NGO	External credit Technical assistance / grant Own budget	IDB IDB
Others	Technical assistance	ACEI

I-4.3.1 Use of Domestic Resources

1. Ordinary Resources (Transfers from Public Treasury)

This is the financial resources to be allocated by the government to each organization within the public sector. The amount is distributed annually based on the Public Sector Budget Law upon approval by the Congress. This is the major budget for rural electrification implemented by MEM/DPR and the local governments.

In 2006, President García announced to provide a budget of 1,937 million dollars to increase the investment for the benefit of the poor. This is called a *Shock de Inversiones*. 88% of the budget was used for social investment including rural electrification. Budget for MEM was 107.8 million dollars; out of which 57.8 million dollars were destined to rural electrification and the projects were implemented in 15 regions.

2. Directly Collected Resources

This includes direct collection, grant, transfer, internal credit, etc.

3. DEVIDA – USAID

In 1999, MEM/DPR concluded an agreement with Commission for the Fight against Drug Consumption – CONTRADROGAS and the activities of electrification were entrusted to MEM/DPR.

Within this framework, USAID has approved financing for the implementation of studies and works in the regions of San Martín, Huánuco and Cajamarca.

The committee was transformed to DEVIDA (National Commission for Development and Life without Drugs) in 2003 and financed to PSE*) Bellavista II Etapa, ramal Valle del Ponasa (San Martín) and PSE Tingo María Circuito II – Sector Monzón (Huánuco) with an amount of S./727,000. In addition, DEVIDA financed 6 projects in 2004, 1 in 2005, 3 in 2006, including study for PSE Acauyacu Etapa I in Huánuco.

*) PSE: Pequeño Sistema Eléctrico = Small Electric System

4. Fondo General de Contravalor Perú-Japón (FGCPJ)

This is a fund established in 1993, based on the counter value fund for grant aid by the Government of Japan. The fund is preferentially allocated to the basic infrastructure projects related to healthcare, education and energy, as well as those projects which will contribute to mitigate the situation of poverty, after 1995. Financing amount ranges from US$20,000 to US$200,000, for such eligible institutions as NGOs, associations, communities and small enterprises. Projects financed by FGCPJ include:

- PSE Aucayacu Etapa I,
- PSE Ayabaca III Etapa – II Fase.

5. Fondo Perú Alemania Deuda por Desarrollo (FPA)

This is a fund established in 1997, based on the counter value fund for debt relief made by the Government of Germany, amounting to €6,646,760.4, corresponding to 40% of the debt relief amount. This fund is destined to finance development project for infrastructure to mitigate poverty in region of Huancavelica, Ayacucho as well as in northern Peru. Most of the projects have been implemented in water and sewerage, healthcare and irrigation. As to electrification project, they supplied materials (S./780,000) to the Electrification Project of District of Salas (Lambayeque).

6. Fondo de Contravalor Italo-Perú (FIP)

This is a fund established in October 2001, based on the counter value fund for debt relied made by the Government of Italy. This fund is destined to fight for the poverty in rural and urban areas in a context of social participation and sustainable use of natural resources. During the period of 2002 to 2006, a non reimbursable fund amounting to US$116 million was financed. The 80% of the amount have been used for projects in rural areas. As to the electrification project, finance was supplied to 15 projects including solar power, small hydropower and PSE including Minicentral Hidroeléctrica Urubamba y PSE Asociado.

Project costs for rural electrification amount to the average level of US$940,000/project, as follows:

- 2003 s/-13,986,860 (US$3,996,000)

- 2004 s/- 7,114,504 (US$2,033,000)
- 2005 s/-28,383,335 (US$8,110,000)

7. Bi-national Plan of Perú-Ecuador

This is a fund operated by *Plan Binacional de Desarrollo de la Región Fronteiza Perú-Ecuador.* Objective of the fund is to raise the living standard of the people living in the frontier region with Ecuador, and financing is made to those projects which will contribute to economic integration, social development, and regional development. During 10 year period from 2000 to 2009, US$3,000 million is scheduled to be expended from the Governments, international cooperation agencies and private sector. The fund is equally used by the two governments.

In addition to the own budget, the Fund has been implementing the project with fund contributed by credit from JBIC and CAF, grant aid from Spain, USAID, Luxemburg and FIP.

As to the rural electrification projects, they have projects with small power system, solar energy as well as small hydropower resources. Up to 2005, nearly 50% of the project has been completed (including those under progress.) As of October 2005, the following expenditure was made for rural electrification projects:

Completed	:	US$ 31.83 million
Under implementation	:	US$ 20.90 million
Under planning	:	US$ 49.64 million
Total	:	US$102.37 million

The projects financed by the Bi-national Plan include the following:

- PSE Lonya Grande y red secundaria
- PSE Bagua I Etapa
- PSE Chulucanas I Etapa
- PSE Ayabaca II Etapa
- PSE San Ignacio I Etapa
- PSE Muyu Kusu I Etapa
- PSE Chucucanas II Etapa
- PSE Huancabamba Huarmaca
- PSE Santo Domingo Chalaco II y II Etapa
- PSE Sullana II y III Etapa
- PSE San Ignacio I Etapa, II Fase
- PSE Ayabaca III Etapa, I Fase
- PSE Nuevo Seasme II Etapa
- Interconexión Fase II y III

8. Fondo de Inversiones para el Desarrollo de Ancash (FIDA)

As a result of privatization of Antamina Mines, Compañía Minera Antamina S.A. obtained concession. As the company invested only US$2,148M, below the agreed investment amount of US$2,520M, they made an additional payment of US$111.5M, corresponding to 30% of the difference, according to the concessionary contract. FIDA is a fund based on this additional payment, and was used for implementation of such projects as road, electrification, education and healthcare. Based on the Urgent Decree No. 018-2002, nine projects totaling US$20.1M were carried out for four years from 2002.

- PSE Jimbe Pamparomás I Etapa
- PSE Huarmey Culebras II Etapa
- PSE Ocros II Etapa
- PSE Pira III Etapa
- PSE Aija Cotaparaco II Etapa
- PSE Chiauián II y III Etapa
- PSE Chacas San Luis II Etapa
- PSE Aija Cotaparaco III Etapa
- PSE Huari IV Etapa

9. Fund for Privatization

This is a fund obtained from the privatization of public electric utilities. Based on the Urgent Decree No.016-2002, 16 projects totaling US$27.7M were carried out from 2003. Due to the cancellation of the privatization process in 2002, however, these projects were implemented with the finance from CAF (see CAF for details.)

10. Fideicomiso Social Proyecto Las Bambas

Bidding for Las Bambas Mine in Apurímac was made in August 2004, and XSTRATA (Schweiz) AG of Switzerland was awarded contract. As a condition for privatization, social contribution for inhabitants of Grau and Cotabamba provinces was included. For this purpose a trust fund amounting to US$45M funded by XSTRATA was established. US$4.8M, corresponding to some ten percent of the total amount was allocated to electrification, and five projects have been implemented.

- PSE Grau II Etapa – I Fase
- PSE Grau II Etapa – II Fase
- PSE Chumbivilcas Secor Cotabambas Fase I
- PSE Chumbivilcas Sector Cotabambas Fase II
- Electrificación de Fuerabamba y Anexos

11. CANON and Royalties

There is a mechanism to distribute the tax imposed on utilities gained from the development of natural resources to the local governments where such development is made. This is called *CANON*. In addition to six types of canon for mining resources, gas resources, hydropower, fishery, wood and petroleum, there are *sobrecanon* for petroleum, mining royalties and Camisea Social Development Fund (FOCAM).

Relevant laws stipulate that the canon is used for locally influential social infrastructure projects, which also include rural electrification projects.

- Distribution of Mining Royalty

80%	Gobierno Local
15%	Universidades Nacionales
5%	Gobiernos Regionales

- Distribution of CANON

50%	Central Government				
50%	Región	10%	Municipios distritales		
		25%	Municipios provinciales		
		40%	Municipios departamentales		
		25%	Gobierno Regional		
				80%	Gobierno Regional
				20%	Universidad

- Distribution of FOCAM

30%	Mnicipalidades distritales (out of the oil tube route)
30%	Mnicipalidades distritales (on the oil tube route)
15%	Universidades Públicas
15%	Gobiernos Regionales
10%	Municipalidades provinciales

The following table shows the result of budget distribution by region during period 2003 to 2005.

Table I-4.3.1-1 Amount of CANON by Region

(Millones de Soles)

Region	CANON Minero			CANON Petroleo y CANON Gasifero			Regalías Mineras	Total		
	2003	2004	2005	2003	2004	2005	2005	2003	2004	2005
Cajamarca	66	182	286	-	-	-	-	66	182	286
Cusco	-	-	19	-	87	264	-	-	87	282
Moquegua	26	34	149	-	-	-	75	26	34	224
Tacna	15	39	151	-	-	-	71	15	39	222
Loreto	-	-	-	189	192	205	-	189	192	205
Piura	-	-	-	113	138	166	-	113	138	166
Puno	71	95	95	-	-	-	30	71	66	125
Ucayali	-	-	-	68	75	78	-	68	75	78

Source: Participa Perú

The following table shows the distributed amounts of CANON Minero and CANON Petroleo. CANON Minero, in particular, has increased in 2007 because of the recent price rise of mineral products.

Table I-4.3.1-2 Allocation of CANON

(unit: Nuevos Soles)

		Gob. Regional	Gob. Local	Total
CANON Minero	2005	222,034,651	666,087,395	888,122,046
	2006	436,593,665	1,309,784,220	1,746,377,885
	2007	1,289,251,432	3,867,751,071	5,157,002,503
CANON Petroleo	2005	233,104,617	303,959,086	537,063,703
	2006	282,111,557	381,278,041	663,389,598
	2007	150,824,811	210,946,249	361,771,060

I-4.3.2 Use of Foreign Resources

Foreign resources include finance, donation and technical assistance from international cooperation agencies.

1. Japan Bank for International Cooperation (JBIC)

JBIC has been financing to Electric Frontier Project since the end of 1990's with MEM as an implementing agency. The first phase project (from 1997 with a total financing amount of J¥10,140M) included three transmission linens, 21 small power systems and a thermal power station: the second phase project (from 1999 with a total financing amount of J¥13,157M) included six transmission lines and 12 small power systems. A part of this financing is incorporated into the project under the Binational Development Plan of the Frontier Region of Perú-Ecuador. The Government of Peru has been requesting another financing of Yen Credit (some US$70M) for the third phase (from 2007 to 2014).

On the other hand, JBIC also financed J¥5,976M to Social Sector Development Project in Amazon Area in 1997, with FONCODES as an implementing agency. The project covered poverty area in the

Amazonian Region (Loreto, Ucayali, Amazonas, Madre de Dios, Cajamarca and Cusco regions). As to the subprojects for water and electrification, a pilot project using solar panel was implemented.

In September 2000, JBIC also financed J¥6,794M to Social Sector Development Project in Sierra Area. This project contemplates to implement construction of basic infrastructure including electrification in four regions in Sierra (Cusco, Puno, Cajamarca and Ancash).

2. World Bank (IBRD)

IBRD financed US$50M to MEM in July 2006 as a Rural Electrification Project in Peru. No energy source is specified, but the finance is to be used for project with less input for subsidy. (See next chapter for details.)

3. Global Environmental Facilities (GEF)

UNDP-GEF financed US$747,500 to Renewable Energy System Project in Amazonian Region (RESPAR) in 2000. With the additional public and private fund totaling US$2.67M, solar panels were installed at Indiana and Padre Cocha.

GEF also financed some US$4M for Solar Energy Pilot Project. With the total fund of some US$5M, a pilot project is to be implemented from 2007 under the management of UNDP.

4. Inter-American Development Bank (IDB)

IDB financed €498,000 to ITDG, a Peruvian NGO, for Small Rural Business and Renewable Energy Plan in 2000. €298,800 was financed as a revolving fund and the rest was used for Technical Assistance. Up to 2005, a total of 29 loans have been extended for development of mini/micro hydro power plants.

IDB also financed US$150M to FONCODES as FONCODES Stage III in September 2002. US$10M was destined to a total of 250 rural electrification projects. Later US$70M was cancelled and the remaining amount as of February 2007 is US$17M.

5. Corporación Andina de Fomento (CAF)

As a result of interruption of privatization process of public electric utilities, MEM introduced a total of S/.28.2M from CAF, and the following projects were carried out:

- PSE Carhuaquero II Etapa
- PSE Valle La Convención II Etapa
- PSE Muyu-Kuzú I Etapa
- PSE Huariaca II Etapa
- PSE Paiján II Etapa
- PSE Paucartambo-Huachón II Etapa
- PSE Cajatambo-Ambar II Etapa
- PSE Chaupihuaranga II y III Etapa

- PSE Iberia — I Etapa
- PSE Tingo María, Circuito — I Etapa – Eje Cayumba
- PSE Valle Colca — II Etapa
- PSE Caballococha — I Etapa
- PSE Ayacucho Circuito II — II Etapa
- PSE Sandia — II Etapa
- PSE Carhuamayo — II Etapa

CAF also financed €181,920 in 2004 through a Spanish Consulting fund, totaling €5M, for Programa Masivo I. The project contemplates to implement feasibility study on rural electrification by solar energy, to bring benefit to 100,000 persons in Huánuco, Puno, Amazonas, Tacna, Pasco, Cusco, Junín regions. The study, however, has not been completed.

6. US Agency for International Development (USAID)

As a part of Bi-national Plan of Perú-Ecuador, USAID finance US$893,500 to implement PSE San Ignacio I, 2nd phase, in Cajamarca. In addition, finance was extended to PSE San Francisco and Nuevo Progreso electrification project.

7. Spain International Cooperation Agency. (AECI)

AECI has been cooperating with its focus on Region of Piura. As a part of Bi-national Plan of Perú-Ecuador, "Improvement of Life standard using solar energy" with University of Piura (totaling Pts.48,482,000=J¥29M), and "Rural Electrification Project of Reserva Nacional de Salinas y Aguada Blanca" (Pts.50,038,000=J¥30M).

8. Government of Luxemburg

Cooperation Mission of Luxemburg financed US$500,000 for PSE Ayabaca III, Phase 1, (Piura) in April 2004, as a part of Bi-national Plan of Perú-Ecuador.

9. Government of Japan

Government of Japan extended non-project grant aid totaling J¥1,000M to Peru in 1998. Out of this aid, MEM/DPR purchased materials for rural electrification, which were used for 26 projects (10 for secondary network, and 16 PSE).

10. ENDESA Foundation

A Foundation (NGO) established by Spanish electric utility ENDESA carried out a study for Solar Energy Project in Centro Poblado Simiris-Navarra with an amount of US$126,000.

I-4.3.3 Investment Scale by Major Implementing Organization

1. MEM/DPR

Budget for MEM/DPR for the past five years is shown below. Ordinary budget includes Antamina (up to 2005) and Grant includes Privatization Fund (in 2003). Due to the distribution of *Sock de Inversiones*, budget for 2007 increased.

Table I-4.3.3-1 Budget of MEM/DPR in the Past 5 Years

(unit: 1,000 Nuevos Soles)

FY	Ordinary budget	External loan	Own finance	Grant	Total
2003	74,892	169,447	2,548	43,683	290,570
2004	61,224	120,924	9,647	2,857	194,652
2005	68,342	85,364	25,425	3,161	182,292
2006	n/a	n/a	n/a	n/a	n/a
2007	240,460	15,607	910	741	257,719

2. FONCODES

FONCODES has been implementing electrification project as a part of social infrastructure project (Mejorando tu Vida Project). Total budget and budget for rural electrification is shown below:

Table I-4.3.3-2 Budget of FONCODES

(Unit: Nuevo Sol)

FY	Total budget	Electrification	Percentage
2003	409,417,600	12,887,177	3.15%
2004	495,035,166	39,129,023	7.90%
2005	489,899,323	32,127,017	6.56%

I-4.4 Review of National Plan for Rural Electrification by MEM/DPR

I-4.4.1 Electrification Target

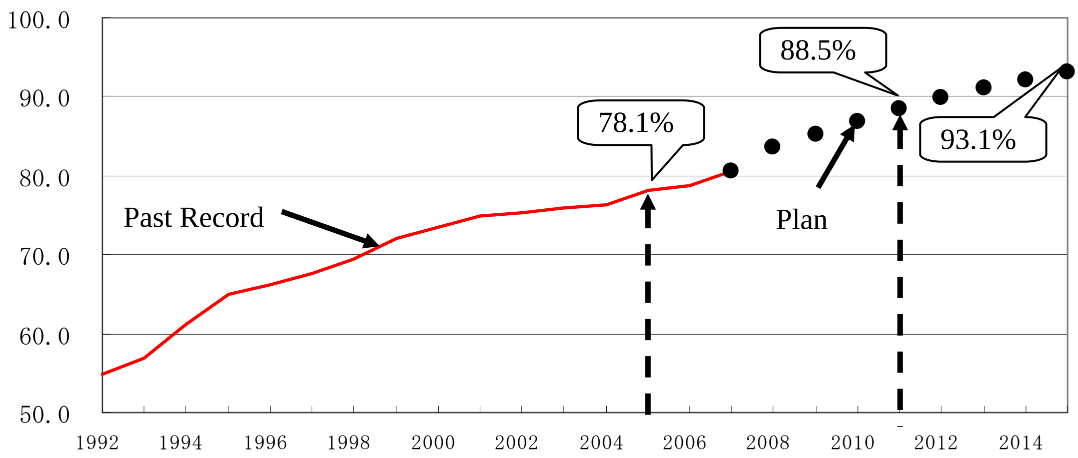
1. Increase and Future Target of the National Electrification Coefficient

DPR (DEP) has been executing the rural electrification plan in order to promote economic development, eliminate poverty and improve the quality of life. According to PNER (2006-2015), 22% of the population currently does not have access to electricity. Therefore, DPR's goal is to increase the electrification coefficient from 78.1% in 2005 to 88.5% in 2011 and eventually to 93.1% by 2015.

Table I-4.4.1-1 History of Electrification Coefficient and Future target (1992-2015)

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Electrification Coefficient (%)	54.8	56.8	61.1	64.9	66.1	67.7	69.5	72.1	73.5	74.9	75.3	76.0
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Electrification Coefficient (%)	76.3	78.1	78.7	80.5	83.7	85.3	86.9	88.5	89.8	91.0	92.1	93.1

Source Study team by PNER (2006-2015)



Source: Study team by PNER (2006-2015)

Fig. I-4.4.1-1 Electrification Coefficient's Evaluation (1992-2015)

As mentioned above, in Peru, increases in the electrification coefficient varied from 0.3% to 4.3% per year during the period from 1992 to 2006 and averaged an annual increase of 1.7% per year. It is expected to increase at an annual average of 1.6% per year from 2007 to 2015. Although grid extension is the primary method for rural electrification, renewable energy electrification such as photovoltaic and hydropower are also included.

Table I-4.4.1-2 shows comparative evolution of the plan and the actual. The actual rate has been achieved in the order of minus 3% with respect to the plan, which trend is considered to continue in the future.

Table I-4.4.1-2 Comparative Evolution of the Plan and the Actual of Electrification Coefficient (1999-2005)

(%)

	1999	2000	2001	2002	2003	2004	2005
Plan	72	75	77	78	79	80	81
Actual	72.1	73.5	74.9	75.3	76.0	76.3	78.1

2. Regional Electrification Coefficient

Table I-4.4.1-3 shows evolution of electrification coefficient by region. Out of 24 regions, 16 regions are under 78.1%, the national average of electrification coefficient, with Sierra and Selva differing considerably from Costa. The former areas are difficult of grid extension and have many poor people with lower ability in payment of power tariff and maintenance of electrification facilities and have not developed industries.

The areas considerably low in electrification coefficient such as Cajamarca and Huánuco are very poor, so that infrastructure such as water and sewerage, education and health have had priority over electricity, delaying electrification.

Table I-4.4.1-3 Evolution of Electrification Coefficient by Region

Departmento	Año											Feature
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	
Amazonas	19.3	20.6	25.8	26.0	25.5	31.0	44.2	54.0	54.5	55.0	55.4	Selva
Ancash	54.2	56.6	57.4	59.0	59.6	62.0	61.8	61.8	64.1	63.3	75.5	Coast & Sierra
Apurimac	25.1	27.4	34.5	47.0	57.6	58.0	59.9	63.3	63.7	66.1	66.2	Sierra
Arequipa	81.9	82.8	84.2	87.0	91.7	94.0	94.0	94.5	94.5	95.3	95.8	Coast & Sierra
Auacucho	31.8	38.3	48.4	55.0	60.1	64.0	63.9	66.3	66.3	68.7	73.0	Sierra & Selva
Cajamarca	19.5	22.6	23.3	25.0	24.6	29.0	29.9	33.0	35.6	35.3	38.7	Sierra
Cusco	51.2	53.6	55.8	58.0	64.1	64.0	70.0	66.7	68.3	68.1	68.2	Sierra
Huancavelica	22.2	23.7	23.9	25.0	28.2	42.0	41.7	57.1	66.4	66.9	66.9	Sierra
Huánuco	28.5	29.8	29.8	30.0	31.6	32.0	35.6	36.9	36.9	38.0	40.9	Sierra & Selva
Ica	79.0	79.5	79.5	80.0	83.0	83.0	83.3	83.3	88.6	88.2	88.2	Coast
Junin	61.5	62.9	70.0	71.0	82.5	83.0	84.0	84.3	84.3	84.4	86.0	Sierra
La Libertad	65.1	67.3	68.9	74.0	73.9	73.0	73.4	73.4	73.4	74.3	77.0	Coast & Sierra
Lambayeque	75.8	76.3	76.7	78.0	81.6	82.0	85.9	85.7	86.1	86.4	86.4	Coast & Sierra
Lima	96.7	97.1	97.3	97.0	98.7	99.0	99.1	99.0	99.0	99.2	99.2	Coast
Loreto	44.3	44.6	45.1	46.0	48.3	48.0	48.3	48.3	48.3	48.5	48.6	Selva
Madre de Dios	52.9	52.1	52.1	55.0	60.8	62.0	62.4	62.4	62.4	62.4	62.4	Selva
Moquegua	75.2	75.9	75.9	76.0	80.5	86.0	85.8	85.8	86.7	86.8	86.8	Coast & Sierra
Pasco	49.5	55.6	55.6	60.0	59.4	59.0	59.4	59.4	61.4	66.6	68.8	Sierra & Selva
Piura	49.4	50.1	51.0	51.0	54.5	55.0	57.7	61.6	61.7	61.6	71.8	Coast & Sierra
Puno	29.0	29.5	34.8	39.0	48.1	49.0	49.1	49.0	49.0	60.2	69.7	Sierra & Selva
San Martin	39.3	38.6	38.6	47.0	43.9	50.0	49.7	50.2	50.2	50.2	50.5	Sierra
Tacna	83.3	91.1	91.0	96.0	89.7	91.0	91.0	97.2	97.8	97.6	97.6	Coast & Sierra
Tumbes	76.8	76.3	76.3	76.0	85.9	86.0	85.9	85.9	85.9	85.9	85.9	Coast
Ucayali	56.7	55.6	55.7	56.0	59.1	62.0	62.1	63.0	63.0	62.4	67.5	Selva
Nacional	64.9	66.1	67.7	69.5	72.2	73.5	74.9	75.3	76.0	76.3	78.1	

Source: MEM/DPR

Regions with less than 78.1% of electrification coefficient

3. Population by Region and Electrification

Table I-4.4.1-4 shows population and electrification coefficient by region (department). Out of 24 regions, 16 regions are under the national average of 78.1% of electrification coefficient, showing an evident disparity between urbanized areas and remote areas.

Table I-4.4.1-4 Population and electrification coefficient by region (2005)

Departmento	Poblacion	Participacion	Electrificacion (%)
Amazonas	405,600	1.5%	55.4
Ancash	1,081,823	4.0%	75.5
Apurimac	435,972	1.6%	66.2
Arequipa	1,187,354	4.4%	95.8
Auacucho	644,607	2.4%	73.0
Cajamarca	1,414,470	5.2%	38.7
Cusco	1,219,300	4.5%	68.2
Huancavelica	465,294	1.7%	66.9
Huánuco	760,690	2.8%	40.9
Ica	692,748	2.5%	88.2
Junin	1,136,156	4.2%	86.0
La Libertad	1,602,596	5.9%	77.0
Lambayeque	1,136,069	4.2%	86.4
Lima	8,982,104	33.0%	99.2
Loreto	920,217	3.4%	48.6
Madre de Dios	95,779	0.4%	62.4
Moquegua	165,806	0.6%	86.8
Pasco	277,648	1.0%	68.8
Piura	1,697,307	6.2%	71.8
Puno	1,296,324	4.8%	69.7
San Martin	697,308	2.6%	50.5
Tacna	285,695	1.0%	97.6
Tumbes	199,535	0.7%	85.9
Ucayali	418,865	1.5%	67.5
Total	27,219,267	100.0%	78.1

Source: MEM/DPR

(highlighted) Regions with less than 78.1% of electrification coefficient

I-4.4.2 Grid Extension Plan and Electrification Coefficient

1. Regional Grid Extension Plan

According to PNER (2006-2015), the annual regional grid extension plan is as follows; over the next decade, 20,364 km of grid extension is planned; and there will be intensive investment in regions with low electrification coefficients. Moreover, the grid is planned to expand at an average of 2,300 km per year.

Table I-4.4.2-1 Regional Grid Extension Plan (2008-2015)

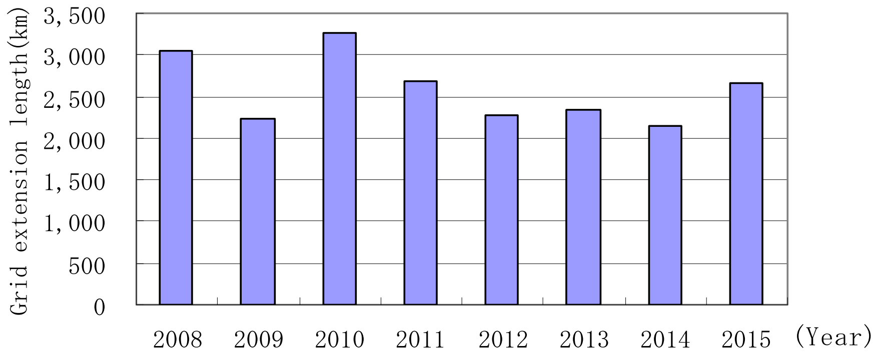
(km)

Region	2008	2009	2010	2011	2012	2013	2014	2015	Total
Amazonas	0	0	112	51	188	187	47	0	585
Ancash	222	0	35	100	296	62	165	0	880
Apurimac	0	35	43	34	85	121	45	123	486
Arequipa	0	35	0	0	0	192	0	612	839
Ayacucho	0	0	0	270	449	245	250	180	1,394
Cajamarca	1,193	1,083	237	195	40	0	244	0	2,992
Cusco	0	255	250	328	332	76	156	115	1,512
Huancavelica	0	52	0	0	90	23	0	20	185
Huanuco	560	445	251	0	0	0	69	0	1,325
Ica	63	0	0	0	0	0	14	33	110
Junin	0	221	404	360	0	0	185	249	1,419
La Libertad	213	0	680	166	0	0	0	120	1,179
Lambayeque	0	0	0	26	0	195	197	106	524
Lima	41	0	0	0	0	0	0	372	413
Loreto	658	110	0	0	123	135	0	0	1,026
Madre De Dios	0	0	0	0	0	0	125	178	303
Moquegua	0	0	0	0	0	0	40	0	40
Pasco	0	0	350	41	114	65	0	50	620
Piura	89	0	657	0	35	536	301	0	1,618
Puno	0	0	0	738	370	252	142	86	1,588
San Martin	0	0	0	177	162	251	87	366	1,043
Tacna	0	0	0	0	0	0	0	5	5
Tumbes	0	0	57	0	0	0	0	0	57
Ucayali	0	0	183	192	0	0	72	44	491
	3,039	**2,236**	**3,259**	**2,678**	**2,284**	**2,340**	**2,139**	**2,659**	**20,634**

* No data of grid extension length at 2006, 2007

Source: Study team by PNER (2006-2015)

[yellow box] Regions with less than 78.1% of electrification coefficient



Source: Study team by PNER (2006-2015)

Fig. I-4.4.2-1 Grid Extension Length (2007-2015)

2. Population in Targeted Areas

According to grid extension plan by MEM/DPR, an additional 2.75 million people require access to electricity in order to achieve the 2015 target household electrification rate of 93.1% according to the aforementioned plan, it is necessary for 57.3% of the population to be electrified.

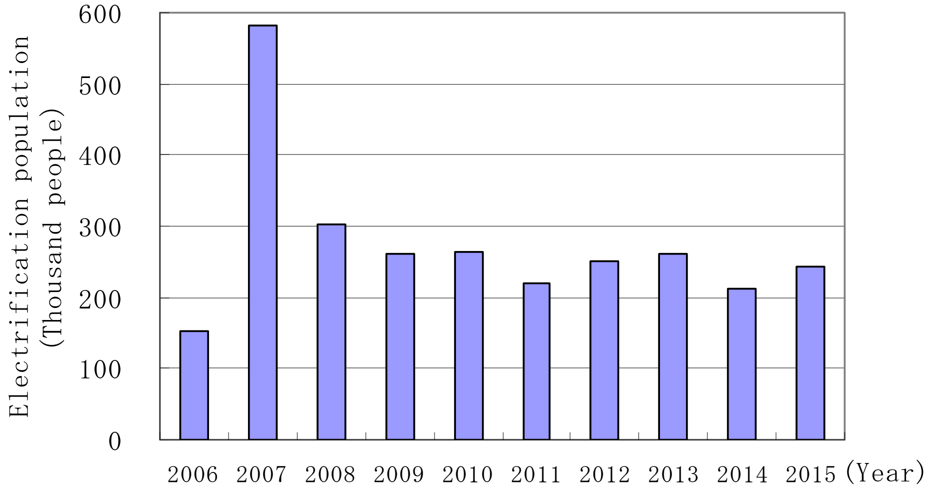
Table I-4.4.2-2 Regional Electrification Population (2007-2015)

(Thousand people)

Region	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Amazonas	0	14	0	0	5	3	14	15	4	0	54
Ancash	53	6	12	0	4	14	55	11	23	0	179
Apurimac	0	4	0	9	3	6	15	26	2	19	83
Arequipa	7	0	0	0	0	0	0	6	0	50	63
Ayacucho	35	87	0	0	0	18	48	12	15	5	220
Cajamarca	0	39	168	161	24	15	2	0	50	0	460
Cusco	0	25	0	21	17	16	24	9	11	12	134
Huancavelica	0	42	0	13	0	0	11	8	0	4	79
Huanuco	13	51	42	26	9	0	0	0	9	0	151
Ica	0	0	3	0	0	0	0	0	9	1	13
Junin	5	14	0	27	27	30	0	0	7	23	132
La Libertad	1	30	26	0	83	23	0	0	0	15	178
Lambayeque	0	29	0	0	0	6	0	35	19	16	105
Lima	0	0	8	0	0	0	0	0	0	34	43
Loreto	4	51	31	5	0	0	18	6	0	0	115
Madre De Dios	4	0	0	0	0	0	0	0	2	12	19
Moquegua	0	0	0	0	0	0	0	0	1	0	1
Pasco	4	5	0	0	16	3	3	1	0	1	34
Piura	5	35	12	0	70	0	1	70	18	0	212
Puno	13	113	0	0	0	69	43	29	20	5	292
San Martin	7	36	0	0	0	8	19	32	16	42	160
Tacna	0	0	0	0	0	0	0	0	0	1	1
Tumbes	0	1	0	0	1	0	0	0	0	0	2
Ucayali	0	0	0	0	5	10	0	0	4	2	21
	152	**583**	**302**	**262**	**264**	**221**	**251**	**261**	**212**	**242**	**2,750**

Source: Study team by PNER (2006-2015)

[yellow box] Regions with less than 78.1% of electrification coefficient



Source: Study team by PNER (2006-2015)

Fig. I-4.4.2-2 Electrification Population by Grid Extension (2007-2015)

3. Classification of Grid Extension and Isolated Power Supply

According to MEM/DPR, grid extension will electrify most locations, however, renewable energy such as photovoltaic and hydropower will be used in areas where it is impossible to extend the grid.

The investment required to electrify each household will be the criteria used to determine whether grid extension is the most economic means of electrification. If the investment required is greater than US$1,000, then electrification by grid extension will not be considered. This investment includes cables, poles, labor cost, transportation cost, and any associated taxes.

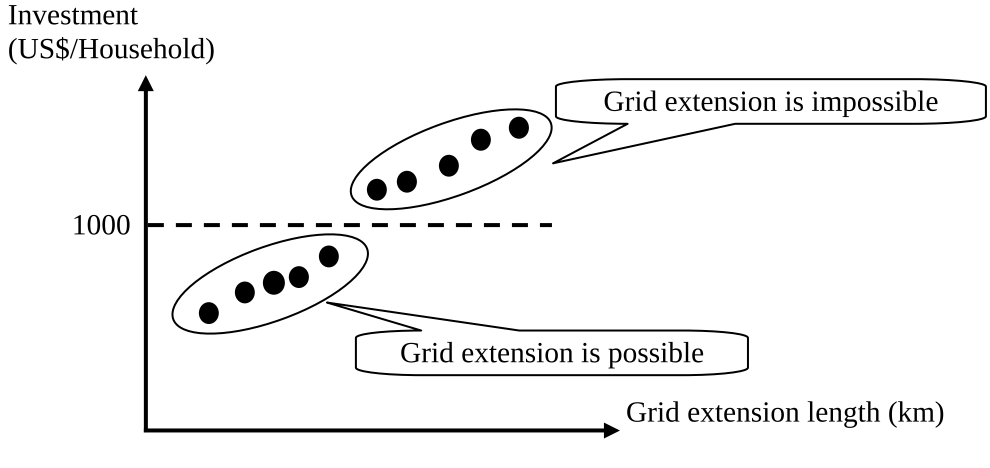
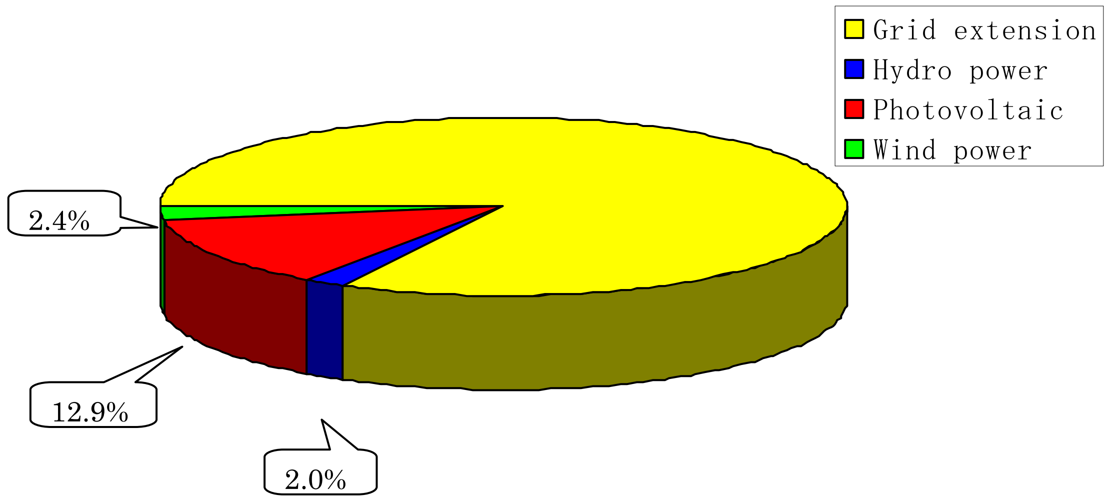


Fig. I-4.4.2-3 Indication of Investment Credit

It is necessary to supply electricity to about 4.8 million people in order to achieve 93.1% electrification rate by 2015. About 830,000 people (17.3% of total) has electricity by renewable energy, furthermore about 97,000 people (2% of total) has electricity by hydropower.



Source: Study team by PNER (2006-2015)

Fig. I-4.4.2-4 Percentage of Electrification Method

4. Calculation of Investment Required

Calculation of investment for grid extension is as follows:

1) Calculation of cost for 23 kV grid
2) Calculation of cost for 23 kV network
3) Calculation of cost for 400 V grid
4) Sum (1) + 2) + 3))
5) Calculation of cost for household (4) / household)
6) Evaluation of investment criteria (< US$1,000/Household)

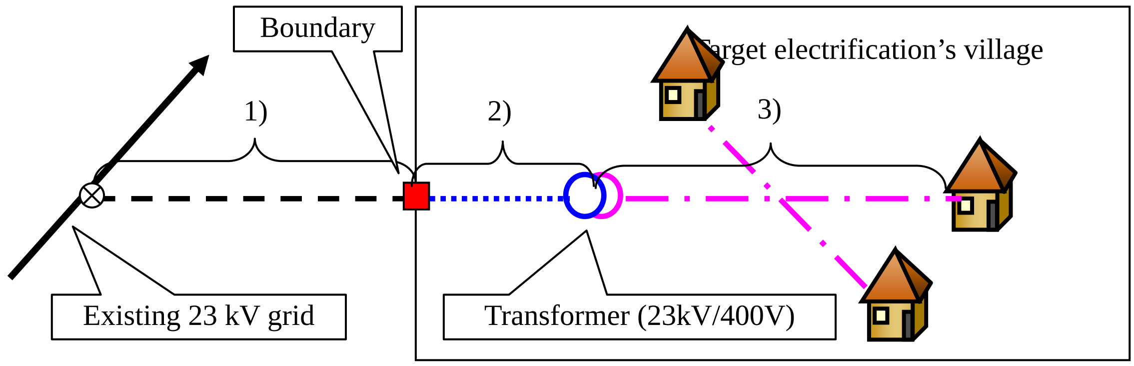


Fig. I-4.4.2-5 Image of Grid Extension

(1) Standard Price of 23 kV Grid

23 kV grid means single-phase line or three-phase lines from existing 23 kV grid to boundary of targeted village for electrification.

Table I-4.4.2-3 Standard Price for Calculation (23 kV Grid)

23kVGrid (Single-Phase)	US$4,000/km
23kVGrid (Three-Phases)	US$8,000/km

(2) Standard Price of 23 kV Network and 400 V Grid

23 kV Network means 23 kV circuit from boundary of targeted village for electrification to the transformer (23kV/400V). Moreover, 400 V grid means low voltage circuit from transformer (23kV/400V) to household. 23 kV Network and the 400 V grid are classified into three types according to location of road and village, location of household in the village.

Type A: Although the village is far from the main road, the households are located in dense clusters.

Type B: The village is located on both sides of a main road and households are distributed evenly near the road

Type C: The village is far from the main road and households are highly scattered.

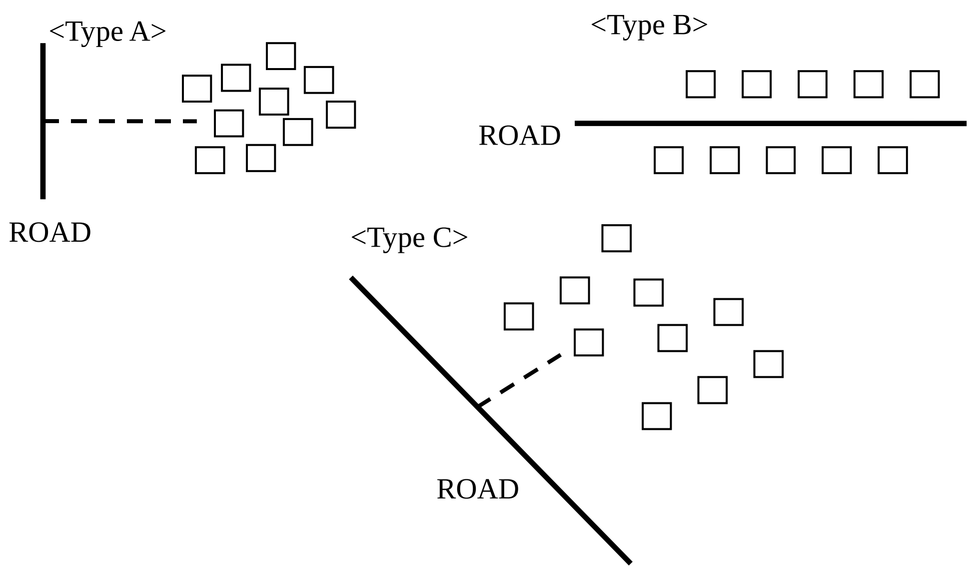


Fig. I-4.4.2-6 Village Type

Table I-4.4.2-4 Standard Price of Calculation (23 kV Network and 400 V Grid)

(US$/Household)

TYPE	23 kV Network	400 V Grid
A	100	250
B	150	350
C	200	500

(3) Calculation of Investment Credit (Example)

<Assumption>

23 kV grid length (Three-phase)	:	30 km
Number of household	:	500
Village type	:	A
1) 23 kV Grid	:	US$8,000/km × 30 km = US$240,000
2) 23 kV Network	:	US$100/household × 500 households = US$50,000
3) 400 V Grid	:	US$250/household × 500 households = US$125,000
4) Sum (1) + 2) + 3))	:	US$415,000
5) Calculation of household (4) / household)	:	US$415,000/500 households = US$830/household < US$1,000/household
6) Evaluation of investment amount	:	5) = US$830/household < US$1,000/household → Grid extension is possible

As mentioned above, this village's investment required is US$830-, which is lower than the criteria and therefore this village should be electrified by grid extension.

In recent years, the type A villages have decreased due to the increased grid extension. In the future, it is expected that type B and type C village will increase in such areas as mountainous and remote areas where grid extension remains difficult.

Furthermore, the standard price for the calculation of grid extension is based on type A villages. In the case of calculation for type B or C villages, however, conditions are different at these villages. Therefore, it is necessary to confirm a standard price for these types of special areas where construction conditions differ from urban areas.

(4) Future Consideration

It is proposed to gather the following information in order to review the standard price for investment credit calculation.

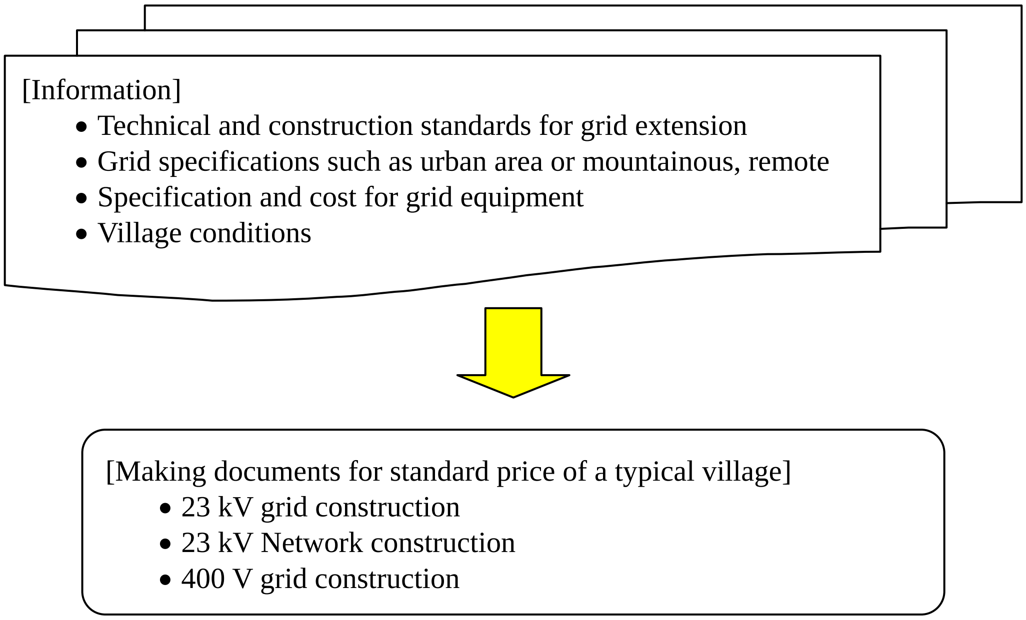


Fig. I-4.4.2-7 Investigation Terms

5. Priority of Electrification

According to MEM/DPR, targeted villages for electrification are classified by the following terms; According to table 8, there are 10 items in the technical, financial, and social fields. These items are evaluated and the actual electrification coefficient and poverty index also play a critical role.

Table I-4.4.2-5 Priority Items

1.- Technical criteria

1.1 Actual state of project (weight: 0.5)

a) Complete Definite study (EDC)	10
b) Basically Engineering (IB)	8
c) Basically Configuration (CB)	2

1.2 Electrical Infrastructure (weight: 0.5)

a) Existence (EX)	10
b) In execution (EJ)	8
c) Programmed in period (PG4,PG5,PG6)	from 4 to 6

1.3 Coefficient of provincial electrification (weight: 5)

a) from 80.1% to 100%	1.5
b) from 70.1% to 80%	3
a) from 60.1% to 70%	4
a) from 50.1% to 60%	5
a) from 40.1% to 50%	6
a) from 30.1% to 40%	7
a) from 20.1% to 30%	8
a) from 10.1% to 20%	9
a) from 0.1% to 10%	10

2.- Economical criteria

2.1 Actual social value net - VANS (weight: 0.5)

a) Positive Value (more than 5 % of amount of investment)	10
b) Positive Value (more than 2.5% and less than 5 % of amount of investment)	8
c) Positive Value (more than 1.5% and less than 2.5 % of amount of investment)	6
d) Positive Value (more than 0% and less than 1.5 % of amount of investment)	4
a) Negative Value of amount of investment)	2

2.2 Investment per capita - US$/inhabitant (weight: 0.5)

a) from 0 to 75	10
b) from 76 to 150	8
c) from 151 to 225	6
d) from 226 to 300	4
e) more than 300	2

3.- Socio - Economical criteria

3.1 Poverty Index (weight: 2.5)

a) Extreme Poverty (IP more than 28.99)	10
b) Some Poverty (IP more than 20.99 and less than 28.99)	8
c) Poverty (IP more than 13.99 and less than 20.99)	6
d) Regular (IP more than 6.99 and less than 13.99)	4
e) Acceptable (IP less than or equal to 6.99)	2

3.2 Geographical Location (weight: 0.5)

a) Drug production area and National boundary area	10
b) Rural zone of the Jungle	8
c) Rural zone of the high Lands	6
d) Rural zone of the Coast	4

I-4.5 Power Facilities and Technology

1. Outline of Generating Facilities

The generating facilities in 2005 is 6,200 MW; hydro power: 52%, thermal power: 48%. There are wind turbines less than 1MW. Table I-4.5-1 shows the trend of power capacity across the nation.

Table I-4.5-1 Trend of Power Capacity

(MW)

Año	Generación				Uso Propio			Total			
	Hidráulica	Térmica	Eólica	Total	Hidráulica	Térmica	Total	Hidráulica	Térmica	Eólica	Total
1995	2,190.0	995.7	—	3,185.7	289.4	986.6	1,276.0	2,479.4	1,982.3	—	4,461.7
1996	2,200.2	1,152.4	0.3	3,352.9	292.5	1,017.2	1,309.7	2,492.7	2,169.6	0.3	4,662.6
1997	2,411.5	1,913.3	0.3	4,325.1	101.5	766.0	867.5	2,513.0	2,679.3	0.3	5,192.6
1998	2,467.4	2,164.6	0.3	4,632.3	104.6	778.4	883.0	2,572.0	2,943.0	0.3	5,515.3
1999	2,587.1	2,240.4	0.7	4,828.2	86.2	828.0	914.2	2,673.3	3,068.4	0.7	5,742.4
2000	2,779.3	2,368.9	0.7	5,148.9	77.6	839.8	917.4	2,856.9	3,208.7	0.7	6,066.3
2001	2,889.4	2,160.7	0.7	5,050.8	76.9	779.0	855.9	2,966.3	2,939.7	0.7	5,906.7
2002	2,917.6	2,149.7	0.7	5,068.0	78.9	788.6	867.5	2,996.5	2,938.3	0.7	5,935.5
2003	2,946.8	2,147.6	0.7	5,095.1	85.5	789.5	875.0	3,032.3	2,937.1	0.7	5,970.1
2004	2,969.1	2,126.3	0.7	5,096.1	86.8	833.5	920.3	3,055.9	2,959.8	0.7	6,016.4
2005	3,119.2	2,100.7	0.7	5,220.6	87.9	892.0	979.9	3,207.1	2,992.7	0.7	6,200.5

2. Outline of Transmission Facilities

Total length of national transmission facilities in 2005 is 15,272 km. Table I-4.5-2 and Fig. I-4.5-1 show national transmission lines.

Table I-4.5-2 Trend of Power Transmission Facilities

(km)

Año	Longitud de Líneas de Transmisión				
	220kV	138kV	60–69kV	30–50kV	Total
1995	3,130	1,873	3,031	1,098	9,132
1996	3,130	1,873	3,278	1,130	9,411
1997	3,625	2,241	3,629	1,329	10,824
1998	3,625	2,411	3,895	1,398	11,329
1999	3,996	2,920	4,190	1,421	12,527
2000	4,860	3,135	4,213	1,447	13,655
2001	5,318	3,183	4,310	1,450	14,261
2002	5,559	3,331	4,335	1,454	14,679
2003	5,559	3,338	4,335	1,461	14,693
2004	5,614	3,338	4,335	1,570	14,857
2005	5,614	3,435	4,678	1,545	15,272

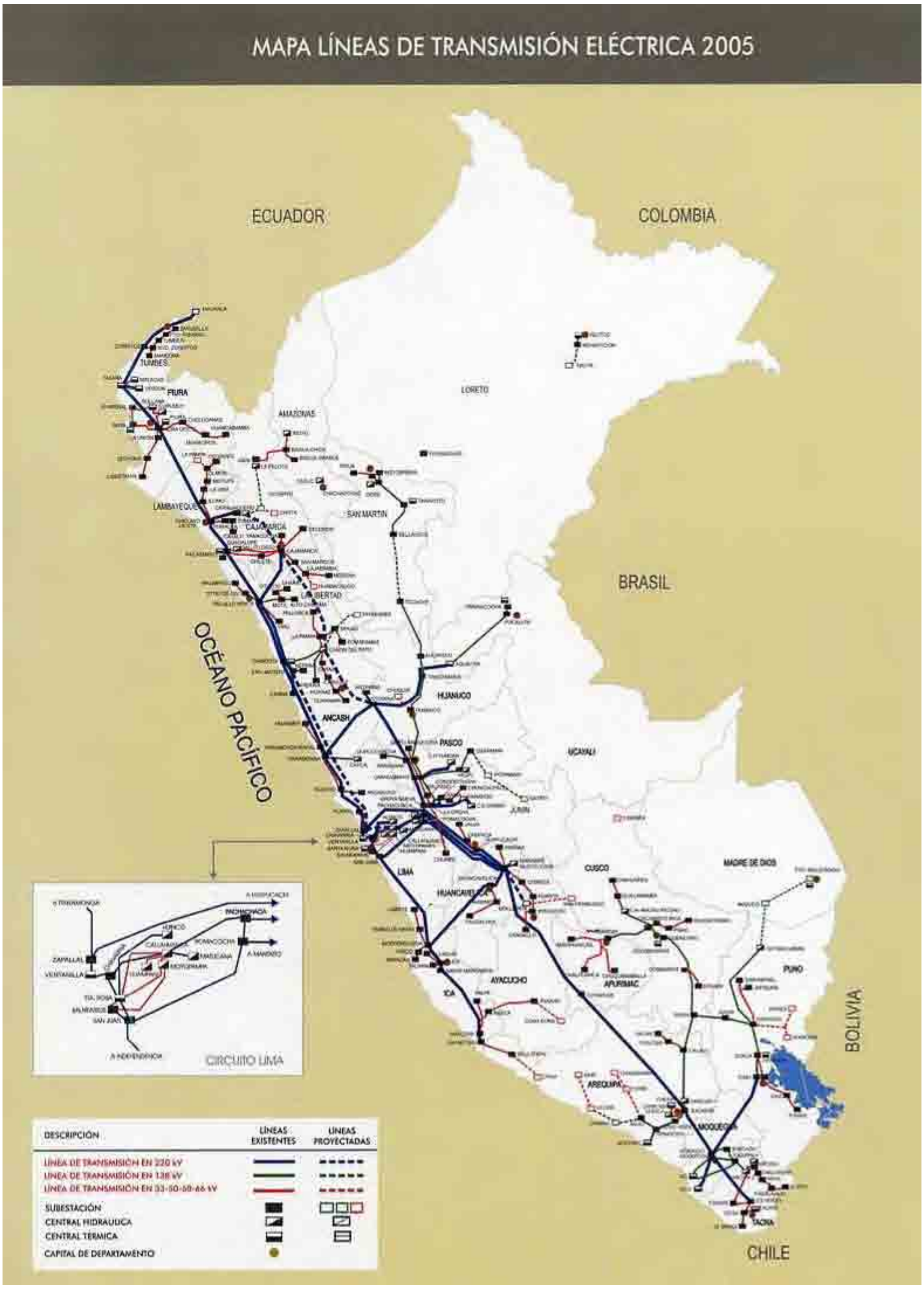


Fig. I-4.5-1 Power System Map (2005)

3. Outline of Power Companies

22 public and private generating companies supply power through transmission and distribution companies. SEIN (Sistema Interconectado Eléctrico Nacional) system supply power about 96% and the rest of 4% are supplied by SSAA (Systemas Aislados). Both system have not been connected yet.

Out of 22 distribution companies, 11 distribution companies supplying urban areas were privatized, while 11 distribution companies in rural areas still public-owned.

Table I-4.5-3 List of Power Companies

Company	Property	Concession Areas
Consorcio Eléctrico de Villacuri S.A.C	Private	Lima,Ica and Huánuco
Electro Paramonga S.A	Private	Paramonga
Electro Utcubamba S.A.C	Private	Utcubamba
Electro Pangoa S.A	Private	Pangoa
Electro Rioja S.A	Private	San Martin
Electro Tocache S.A	Private	Tocache
Ede Cañete S.A	Privatized	Cañete
Edelnor S.A.A	Privatized	Metropolitan north of Lima, Callao and the provinces: Huaura, Barranca, Huaral and Oyón
Edechancay	Privatized	Chancay(Huacho, Huaral and Supe)
Electro Sur Medio S.A.A	Privatized	Ica, and part pf Huancavelica and Ayacucho
Luz del Sur S.A.A	Privatized	Metropolitan south of Lima
Chavimochic	Public	La Libertad
Electro Oriente S.A	Public	Loreto, San Martin
Electro Puno S.A.A	Public	Puno
Electrosur S.A	Public	Tacna and Moquegua
Electro Sur Este S.A.A	Public	Puno, Cuzco, Apurimac and Madre de Dios
Electro Ucayali S.A	Public	Ucayali
Electrocentro S.A	Mixed(*1)	Huánuco, Pasco, Junín, and part of Huancavelica and Ayacucho
Electro Norte Medio S.A-Hidrandina	Mixed(*1)	La Libertad, Ancash and part of Cajamarca
Electronoroeste S.A	Mixed(*1)	Tumbes and Piura
Electronorte S.A	Mixed(*1)	Lambayeque, Cajamarca and Amazonas
Sociedad Eléctrica del Sur Oeste S.A	Mixed(*1)	Arequipa

*1 Privatized and returned to the State

Table I-4.5-4 shows the number of the customers of each distribution company. Retail market in Peru consists of both liberal market above 1,000 kW and regulated market less than 1,000 kW.

Table I-4.5-4 Number of Customers of Distribution Companies

Company's Name	Clientes Libres	Clientes Regulados	Total
Consorcio Eléctrico de Villacuri S.A.C		748	748
Edernor S.A.A	81	924,638	924,719
Electro Oriente S.A.		132,058	132,058
Electro Pangoa S.A.		1,113	1,113
Electro Puno S.A.A	2	122,376	122,378
Eletro Sur Este S.A.A	3	238,360	238,363
Eletro Sur Medio S.A.A	12	126,731	126,743
Electro Ucayali S.A	1	43,369	43,370
Electrocentro S.A	1	381,512	381,513
Electronoroeste S.A	1	237,957	237,958
Electronorte Medio S.A - HIDRANDINA	1	411,436	411,437
Electronorte S.A	11	226,195	226,206
Electrosur S.A		98,933	98,933
Ede Cañete S.A	1	26,724	26,725
Edechancy		887	887
Electro Tocache S.A		7,677	7,677
Electro Paramonga S.A		5,783	5,783
Electro Utcubamba S.A.C		5,233	5,233
Chavimochic		3,519	3,519
Luz del Sur S.A.A	44	737,228	737,272
Electro Rioja S.A		4,263	4,263
Sociedad Eléctrica del Sur Oeste S.A	6	240,116	240,122
Total	**164**	**3,976,856**	**3,977,020**

Clientes Libres: Electricity consumption is more than 1,000kW
Clientes Regulados: Electricity consumption is less than 1,000kW

4. Outline of Distribution Facilities

Distribution system (Sistema de Distribucion) are operating the voltage of middle tension from 1 kV to 30 kV and Low tension less than 1 kV. Standard systems have power primary distribution lines from transmission companies or generating companies. Its power voltage is dropped in pole transformers and supply to secondary distribution line.

Table I-4.5-5 Power Voltage

Sistema de Distribucion	Nivel de Tension
Distribucion Primaria	22.9, 13.2, 10, 7.62 kV
Distribucion Secundaria	440, 380, 220 V
Transformador en poste(Distribución Secundaria)	3, 5, 10, 15, 25, 50, 75, 100, 160, 250 kVA

Power voltages are classified MAT (23%), AT (9%), MT (31%) and BT (37%). Liberalized ultra high and high tension customers are directly supplied by generating companies. Customers classifications are industrial (55%), commercial (18%) and residential (24%)

5. Cost of Distribution line

The distance and isolation of remote communities makes electricity access in rural area in Peru very difficult because of its geographic features. This fact results in high installation and O&M costs. The geography throughout the nation is divided into four categories "Costa (Coast)" "SIERRA Alta (High Mountain)" "SIERRA Baja (Low Mountain)" "SELVA (Amazon)". Generally speaking, the cost gradually increases from Coast, Mountain, to the Amazon being the most expensive. This is because it requires special labor or maritime transport in the mountainous regions and the freight on the Amazon River.

The table below shows the average construction cost of distribution system, calculated on the basis of several rural electrification projects in the past. Transportation cost varies by region and poles cost the most of the construction materials.

Table I-4.5-6 Distribution Construction Cost

(%)

		Wood pole and Aluminum wire	Wood pole and Copper wire	Concrete pole and Aluminum wire
Material	Posts and Crucetas	24	20	17
	Conductors	9	37	23
	Aisladores and Ferretria	9	5	5
	Proteccion	1	1	1
Construc-tion fee	Montaje	37	18	29
	Transporte	4	3	5
	Gastos Generales	9	8	12
	Utilidades	7	8	8

The following table shows the detail of distribution work by JBIC project called PAFE. Primary line work is main portion (62%).

Table I-4.5-7 Detail of Distribution Work

(%)

Name of Work	Linea Primaria	Redes Primaria	Redes Secondaria
PAFE-I	44	20	36
PAFE-II	46	14	40
PAFE-III	42	19	39
Average	44	18	38

The following table shows the price of distribution material.

Table I-4.5-8 Material Price for High Voltage Distribution (1)

Descripción de Partidas	Unidad	Precio
POSTE DE MADERA		
POSTE DE MADERA TRATADA DE 12 m, CLASE 6 (EUCALIPTO NACIONAL)	U	550
POSTE DE MADERA TRATADA DE 12 m, CLASE 5 (EUCALIPTO NACIONAL)	U	580
POSTE DE MADERA TRATADA DE 11 m, CLASE 6 (EUCALIPTO NACIONAL)	U	530
POSTE DE MADERA TRATADA DE 11 m, CLASE 5 (EUCALIPTO NACIONAL)	U	550
POSTE DE MADERA TRATADA DE 9 m, CLASE 7 (EUCALIPTO NACIONAL)	U	340
POSTE DE MADERA TRATADA DE 9 m, CLASE 6 (EUCALIPTO NACIONAL)	U	360
POSTE DE MADERA TRATADA DE 12 m, CLASE 6 (EUCALIPTO IMPORTADO)	U	714
POSTE DE MADERA TRATADA DE 12 m, CLASE 5 (EUCALIPTO IMPORTADO)	U	774
POSTE DE MADERA TRATADA DE 11 m, CLASE 6 (EUCALIPTO IMPORTADO)	U	699
POSTE DE MADERA TRATADA DE 11 m, CLASE 5 (EUCALIPTO IMPORTADO)	U	734
POSTE DE MADERA TRATADA DE 9 m, CLASE 7 (EUCALIPTO IMPORTADO)	U	437
POSTE DE MADERA TRATADA DE 9 m, CLASE 6 (EUCALIPTO IMPORTADO)	U	238
POSTE DE MADERA TRATADA DE 12 m, CLASE 6 (PINO)	U	921
POSTE DE MADERA TRATADA DE 12 m, CLASE 5 (PINO)	U	1,132
POSTE DE MADERA TRATADA DE 11 m, CLASE 6 (PINO)	U	733
POSTE DE MADERA TRATADA DE 11 m, CLASE 5 (PINO)	U	850
POSTE DE MADERA TRATADA DE 9 m, CLASE 7 (PINO)	U	493
POSTE DE MADERA TRATADA DE 9 m, CLASE 6 (PINO)	U	574
POSTE DE CONCRETO		
POSTE DE CONCRETO ARMADO 13 / 200 / 165 / 360	U	593
POSTE DE CONCRETO ARMADO 13 / 300 / 165 / 360	U	671
POSTE DE CONCRETO ARMADO 13 / 400 / 165 / 360	U	775
POSTE DE CONCRETO ARMADO 12 / 200 / 165 / 360	U	502
POSTE DE CONCRETO ARMADO 12 / 300 / 165 / 360	U	585
POSTE DE CONCRETO ARMADO 11 / 200 / 165 / 360	U	408
POSTE DE CONCRETO ARMADO 11 / 300 / 165 / 360	U	479
POSTE DE CONCRETO ARMADO 10 / 200 / 165 / 360	U	354
POSTE DE CONCRETO ARMADO 9 / 200 / 165 / 360	U	281
POSTE DE CONCRETO ARMADO 9 / 300 / 150 / 360	U	338
CONDUCTOR DE ALEACION DE ALUMINIO		
CONDUCTOR DE ALEACION DE ALUMINIO DE 16 mm^2, POR FASE	km	574
CONDUCTOR DE ALEACION DE ALUMINIO DE 25 mm^2, POR FASE	km	1,356
CONDUCTOR DE ALEACION DE ALUMINIO DE 35 mm^2, POR FASE	km	1,866
CONDUCTOR DE ALEACION DE ALUMINIO DE 50 mm^2, POR FASE	km	2,648
CONDUCTOR DE ALEACION DE ALUMINIO DE 70 mm^2, POR FASE	km	3,669
CONDUCTOR DE ALEACION DE ALUMINIO DE 95 mm^2, POR FASE	km	5,295
CONDUCTOR DE ALEACION DE ALUMINIO DE 120 mm^2, POR FASE	km	6,603

Table I-4.5-9 Material Price for High Voltage Distribution (2)

Descripción de Partidas	Unidad	Precio
TRANSFORMADORES DE DISTRIBUCION		
CONDUCTOR DE COBRE RECOCIDO, CABLEADO, DE 16 mm^2, PARA PUESTA A TIERRA	U	3,927
CONDUCTOR DE COBRE RECOCIDO, CABLEADO, DE 25 mm^2, PARA PUESTA A TIERRA	U	6,217
CONDUCTOR DE COBRE RECOCIDO, CABLEADO, DE 35 mm^2, PARA PUESTA A TIERRA	U	8,634
CONDUCTOR DE COBRE DURO RECOCIDO, CABLEADO DESNUDO, DE 10 mm^2	U	2,424
CONDUCTOR DE COBRE DURO RECOCIDO, CABLEADO DESNUDO, DE 16 mm^2	U	3,834
TABLEROS DE DISTRIBUCION		
TRANSFORMADOR MONOFASICO DE 5 kVA; 7,62 / 0,46 - 0,23 kV, 4000 msnm	U	3,472
TRANSFORMADOR MONOFASICO DE 10 kVA; 7,62 / 0,46 - 0,23 kV, 4000 msnm	U	3,768
TRANSFORMADOR MONOFASICO DE 15 kVA; 7,62 / 0,46 - 0,23 kV, 4000 msnm	U	4,287
TRANSFORMADOR MONOFASICO DE 25 kVA; 7,62 / 0,46 - 0,23 kV, 4000 msnm	U	5,288
TRANSFORMADOR MONOFASICO DE 40 kVA; 7,62 / 0,46 - 0,23 kV, 4000 msnm	U	7,273
TRANSFORMADOR MONOFASICO DE 3 kVA; 13,2 / 0,46 - 0,23 kV	U	2,100
TRANSFORMADOR MONOFASICO DE 5 kVA; 13,2 / 0,46 - 0,23 kV	U	2,829
TRANSFORMADOR MONOFASICO DE 10 kVA; 13,2 / 0,46 - 0,23 kV	U	3,424
TRANSFORMADOR MONOFASICO DE 15 kVA; 13,2 / 0,46 - 0,23 kV	U	4,031
TRANSFORMADOR MONOFASICO DE 25 kVA; 13,2 / 0,46 - 0,23 kV	U	4,982
TRANSFORMADOR MONOFASICO DE 40 kVA; 13,2 / 0,46 - 0,23 kV	U	7,273
TRANSFORMADOR MONOFASICO DE 5 kVA; 23,0 / 0,46 - 0,23 kV	U	3,860
TRANSFORMADOR MONOFASICO DE 10 kVA; 23,0 / 0,46 - 0,23 kV	U	4,291
TRANSFORMADOR MONOFASICO DE 15 kVA; 23,0 / 0,46 - 0,23 kV	U	4,849
TRANSFORMADOR MONOFASICO DE 25 kVA; 23,0 / 0,46 - 0,23 kV	U	5,519
TRANSFORMADOR MONOFASICO DE 40 kVA; 23,0 / 0,46 - 0,23 kV	U	8,422
TRANSFORMADOR TRIFASICO DE 25 kVA; 23,0 / 0,40 - 0,23 kV	U	7,401
TRANSFORMADOR TRIFASICO DE 40 kVA; 23,0 / 0,40 - 0,23 kV	U	8,932
TRANSFORMADOR TRIFASICO DE 75 kVA; 23,0 / 0,40 - 0,23 kV	U	10,687
TRANSFORMADOR TRIFASICO DE 100 kVA; 23,0 / 0,40 - 0,23 kV	U	13,494
TRANSFORMADOR TRIFASICO DE 160 kVA; 23,0 / 0,40 - 0,23 kV	U	16,748
TRANSFORMADOR TRIFASICO DE 250 kVA; 23,0 / 0,40 - 0,23 kV	U	22,011
CONDUCTOR DE COBRE		
TABLERO DE DISTRIBUCION COMPLETA PARA S.E. MONOFASICA DE 3 kVA; 440-220 V	U	1,755
TABLERO DE DISTRIBUCION COMPLETA PARA S.E. MONOFASICA DE 5 kVA; 440-220 V	U	1,755
TABLERO DE DISTRIBUCION COMPLETA PARA S.E. MONOFASICA DE 10 kVA; 440-220 V	U	1,755
TABLERO DE DISTRIBUCION COMPLETA PARA S.E. MONOFASICA DE 15 kVA; 440-220 V	U	2,002
TABLERO DE DISTRIBUCION COMPLETA PARA S.E. MONOFASICA DE 25 kVA; 440-220 V	U	2,090
TABLERO DE DISTRIBUCION COMPLETA PARA S.E. MONOFASICA DE 40 kVA; 440-220 V	U	2,170
TABLERO DE DISTRIBUCION COMPLETA PARA S.E. TRIFASICA DE 40 kVA; 380/220 V	U	2,702
TABLERO DE DISTRIBUCION COMPLETA PARA S.E. TRIFASICA DE 75 kVA; 380/220 V	U	2,702
TABLERO DE DISTRIBUCION COMPLETA PARA S.E. TRIFASICA DE 100 kVA; 380/220 V	U	2,702
TABLERO DE DISTRIBUCION COMPLETA PARA S.E. TRIFASICA DE 160 kVA; 380/220 V	U	3,792
TABLERO DE DISTRIBUCION COMPLETA PARA S.E. TRIFASICA DE 250 kVA; 380/220 V	U	4,773

Table I-4.5-10 Material Price for Low Voltage Distribution

Descripción de Partidas	Unidad	Precio
POSTE DE MADERA		
POSTE DE MADERA DE TRATADA DE 8 m, CLASE 6 (EUCALIPTO NACIONAL)	U	364.38
POSTE DE MADERA DE TRATADA DE 8 m, CLASE 7 (EUCALIPTO NACIONAL)	U	338.43
POSTE DE MADERA DE TRATADA DE 8 m, CLASE 6 (EUCALIPTO IMPORTADO)	U	451.07
POSTE DE MADERA DE TRATADA DE 8 m, CLASE 7 (EUCALIPTO IMPORTADO)	U	414.98
POSTE DE C.A.C. 8/200	U	232.84
POSTE DE C.A.C. 8/300	U	267.39
POSTE DE C.A.C. 8/150	U	216.18
POSTE DE C.A.C. 9/200	U	283.86
POSTE DE C.A.C. 9/300	U	326.57
POSTE DE MADERA DE TRATADA DE 8 m, CLASE 6 (PINO)	U	440.24
POSTE DE MADERA DE TRATADA DE 8 m, CLASE 7 (PINO)	U	436.82
CABLES Y CONDUCTORES DE ALUMINIO		
CONDUCTOR AUTOPORTANTE DE ALUMINIO 3×35+16/25 mm^2	m	10.01
CONDUCTOR AUTOPORTANTE DE ALUMINIO 3×25+16/25 mm^2	m	8.31
CONDUCTOR AUTOPORTANTE DE ALUMINIO 3×16+16/25 mm^2	m	6.56
CONDUCTOR AUTOPORTANTE DE ALUMINIO 3×35/25 mm^2	m	8.85
CONDUCTOR AUTOPORTANTE DE ALUMINIO 3×25/25 mm^2	m	7.09
CONDUCTOR AUTOPORTANTE DE ALUMINIO 3×16/25 mm^2	m	5.38
CONDUCTOR AUTOPORTANTE DE ALUMINIO 2×35+16/25 mm^2	m	7.73
CONDUCTOR AUTOPORTANTE DE ALUMINIO 2×25+16/25 mm^2	m	6.54
CONDUCTOR AUTOPORTANTE DE ALUMINIO 2×16+16/25 mm^2	m	5.36
CONDUCTOR AUTOPORTANTE DE ALUMINIO 2×35/25 mm^2	m	6.49
CONDUCTOR AUTOPORTANTE DE ALUMINIO 2×25/25 mm^2	m	5.31
CONDUCTOR AUTOPORTANTE DE ALUMINIO 2×16/25 mm^2	m	4.1
CONDUCTOR AUTOPORTANTE DE ALUMINIO 1×16+16/25 mm^2	m	4.1
CONDUCTOR AUTOPORTANTE DE ALUMINIO 1×16/25 mm^2	m	2.93
CABLES Y CONDUCTORES DE COBRE		
CONDUCTOR DE Cu RECOCIDO, TIPO N2XY, BIPOLAR, 2×10 mm^2, CUBIERTA NEGRA	m	9.16
CONDUCTOR DE Cu RECOCIDO, TIPO N2XY, TRIPOLAR, 3×10 mm^2, CUBIERTA NEGRA	m	11.3
CONDUCTOR DE Cu RECOCIDO, TIPO N2XY, TETRAPOLAR, 4×10 mm^2, CUBIERTA NEGRA	m	14.32
CONDUCTOR DE Cu CONCENTRICO, 2×4 mm^2, CON AISLAMIENTO Y CUBIERTA DE PVC	m	2.67
CONDUCTOR DE Cu RECOCIDO, TIPO N2XY, BIPOLAR, 2×2,5 mm^2, CUBIERTA NEGRA	m	2.96
CONDUCTOR DE Cu RECOCIDO, CABLEADO, DESNUDO DE 16 mm^2	m	3.73
LUMINARIAS, LAMPARAS Y ACCESORIOS		
LUMINARIA COMPLETA CON EQUIPO PARA LAMPARA DE 50 W	U	202.5
LUMINARIA COMPLETA CON EQUIPO PARA LAMPARA DE 70 W	U	211.31
LUMINARIA COMPLETA CON EQUIPO PARA LAMPARA DE 150 W	U	220.11
LAMPARA DE VAPOR DE SODIO DE ALTA PRESION DE 50 W	U	25.52
LAMPARA DE VAPOR DE SODIO DE ALTA PRESION DE 70 W	U	27.12
LAMPARA DE VAPOR DE SODIO DE ALTA PRESION DE 150 W	U	82.94
CONEXIONES DOMICILIARIAS		
TUBO DE AºGº DE 19 mmØ×4,0 m, PROVISTO DE CODO	U	36.4
TUBO DE AºGº DE 19 mmØ×1,5 mm×2,40 m, PROVISTO DE CODO	U	10.77
TUBO DE AºGº STANDARD / REDONDO DE 19mm×1,5mm×2,5m, PROVISTO DE CODO	U	26.34
TUBO DE AºGº STANDARD / REDONDO DE 19mm×1,5mm×4,0m, PROVISTO DE CODO	U	42.92
TUBO DE AºGº STANDARD / REDONDO DE 38mm×1,5mm×4,0m, PROVISTO DE CODO	U	77.9
TUBO DE AºGº STANDARD / REDONDO DE 38mm×1,5mm×6,0m, PROVISTO DE CODO	U	85.72
TUBO DE AºGº STANDARD / REDONDO DE 38mm×1,5mm×2,5m, PROVISTO DE CODO	U	47.38
TUBO PLASTICO DE PVC SAP, DE 19 mmØ×3 m, CON CURVA PLASTICO DE 19mmØ×180°	U	6.45
TUBO PLASTICO DE PVC SAP, DE 19 mmØ×5 m, CON CURVA PLASTICO DE 19mmØ×180°	U	13.06

As shown above, various materials are used in the distribution construction work for high and low voltage. And construction cost varies depending on the scale of power demand of customers and their locations.

6. National Electrical Code

National Electrical Code is applicable to any types of electric power facilities in Peru. This code contains safe distance from conductors, grounding regulation, wind pressure load etc, to keep safety when the power facilities are installed. Then this code should be applied in and outside of Concession Area. Furthermore, installing power facilities should obey both environmental and protection of cultural property regulations.

7. Technical Standards (Compendio de Normas para Proyectos y Ejecucion de Obras en Sistemas de Distribucion y Sistemas de Utilizacion de Media Tension)

When power distribution lines are installed, technical standards for medium tension lines should be applied. The technical standards are rules compiled with the previously mentioned National Electrical Code and contain the design standards and the proper materials and method of work to secure the safety of electric power facilities. The ultimate goal is to reduce expenditures and improve efficiency by standardization and the introduction of appropriate techniques to carry out the work.

MEM encourages electrification enterprises in rural areas to adopt appropriate facilities conforming to technical standard different from urban areas.

8. Technical Standard in Urban Area

Electric power facilities in concession area should be constructed according to technical standard regulated by MEM/DGE mentioned above. As power company who has concession have supply responsibilities, they should follow this technical standard. Therefore all facilities in concession area follows the same specifications in urban areas.

9. Rural electrification technical standard

Whether on- or off- grid electrification methods, different technical standards in rural areas from those for Concession Areas are applied to Non-Concession Areas. The rural standards were published in 2003, and it allows rural specifications to build and maintain at low cost when compared with urban distribution facilities. In this way MEM/DGE are trying to ensure the economic feasibility of the rural projects

10. Quality of Electrical Services

MEM set up the power supply quality in Concession Areas in “TECHNICAL STANDARD ON QUALITY OF ELECTRICAL SERVICES”, which oblige the concession holders to the quality index as follows:

1) QUALITY OF PRODUCT: Voltage drop, Frequency, Flicker, Harmonic Wave

2) QUALITY OF SUPPLY: Interruptions (Planned and Unplanned Outage)

3) QUALITY OF SERVICE: Service and Obligation to the Client, Metering

4) QUALITY OF PUBLIC LIGHTING

The power qualities are checked by annual sampling survey and penalties are imposed on violators according to the technical standards mentioned before.

I-5 Situation of Rural Electrification by Renewable Energies

I-5.1 PV System

I-5.1.1 Solar Energy Potential

1. Solar Irradiation in Peru

“Solar Atlas of Peru” was developed by MEM/DPR(DEP) and SENAMHI (Servicio Nacional de Meteorología e Hidrología) in June 2003. The atlas was developed under the project of "Proyecto PER/98/G31: Electrificación Rural a Base de Energía Fotovoltáica en el Perú" financed by the Global Environment Facility **(**GEF), through the United Nations Development Program (UNDP). One of the important objectives for the development is to create basic database for rural electrification by PV power supply system. The irradiation atlas was developed based on the monthly and annual data from 1975 to 1990. The data were obtained from CIP (Centro Internacional de la Papa), which developed them by using estimation and interpolation techniques based in Physical process. The atlas includes information on solar irradiation (kWh/m^2/day) in average of annual and monthly at all regions. The atlas indicates high annual irradiation at mountain range around 5.5 to 6.5 kWh/m^2. And the irradiation of coastal region is 5.0 to 6.0 kWh/m^2 and that of Amazon region around 4.5 to 5.0 kWh/m^2. The solar irradiation atlas is shown below.

Fig. I-5.1.1-1 Solar Irradiation Atlas

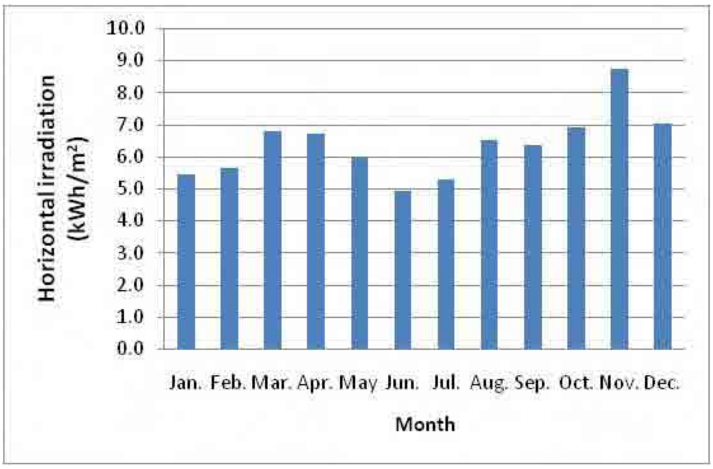
2. Solar Irradiation Data in Neighboring Countries

(1) Charaña, Bolivia

Charaña is a border town between Bolivia and Chile and 10 km to Tacna Region of Peru. In Charaña, wind monitoring was carried out by JICA Study Team on rural electrification by renewable energy from February 2000 to January 2001. Stand-alone wind monitoring system was installed to collect meteorological data of wind speed, wind direction, temperature, humidity, absolute pressure and horizontal solar irradiation.

The temperature in Charaña is low being located at 4,054 meters above sea level and near the high mountains of 6,000 meters. Annual average temperature was 5.1C° and minimum temperature was -18.4C° in July. There are two different seasons, dry and rainy seasons.

The result of solar irradiation monitoring shows that the irradiations are quite high through the year. Compared to the annual average of solar irradiation in Tokyo at 3.5 kWh/m^2, the annual average of Charaña is high at 6.3 kWh/m^2.



Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Horizontal irradiation (kWh/m^2)	5.4	5.6	6.8	6.7	6.0	4.9	5.3	6.5	6.3	6.9	8.7	7.0	6.3

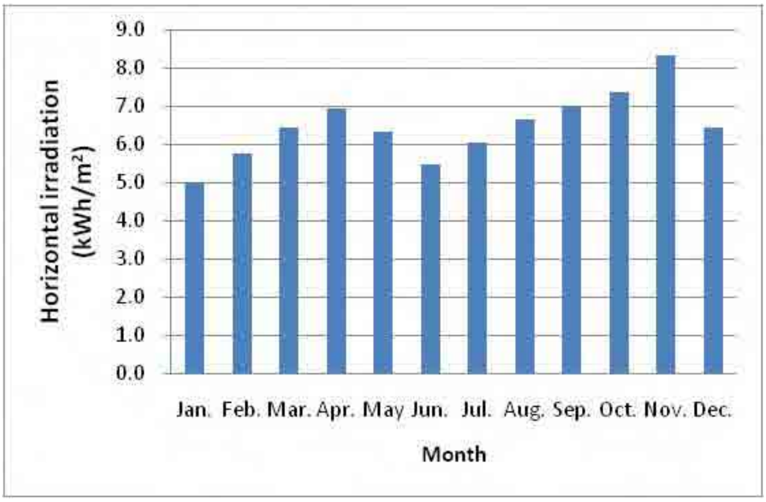
Fig. I-5.1.1-2 Monitoring Data of Solar Irradiation (Charaña, Bolivia)

(2) Isla Taquile, Bolivia

Isla Taquile is an island in Lake Titicaca and next to Puno Region of Peru. In Isla Taquile, monitoring of solar irradiation was carried out by JICA Study Team on rural electrification by renewable energy from February 2000 to January 2001.

The temperature in Isla Taquile is low being located at 3,919 meters. Annual average temperature was 9.4°C and minimum temperature was -0.9°C in July. There are two different seasons, dry and rainy seasons.

The result of solar irradiation monitoring shows that the irradiation is quite high through the year. The annual average of solar irradiation is high as same as that of Charaña at 6.5 kWh/m^2.



Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Horizontal irradiation (kWh/m^2)	5.0	5.7	6.4	6.9	6.3	5.5	6.0	6.6	7.0	7.4	8.3	6.4	6.5

Fig. I-5.1.1-3 Monitoring Data of Solar Irradiation (Isla Taquile, Bolivia)

I-5.1.2 Solar Power Projects in Peru

Solar power projects have been conducted mainly for SHS and systems for public facilities. Those projects are carried out by related governmental organizations and NGOs. Current situation of each system is explained below.

1. SHS (Solar Home System)

Most of electrification projects by SHS are carried out under MEM/DPR(DEP) and universities. MEM/DPR(DEP) has been working for UNDP project on rural electrification by PV system. In the project, 4,500 of SHS have been installed by the end of 2007. Power tariff is collected by "pay for service" method and the monthly power tariff is decided as 18 soles.

As for the project by university, CER-UNI (Centro de Energias Renovables, Universidad Nacional de Ingenieria) implemented a project for solar home system on Taquile island at Lake Titikaka in 1996. About 430 of SHS were installed on Taquile in this project. In the project, loan repayment method was selected. The total amount of repayment is US$750. In divided repayment, 5 times of US$150 within 3 years.

INADE, an organization under the Ministry of Agriculture has been carrying out PV project at the border to Colombia from 2001. INADE has installed SHS in 329 of households and 25 of health posts. The project is carried out by national donation, therefore power tariff has not been collected in the project.

2. BCS (Battery Charge Station)

At the community of Huancho Lima in Puno region, PV battery charging station and 30 solar home systems were installed. At the charging station, users pay a fee as US$0.80 for charging a battery. The payments were deposited into a bank account for spare parts and battery replacements in the future.

3. Rural School

Schools in rural communities are generally worse off than those located in urban areas. Huascaran program is a program under the MOE (Ministry of Education) and the objective is to improve educational services of rural schools. A large proportion of schools in the rural areas of Peru do not have access to basic services. In this program, PV power supply systems have been installed at rural schools. The generated power is being supplied not only for lighting but also communication radio, computer and audio-visual equipment for educational program. There are 3,050 schools in rural area of Peru and already at 34 schools PV systems are installed. Huascaran program has replaced batteries at 17 schools. Huascaran program replace the batteries every 6 years. Daily operation and maintenance is carried out by teacher or parents of students to whom O&M skills were transferred. The cost of PV system in the program is around US$30,000 including US$14,000 for battery. There is no power tariff collection system from schools because education is one of the important public services. Therefore, O&M including battery replacement are financed from budget of MOE. In MOE, around 15 staffs are working on Huascaran program and more than 100 people are working including operators at schools. There is no unified specification of PV system for rural schools. The conditions of rural schools are different such as number of students, demand of power and configuration of buildings..

4. Rural Health Post

Energy from solar is an abundant resource of renewable energy all over the Peru. Reliable electricity produced on site has proven capable of delivering high quality electricity for vaccine refrigeration, lighting and medical appliances. Also, radio and radiotelephone communications will greatly improve health care services at rural health clinics. Emergency medical treatment is greatly facilitated with reliable communications to other health clinics and facilities in the region.

ISF (Ingenieria sin Fronteras) is a Spanish NGO working on installation of PV system for rural health clinic with Universidad Politécnica de Madrid, PUCP(Universidad Católica de Perú), UPCH (Universidad Peruana Cayetano Heredia) and Ministry of Health. This program is called EHAS (Enlace Hispano Americano de Salud) and the objective is to improve access to medical information by installation of telecommunication system.

5. Communication

Peru began reforming its telecommunications sector in 1992, privatizing the state-owned telecommunications companies, establishing as the regulatory authority the OSIPTEL (Organismo

Supervisor de la Inversión Privada en Telecomunicaciones), and gradually opening the market to competition. The policies that OSIPTEL has implemented through FITEL (Fund of Investment in Telecommunications) are designed to reduce poverty and increase the well-being of the rural population. In 1995 a team from FITEL went to every district in the country and spoke with local stakeholders and authorities to determine which towns and villages the new network should cover. The discussion was organized in approximately 90 workshops to ensure the participation of main stakeholders and authorities.

FITEL program have implemented up to phase 4 and almost 7,000 of satellite phone system using PV system were installed. The beneficiaries from FITEL project is reported around 5.7 million people. In FITEL program, 400 systems supply electricity to not only telecommunication but also computer for internet service. Tariff for telecommunication are charged by mainly pre-paid card. For the some telecommunication system, the tariff is paid by coins instead of pre-paid card.

6. Industry

PV system for industrial purposes was installed under UNDP project at Vilcallama village, Chuncuito prefecture of Puno region at border to Bolivia in November 2007. Installed capacity of PV system is 2 kWp. The system supplies electricity to both rural school and industrial center. In the center, wools of alpaca and llama are collected by wool clipper to produce woolen yarn by distaff machine. After that process, sweater or blanket are made by handy machine to sell in market according to the plan.

7. Technical Standard on PV System

There are two technical standards on PV system as shown below.

- “REGLAMENTO TÉCNICO: ESPECIFICACIONES TÉCNICAS Y PROCEDIMIENTOS DE EVALUACIÓN DEL SISTEMA FOTOVOLTAICO Y SUS COMPONENTES PARA ELECTRIFICACIÓN RURAL” 2007.1
- “NORMA TÉCNICA PERUANA: SISTEMAS FOTOVOLTAICOS HASTA 500 Wp. Especificaciones técnicas y método para la calificación energética de un sistema fotovoltaico” 2006.2

There is no national certification system for PV components in Peru. Instead of that, testing of PV components for national projects are being carried out at testing facilities installed at CER-UNI and PUCP under UNDP project. On the basis of “Procedures of Measurement Domestic PV System” prepared by Polytechnic University of Madrid in Spain, PV components are being tested. The performance of PV panel, battery, light and controller are tested in the laboratories. The laboratory has been testing imported PV components to confirm the performance. In addition, the testing facilities are being used for lectures in University and testing requested by private sector.

I-5.2 Wind Power

I-5.2.1 Wind Power Potential

1. Wind Map in Peru

There is no reliable wind map available in Peru. The map shown below is prepared by MEM. The map indicates wind potentials in Peru. The map shows high wind potential in coastal area and low potential in Amazon area.

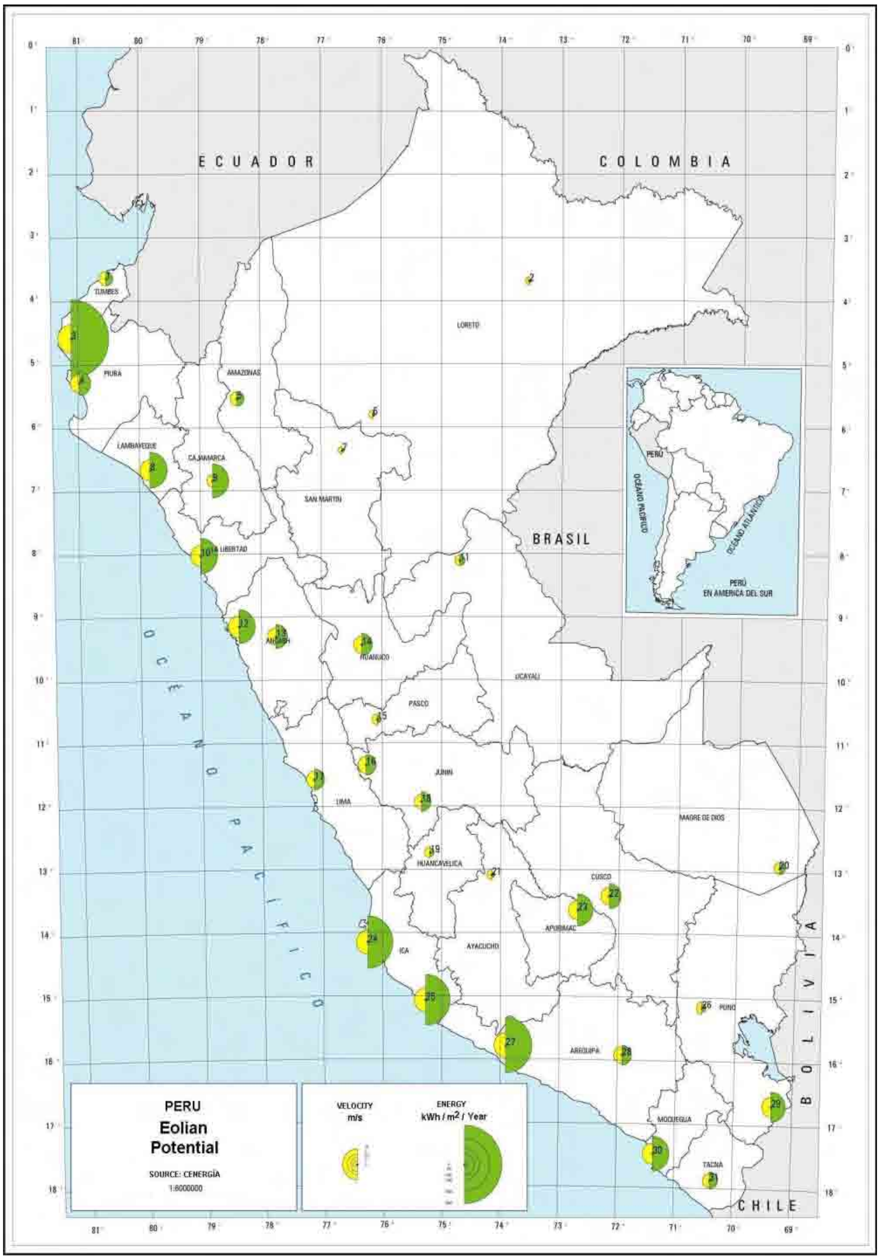


Fig. I-5.2.1-1 Wind Potential Map

2. Wind Data in Neighboring Countries

(1) Charaña, Bolivia

The monthly average wind speeds at 20 meters above ground level are shown below. The annual average wind speed at Charaña is 4.4 m/s. In Charaña, the monthly average wind speed from September to December is as high as 5.2 m/s, while the average monthly wind speed from January to August is as low as 3.9 m/s.

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Wind Speed (m/s)	3.5	4.1	4.0	3.5	3.6	4.2	4.3	4.3	5.1	4.9	5.7	5.2	4.4

Fig. I-5.2.1-2 Monthly Average Wind Speed (Charaña)

According to the diurnal wind pattern, the wind blows strong from 14:00 to 20:00 at 7.9 m/s in annual average. Considering wind pattern at Charaña, a hybrid generation system with other energy source is necessary for stable power supply. The following figure shows complementary relation between wind speed and solar irradiation in Charaña. The energy potential of solar is high from 9:00 to 15:00 when the wind speed is still low, while the wind speed is high from 14:00 to 20:00 when the solar irradiation is weak. Therefore, it is effective to use wind and PV combined in a hybrid system to obtain stable energy supply.

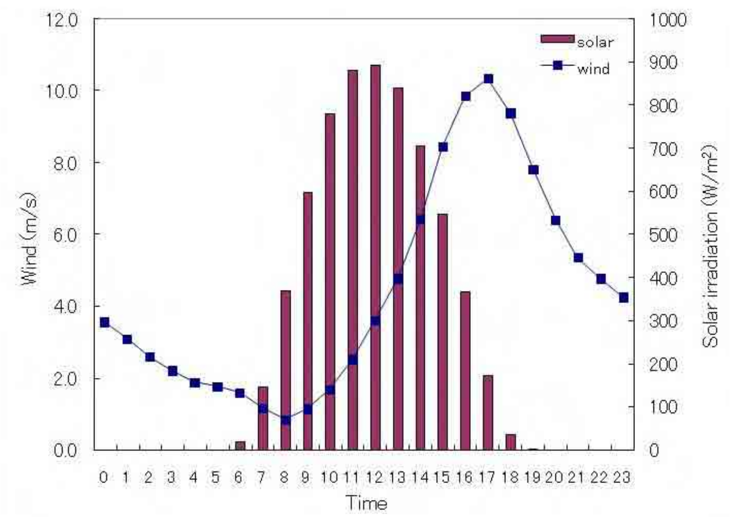


Fig. I-5.2.1-3 Diurnal Wind Speed vs. Solar Radiation at Charaña

(2) Isla Taquile, Bolivia

The monthly average wind speeds at 20 meters above ground level are shown below. The annual average wind speed at Isla Taquile is 2.9 m/s. In Isla Taquile, the monthly average wind speed is small through the year. There is no enough wind potential for power generation in this region.

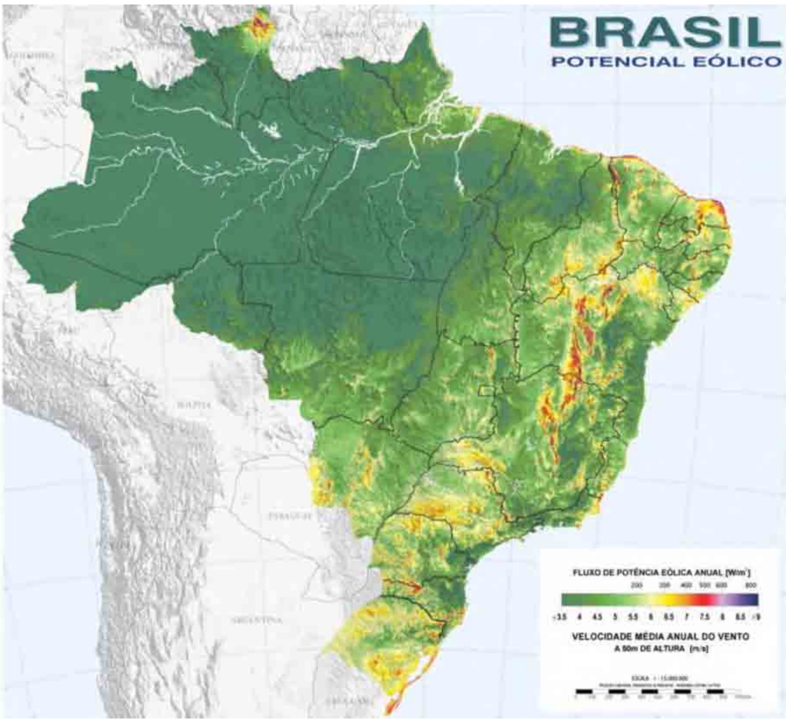
Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Wind Speed (m/s)	3.2	3.2	2.7	2.7	2.5	2.5	2.7	2.9	2.8	3.3	3.3	3.4	2.9

Fig. I-5.2.1-4 Monthly Average Wind Speed (Isla Taquile)

(3) Brazil

In Brazil, a wind map was developed through SWERA (Solar and Wind Energy Resource Assessment) project. The SWERA project is an international project financed by GEF/UNEP.

Brazil has a border with Peru, in the regions of Ucayali and Madre de Dios. The Brazilian wind map shows small wind potential at the border of both regions. The average wind speed of this area is around 3.5 to 4.5 m/s at 50 meters above ground level. This wind speed is too small to generate electricity by a wind turbine.



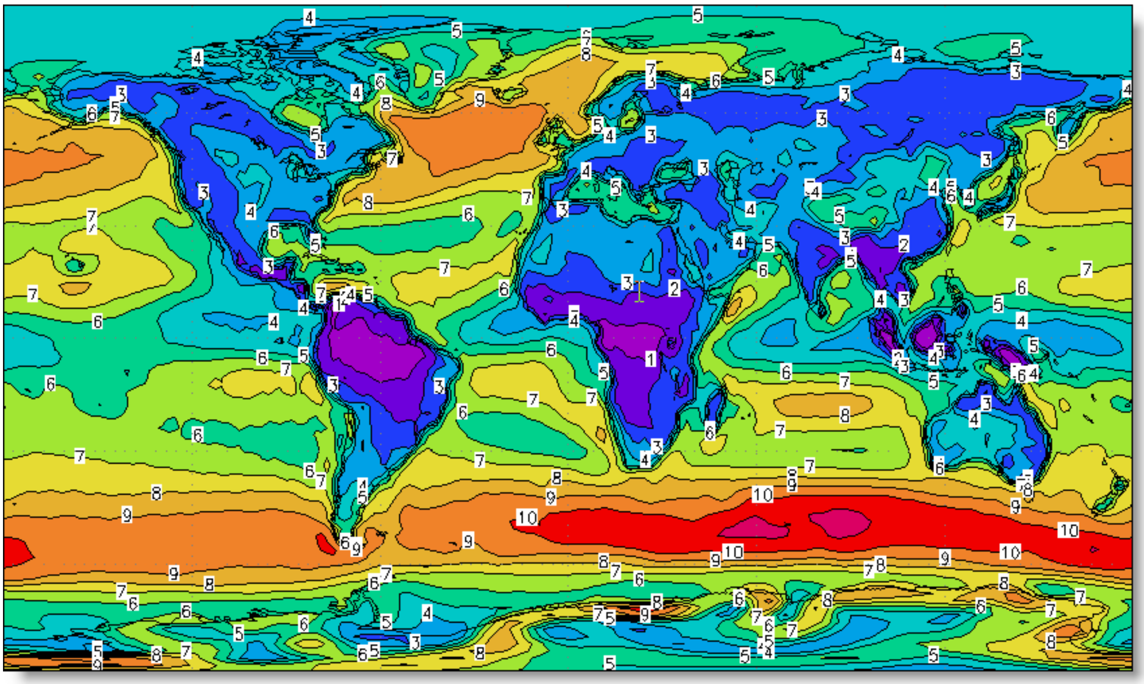
Source: SWERA

Fig. I-5.2.1-5 Wind Map of the Brazil

3. World Wind Atlas

The world wind atlas was developed by Risø National Laboratory in Denmark. The map shows the mean wind speed (m/s) at 10 m above ground level. The map was developed based on the data re-analyzed by NCEP/NCAR for the period of 1976-1995.

For wind resource assessment, more detailed and reliable data are required. However, the map indicates wind potential of the world roughly. According to the world wind map, wind potential is strong at off-shore of Peru, while it is weak at inland. In the coastal area of Peru, average wind is indicated as around 5 to 6 m/s at 10 meters above ground level. This wind speed is enough for generating electricity by a wind turbine.



Source: Risø National Laboratory

Fig. I-5.2.1-6 Wind Map of the World

I-5.2.2 Wind Power Projects in Peru

MEM/DPR(DEP) has carried out UNDP Project PER/94/028 “Non-Conventional Energy” funded by the Government from 1994. In this project, grid-connected wind turbine with the capacity of 250 kW was installed in Malabrigo at April 1996. MEM/DPR(DEP) has installed 450 kW wind turbine by UNDP special procurement project. The 450 kW wind generator was installed in Marcona, Ica, and has been operating by 1998. Both of the wind turbines are being operated by ADINELSA.

I-5.3 Mini/Micro Hydropower Potential

I-5.3.1 Current Status

The status of rural electrification by mini/micro hydropower are as follows at the beginning of this study.

The target villages for rural electrification by mini/micro hydropower will be generally selected from the sites which will not be covered by grid extension and where there exists hydropower potential nearby. However, it was difficult to identify exactly a location of non-electrified village throughout the country because some rural electrification projects are being implemented by the local level and the local governments do not inform the central government (MEM/DPR) about project information. For this reason, the study team could not receive any answer and also encountered the situations that hydropower station had already started to construct or finished when the study team went to the project sites.

The central government including MEM/DPR, the local governments, NGO and private companies are involved in rural electrification by mini/micro hydropower in Peru as shown in Fig. I-5.3.1-1. The local governments that have ample funds will develop mini/micro hydropower in their own right in some cases. However, the local governments often do not actively provide the central government (MEM/DPR) with information about project planning and construction.

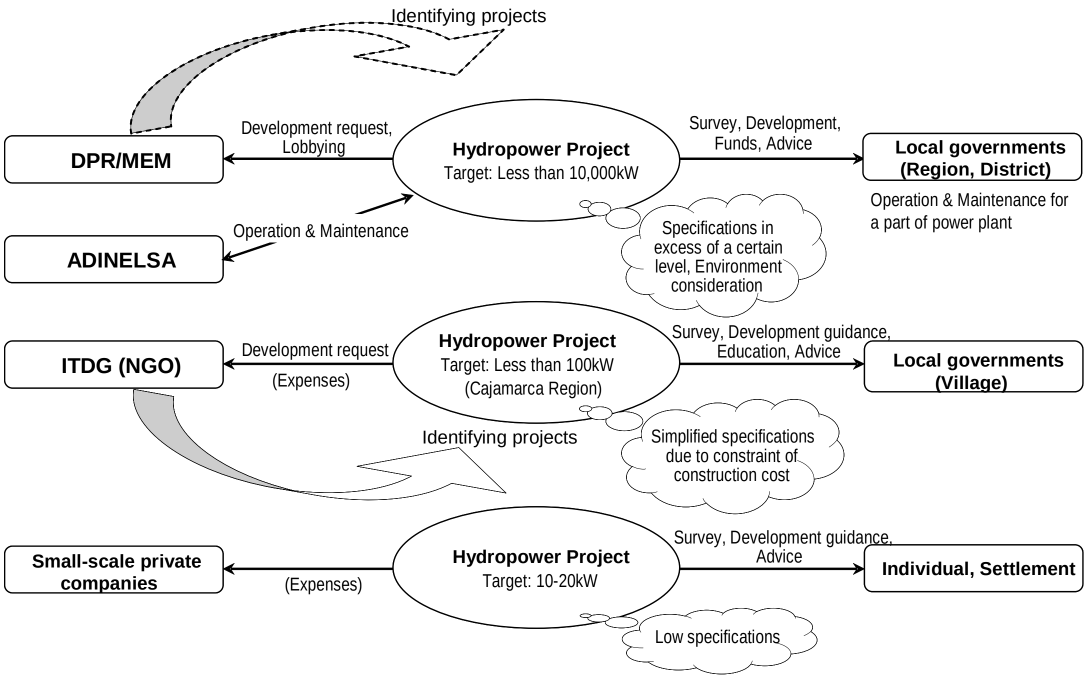


Fig. I-5.3.1-1 Responsible Organizations for Mini/micro Hydropower

Although it is absolutely imperative that a river discharge, topography and access road condition should be actually confirmed in judgment of hydropower project feasibility, a bottom-up approach shall be adopted because of availability of concrete information regarding hydro potential at a local level in the identifying stage of mini/micro hydropower potentials. Consequently, the methods shown below will be applicable as a bottom-up approach.

- Implementation of questionnaire and interview survey continually
- Utilization of geographical information system (GIS) developed by MEM/DPR

GIS has reached practical use in latter half of this study so it can be expected to make active use in the future.

On the other hand, in the rural electrification plan drawn up by MEM/DPR (PNER: Plan Nacional de Electrificación) a development plan is shown with capacity, beneficiary population and investment cost year by year. In PNER 2005-2014 (hereinafter referred to as “PNER 2005”), a development plan for mini/micro hydropower is shown for 9 years (year 2005-2013) and in PNER 2006-2015 (Draft) (hereinafter referred to as “PNER 2006”) it is also shown for 9 years (year 2006-2014) (refer to Table I-5.3.1-2, Table I-5.3.1-3 and Fig. I-5.3.1-2).

Although the number of projects that are specifically described in the above are 23 but all of them are not owned by MEM/DPR, a part of project belongs to the local governments and a power distribution company. In addition, its state of implementation as of 2008 is shown in Table I-5.3.1-1. From this, the number of completion and under construction projects are 12 but the number of under study and discontinuation projects are 8, therefore, these projects are not necessarily executed smoothly.

Table I-5.3.1-1 State of Implementation on Mini/Micro Hydropower Projects

Status / Responsible Organization	Completion (Operation)	Under Construction	Under Study	Abort	Total
MEM/DPR	1 (ADINERSA)	4	0	0	5
MEM/DPR and Local Government	0	0	1	0	1
Local Government	5	2	1	6	14
Total	6	6	2	6	20
Distribution Company	3 (Unconfirmed)				23

In addition, as above, both PNER 2005 and 2006 do not mention any specific sites after 2009, instead they only show planned value of 600 kW/year. So from now the detailed plan should be drawn up as soon as possible.

Table I-5.3.1-2 Plan for Small Hydropower by MEM/DPR (Year 2005-2013)

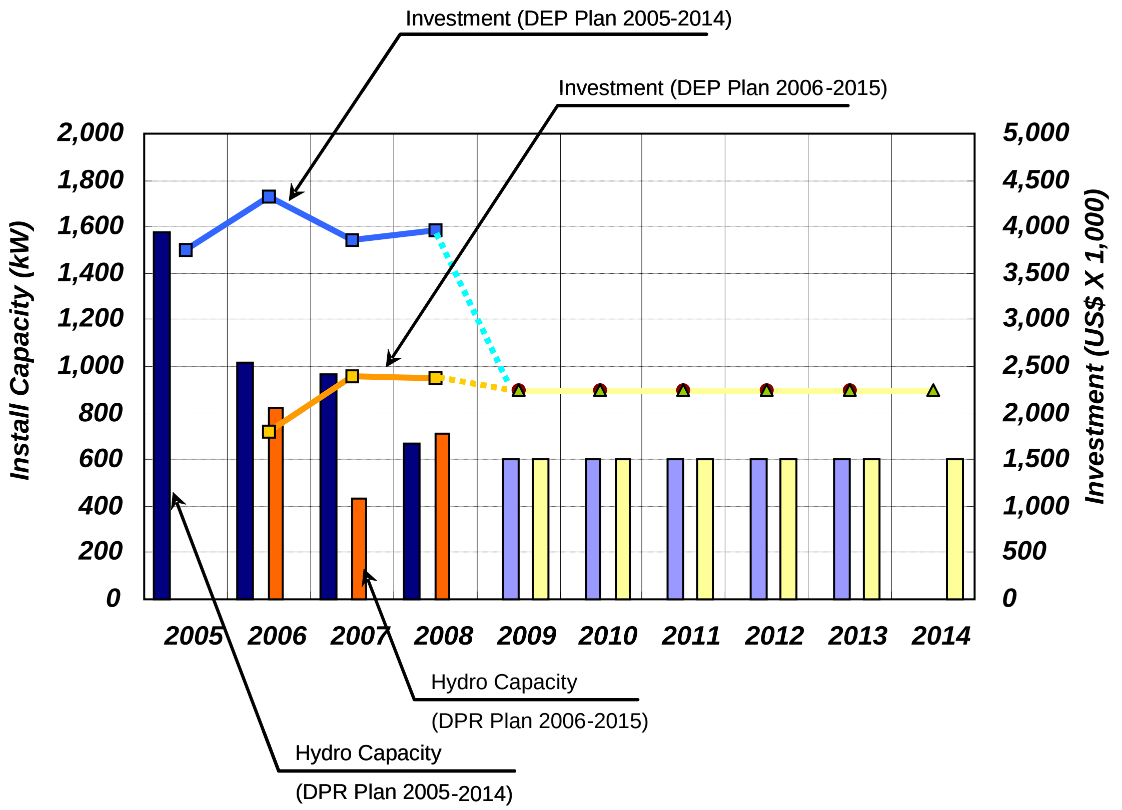
No	Year	Name of Project	Region	Province	District	Potential (kW)	Beneficiary Population	Investment US$×1,000
1	2005	CH CONTANGE (AMPLIACION)	CAJAMARCA	-	-	467	0	845
2	2005	CH VERSALLES (AMPLIACION)	CUSCO	-	-	586	0	495
3	2005	CH SICACATE (AMPLIACION)	PIURA	-	-	210	0	79
4	2005	CH OMIA	AMAZONAS	RODORIGUEZ DE MENDOZA		100	1,702	804
5	2005	CH SALLIQUE	CAJAMARCA	JAEN		120	2,285	951
6	2005	CH LANCHEMA	CAJAMARCA	JAEN		90	1,645	577
		SUB TOTAL Year 2005				**1,573**	**5,632**	**3,751**
7	2006	CH NUEVO SEASME II ETAPA	AMAZONAS	CONDORCAN QUI	NIEVA	206	0	988
8	2006	CH CHALLUAYACU	AMAZONAS	RODRIGUEZ DE MENDOZA	LIMABAMNA	100	850	305
9	2006	CH CATILLUC II ETAPA	CAJAMARCA	SAN MIGUEL	CATILLUC	75	1,552	269
10	2006	CH URUMBA I ETAPA	CAJAMARCA	SAN IGNACIO	TABACONAS	90	3,180	962
11	2006	CH BELLA LUZ	LIMA	OYON	OYON	274	0	309
12	2006	CH PUQUIANQUI I ETAPA	LIMA	HUAURA	LEONCIO PRADO	40	828	170
13	2006	CH SHINTUYA	MADRE DE DIOS	MANU	MANU	234	2,421	1,310
		SUB TOTAL Year 2006				**1,019**	**8,831**	**4,313**
14	2007	CH SEPAHUA I ETAPA	UCAYALI	ATALAYA	SEPAHUA	60	1,241	455
15	2007	CH CHALLUAYACU II ETAPA	AMAZONAS	RODRIGUEZ DE MENDOZA	LIMABAMNA	90	845	295
16	2007	CH COCHALAN	CAJAMARCA	JAEN	SAN JOSE DEL ALT	75	1,552	359
17	2007	CH CALABOZO	CAJAMARCA	SAN IGNACIO	SAN JOSE DE LOL	100	4,136	929
18	2007	CH PUQUIANQUI II ETAPA	LIMA	HUAURA	LEONCIO PRADO	60	1,241	229
19	2007	CH PIZQUIA	AMAZONAS	LUYA	PISQUIA	70	1,448	240
20	2007	CH PẼNA BLANCA	CAJAMARCA	SAN IGNACIO	-	59	1,221	275
21	2007	CH CONTAMANA	LORETO	UCAYALI	CONTAMAN A	400	8,276	702
22	2007	CH SINA	PUNO	SAN ANTONIO DE PUTINA	SINA	50	828	378
		SUB TOTAL Year 2007				**964**	**20,788**	**3,862**
23	2008	TBD				50	2,069	575
24	2008	TBD				80	1,665	375
25	2008	TBD				100	2,069	399
26	2008	TBD				35	724	325
27	2008	TBD				100	2,843	1,427
28	2008	TBD				158	2,427	854
		SUB TOTAL Year 2008				**673**	**11,787**	**3,955**
29	2009	TBD				600	12,412	2,238
		SUB TOTAL Year 2009				**600**	**12,412**	**2,238**
30	2010	TBD				600	12,412	2,238
		SUB TOTAL Year 2010				**600**	**12,412**	**2,238**
31	2011	TBD				600	12,412	2,238
		SUB TOTAL Year 2011				**600**	**12,412**	**2,238**
32	2012	TBD				600	12,412	2,238
		SUB TOTAL Year 2012				**600**	**12,412**	**2,238**
33	2013	TBD				600	12,412	2,238
		SUB TOTAL Year 2013				**600**	**12,412**	**2,238**
		TOTAL				**7,229**	**109,106**	**27,071**

Source: PNER 2005-2014 by MEM/DPR

Table I-5.3.1-3 Plan for Small Hydropower by MEM/DPR (Year 2006-2014)

No	Year	Name of Project	Region	Province	District	Potential (kW)	Beneficiary Population	Investment US$×1,000
1	2006	CH OMIA	AMAZONAS	RODRIGUEZ DE MENDOZA	OMIA	100	1,160	842
2	2006	CH SALLIQUE	CAJAMARCA	JAEN	SALLIQUE	120	2,285	951
3	2006	CH LANCHEMA	CAJAMARCA	JAEN	POMAHUACA	90	0*	0*
4	2006	CH CHALLUAYACU	AMAZONAS	RODRIGUEZ DE MENDOZA	LIMABAMNA	100	0*	0*
5	2006	CH CATILLUC II ETAPA	CAJAMARCA	SAN MIGUEL	CATILLUC	75	0*	0*
6	2006	CH SEPAHUA I ETAPA	UCAYALI	ATALAYA	SEPAHUA	60	0*	0*
7	2006	CH BELLA LUZ	LIMA	OYON	OYON	274	0*	0*
		SUB TOTAL Year 2006				**819**	**3,445**	**1,793**
8	2007	CH SAN CAYETANO (PIZQUIA)	AMAZONAS	LUYA	PISQUIA	70	2,982	954
9	2007	CH PẼNA BLANCA	CAJAMARCA	JAEN	SAN JOSE DEL ALT	59	2,056	514
10	2007	CH CONCHAN	CAJAMARCA	CHOTA	CONCHAN	100	2,110	925
11	2007	CH NUEVO SEASME II ETAPA	AMAZONAS	CONDORCANQUI	NIEVA	206	0*	0*
		SUB TOTAL Year 2007				**435**	**7,148**	**2,393**
12	2008	CH SHINTUYA	MADRE DE DIOS	MANU	MANU	234	2,421	1,310
13	2008	CH COCHALAN	CAJAMARCA	JAEN	SAN JOSE DEL ALT	75	1,552	359
14	2008	CH CONTAMANA	LORETO	UCAYALI	CONTAMANA	400	8,276	702
		SUB TOTAL Year 2008				**709**	**12,249**	**2,371**
15	2009	TBD				600	12,412	2,238
		SUB TOTAL Year 2009				**600**	**12,412**	**2,238**
16	2010	TBD				600	12,412	2,238
		SUB TOTAL Year 2010				**600**	**12,412**	**2,238**
17	2011	TBD				600	12,412	2,238
		SUB TOTAL Year 2011				**600**	**12,412**	**2,238**
18	2012	TBD				600	12,412	2,238
		SUB TOTAL Year 2012				**600**	**12,412**	**2,238**
19	2013	TBD				600	12,412	2,238
		SUB TOTAL Year 2013				**600**	**12,412**	**2,238**
20	2014	TBD				600	12,412	2,238
		SUB TOTAL Year 2014				**600**	**12,412**	**2,238**
		TOTAL				**5,563**	**97,322**	**19,985**

Source: PNER 2006-2015 by MEM/DPR



Source: PNER by MEM/DPR

Fig. I-5.3.1-2 Plan for Small Hydropower by MEM/DPR (PNER 2005-2014/2006-2015)

I-5.3.2 Hydropower Potential

Hydropower potential is generally defined by river discharge and head. The mountain area where there are several thousand mountains and turbulent rivers in Peru has an abundance of hydropower potential. On the other hand, in Amazon and Coastal area, hydropower potential is smaller than that of the mountain area, because the gradient of rivers in the latter area is gentle as compared with mountain side (refer to Fig. I-5.3.2-1). Actually, many promising hydropower plants have been developed in the mountain area so far. The hydropower capacity in Peru occupies about 70% of total generating capacity (5,700 MW) in Peru as of 2003.

In the case of mini/micro hydropower, if evaluation factors are only river discharge and head, its potential distribution will be promising in the mountain area like a medium and large hydropower. However, if the range of capacity of mini/micro hydropower that are covered in this study is set from several dozen to 500 kW approximately, its potential will not necessarily correspond to potential of medium and large hydropower. Because mini/micro hydropower potential is sometimes feasible with a head ranging from several to several dozen meters, and it will be necessary for location of power stations to be near to demand sites (village) due to adoption of independent mini-grid, taking reduction of the construction cost for distribution lines into consideration. Some hydropower potential may exist in the existing facilities such as irrigation canal. Therefore, active use should be made of irrigation canal as promising hydropower potential, including use of irrigation canal as water conduit for power generation.

For this reason, in the discussion and identification of mini/micro hydropower potential, study needs to focus not only on river discharge and head governed by topography and climate and other natural conditions but also on local view point such as distance relation between the construction site determined by natural condition and neighboring villages and the existing infrastructures as well as supply and demand, etc.

1. Grasping Status of Hydropower Potentials

Grasping hydropower potentials is an important factor to select development sites regardless of generating capacity. However, from the result of the questionnaire that MEM/DPR(DEP) sent out to each regional government and the status of the rural electrification plan (PNER), MEM/DPR(DEP) has not totally figured out mini/micro hydropower potentials at the beginning of this study. The reason for this can be considered as below.

- Unavailability of fundamental data
  An isohyetal map and specific flow map is useful for grasping hydropower potentials. But these data have not been available so far.
- Problems of collecting data and channel of information
  As mentioned above, information of existing infrastructures and development requests in possible sites should be actively used with climate and topographical features. Therefore, a channel of information from possible sites to MEM/DPR should be established and a capacity building for local governments and residents is necessary.

2. Grasping Method of Mini/Micro Hydropower Potentials

There are two following methods to grasp hydropower potentials in the planning stage. In this study, both methods will be adopted fundamentally.

- Method by map study (use of topographical map)
- Method on the basis of request from residents (Bottom-up system)

The former is a method to assess a possibility for development by confirming river, head and existing villages, using a topographical map (scale: 1/50,000-1/100,000). In this method, it is important to estimate an amount of river discharges; therefore an isohyetal and specific flow map should be prepared. However, in the case of no data like the above, those necessary data must be prepared by site survey. On the contrary, the latter is a method to estimate river discharge, head and demand by residents in possible sites.

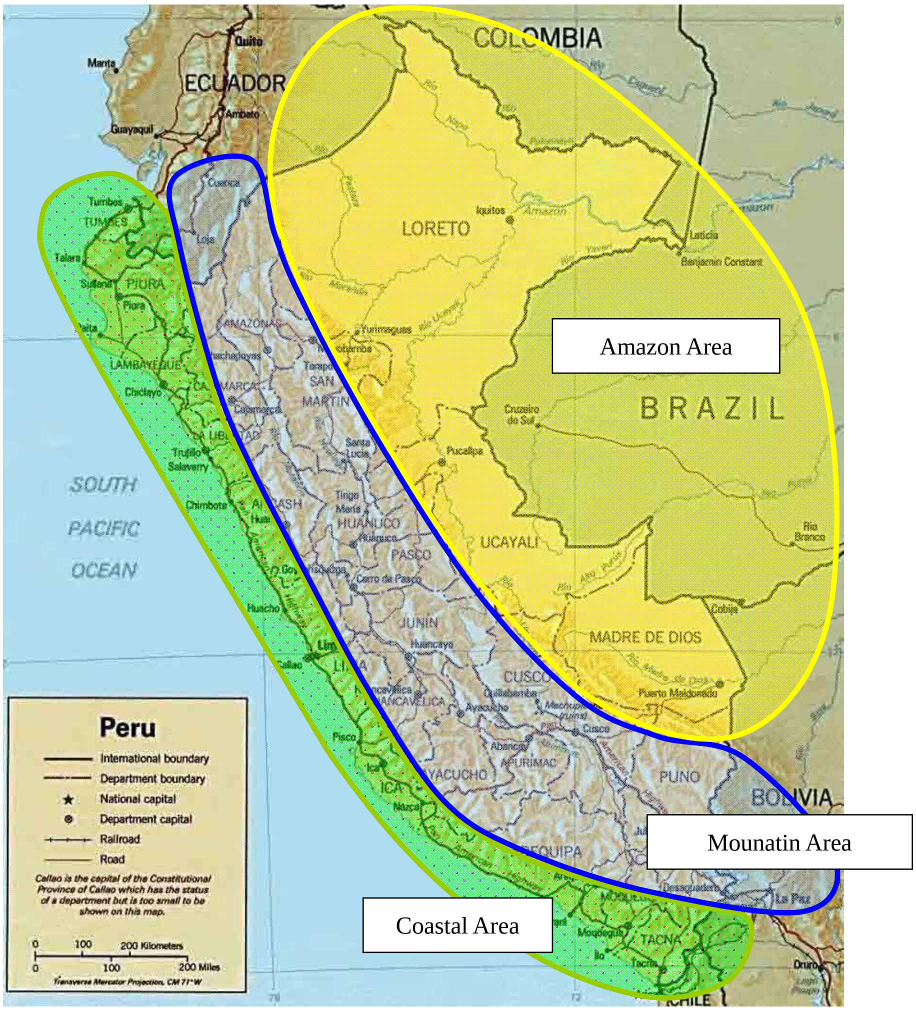


Fig. I-5.3.2-1　Distribution of Hydropower Potentials

3.　Mini/micro Hydropower Potentials in the Master Plan

Grasping mini/micro hydropower projects was carried out by investigation for existing project and desk study using GIS by MEM/DPR. From the results, identified candidate projects for mini/micro hydropower are 29 sites including the Pre-FS sites (2 sites) as of the end of March, 2008 as shown in Fig. I-5.3.2-1. The mini/micro hydropower sites with less than 100 kW are 25 sites among 29 projects, and regarding the 4 remaining sites, the hydropower sites with more than 200 kW are 3 sites and with more than 500 kW is 1 site. The beneficiary population by these projects will be 519 villages, about 92,000 people (18,498 households × 5 persons/households) and the total installed capacity will be 2,655 kW. In addition, Santa Catalina is planning the installed capacity with 620 kW, so this project will be regarded as a target for environment impact assessment required for development of more than 500 kW.

Table I-5.3.2-1 List of Mini/Micro Projects

	Project Name	Location: Region	Location: Province	Location: District	Beneficiary: Number of Villages	Beneficiary: Number of Households	Installed Capacity (kW)	Discharge (m^3/s)	Head (m)	Length of Primary Lines (km)
1	P.C.H Cachiyacu	Amazonas	Condorcanqui	Santa María de Nieva	17	358	50	0.064	110.00	77.78
2	P.C.H Palcapampa	Arequipa	Caylloma	Syballo	3	166	25	0.035	110.00	42.81
3	P.C.H La Majada	Cajamarca	San Miguel	Calquis	11	420	60	0.085	100.00	29.76
4	P.C.H Quebrada Honda		San Miguel	San Silvestre de Cochán	5	194	30	0.050	100.00	11.50
5	P.C.H Yerba Buena		Cajamarca	Encañada	12	535	80	0.112	125.00	23.67
6	P.C.H Quellouno	Cusco	La Convención	Quellouno	11	198	30	0.020	250.00	26.00
7	P.C.H Sarapampa		La Convención	Vilcabamba	13	426	60	0.090	100.00	28.10
8	P.C.H Yanama		La Convención	Santa Teresa	8	206	30	0.050	100.00	32.60
9	P.C.H Cayay	Huanuco	Huacaybamba	Cochabamba	18	405	60	0.120	70.00	35.30
10	P.C.H Chontabamba		Pachitea	Panao	13	447	65	0.090	110.00	53.00
11	P.C.H Quechuarpata		Dos de mayo	Marías	83	1,432	200	0.260	110.00	68.73
12	P.C.H Lomo Largo	Ica	Ica	San José de Los Molinos	9	142	20	0.030	100.00	22.50
13	P.C.H Poyeni	Junin	Satipo	Río Tambo	8	375	50	0.070	105.00	43.63
14	P.C.H Saureni		Satipo	Mazamari	11	426	60	0.090	100.00	61.60
15	P.C.H Shima		Satipo	Río Tambo	17	561	75	0.130	90.00	105.20
16	P.C.H Huaraday	La Libertad	Viru	Chao	16	534	75	0.060	165.00	57.46
17	P.C.H Marachanca	Lima	Huarochiri	Matucana	10	107	15	0.045	50.00	10.80
18	P.C.H Quiula		Huarochirí	Laraos	6	569	100	0.201	80.00	10.80
19	P.C.H Aichiyacu	Loreto	Alto Amazonas	Barranca	10	190	30	0.085	50.00	68.80
20	P.C.H Balsapuerto		Alto Amazonas	Balsapuerto	14	487	80	0.090	125.00	37.17
21	P.C.H San Antonio		Alto Amazonas	Balsapuerto	37	1,420	200	0.200	150.00	137.70
22	P.C.H Santa Catalina		Ucayali	Sarayacu	43	4,422	620	1.300	110.00	225.70
23	P.C.H Challapampa	Puno	Carabaya	Corani	22	308	45	0.060	110.00	68.31
24	P.C.H Huari Huari		Sandia	Limbani	22	715	100	0.093	110.00	86.44
25	P.C.H Porotongo	San Martin	Huallaga/Omia	Alto Saposoa	12	329	50	0.133	52.00	32.47
26	P.C.H Selecachi		Mariscal Caceres	Huicungo	14	214	30	0.045	100.00	16.40
27	P.C.H Quebrada Tahunia	Ucayali	Atalaya	Tahuanía	14	386	55	0.070	110.00	62.00
28	P.C.H Rio Iparia		Coronel Portillo	Iparia	40	1,948	280	0.770	50.00	217.73
29	P.C.H Shinipo		Atalaya	Raymondi	20	578	80	0.220	50.00	50.80
				Total	**519**	**18,498**	**2,655**			

(Highlighted rows 5 and 20:) Pre-FS site

I-6 Donors' Trend

Japan Bank for International Cooperation (JBIC) has been examining the possibility of extending credit for Electric Frontier Extension Project III (PAFE-III), to implement rural electrification for 34 projects of grid extension. In this project, it is contemplated to electrify 1,785 villages with 372,000 people in three regions (Huánuco, Cajamarca and Loreto) with less electrification rate, with a total investment cost of some US$96M.

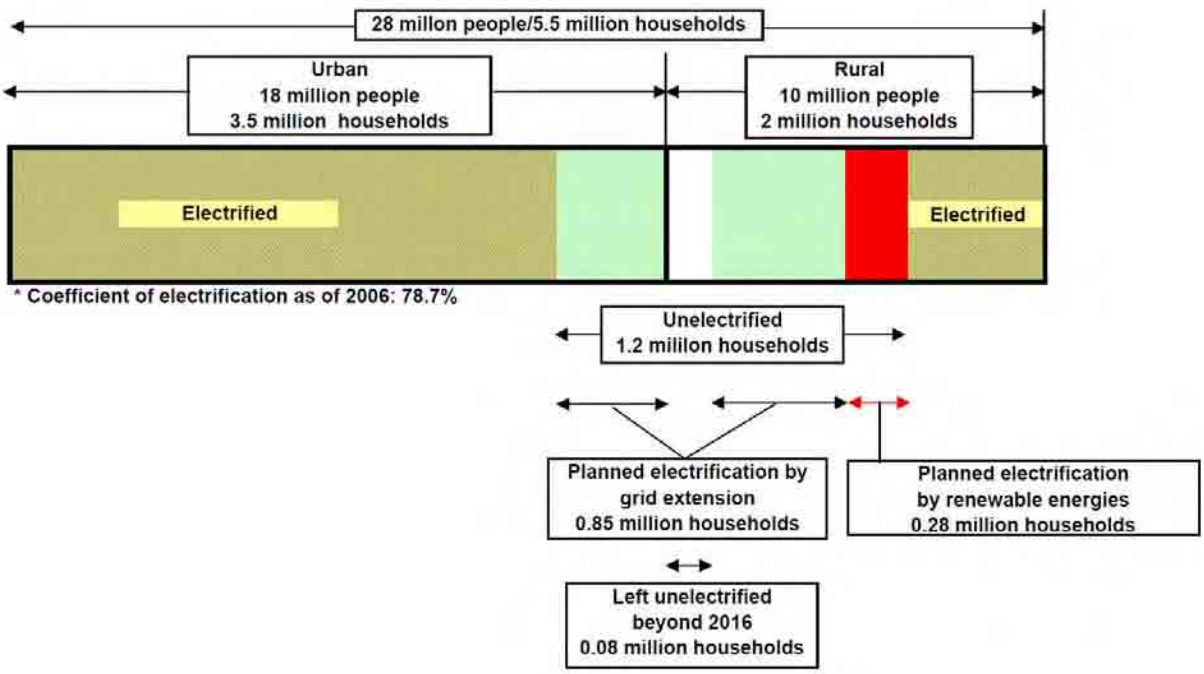
Inter-American Development Bank (IDB) has also shown interest in electrification by grid extension.

On the other hand, as to the renewable energy, the Eurosolar Project was started in January 2007, based on the agreement between MEM and the European Community. This project will bring about benefits to 50,000 peoples in 130 villages, by installing 130 sets of solar panel and wind power facilities during period 2007 to 2011. Total project budget is estimated as 30,244,800 Euros, out of which 24,000,000 Euro will be donated by European Union.

I-7 Problems in Execution and Diffusion of Rural Electrification by Renewable Energies

I-7.1 Necesity for Master Plan

The actual situation and plan of electrification is broadly as shown in the diagram below: some 1 million households are to be electrified, of which some 280 thousand households by renewable energies.



The government of Peru aims to raise the coefficient of national electrification to 93.1% by 2015, by electrification including the above households, which can be interpreted that it aims at universal services of power supply at national level. To that effect, the following policies have been taken:

- Power supply by National Interconnected System
  - Plays a central role in power supply, promoting foreign investment and private sector participation and adopting concession system in the sectors of hydropower generation and transmission/distribution.
  - In order to improve the coefficient of electrification, cross subsidy regime called “FOSE” is introduced for the whole power industry operating under the National Interconnected System to subsidize power tariff for consumers with small demand.
- Grid extension to outside of concession areas of concessionaire distribution companies by use of FONER fund
  - In order to promote electrification in areas difficult of grid extension in terms of business management, subsidize initial costs by means of FONER established with financial assistance from World Bank/GEF

- The subsidy is capped at US$800/connection and competitive bidding system is introduced in such a form that those bidders offering projects with less amount of subsidy required are granted subsidy.
- The minimum number of connections is 1,000 and financial/economic efficiency is given great importance, which can lead to think that remote areas with small dispersed households, distant from existing grid and with small demand, are left out of the target of electrification.

➢ Grid extension by MEM/DPR according to PNER (Plan Nacional de Electrificación Rural:)

- The government bear initial investments, transferring electrification systems and entrusting administration to concessionaire distribution companies or ADINELSA in order to electrify those areas which do not allow for electrification even with subsidy such as FONER in terms of business management.
- One of the criteria is the cost of grid extension, that is, US$1,000/connection; those areas requiring over that amount of investment are left out of the target of electrification.
- Included are PAFE I & II under yen credit and at the time of preparation of this Report PAFE III in the pipeline to loan.

Electrification in such areas as are difficult to be covered by the above three electrification strategies is one of the issues to be dealt with in this Master Plan.

➢ SPERAR(**S**oluciones **P**eruanas a **E**lectrificación **R**ural en las **A**reas Aisladas y de Frontera con Energías **R**enovables): electrification by renewable energy

- SPERAR of the Master Plan will cover those remote areas not covered by the above three strategies of electrification, which have small power demand due to poverty and where households are scattered in wide area.
- As for those areas electrification cannot be justified by financial/economic/social efficiency, so that it is necessary to give political priority or social preference.

  As for the number of target villages and household to be electrified by renewable energy, the II-1.6.2 will describe them.

The policy position and main features of each strategy for electrification are summarized in the diagrams below.

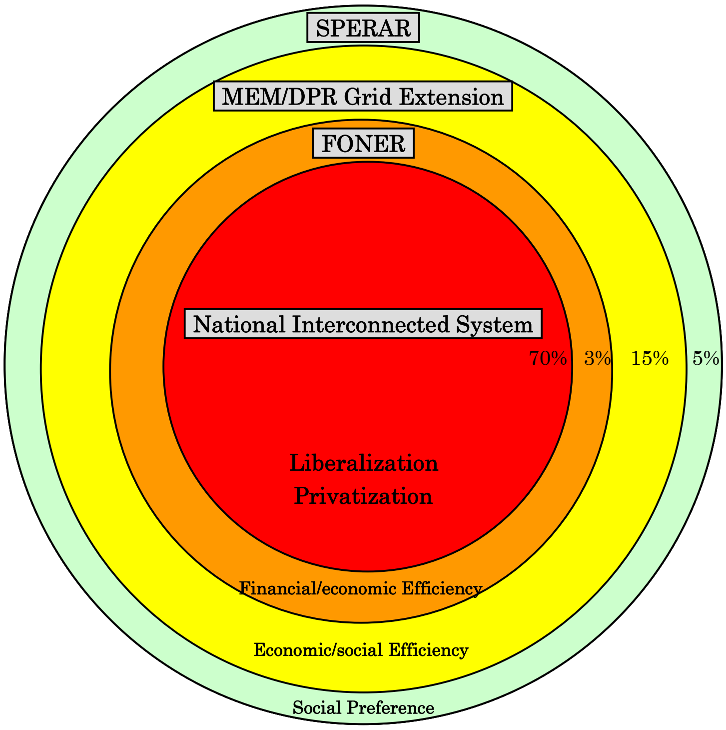


Fig. I-7.1-1 Hierarchical Strategy for Universal Services of Power Supply

Table I-7.1-1 Strategies for Electrification in Peru

	Principle	Initiative	Tactics	Customers	Coefficient
National Interconnected System	• Liberalization • Privatization	• Private sector • Concessionaire distribution companies • OSINERGMIN	• Concession • Free/regulated markets • FOSE	Within concession areas	70%
FONER	• Financial/ economic efficiency	• Concessionaire distribution companies	• Competitive bidding for least subsidy • Grid extension	Outside of concession areas	3%
MEM/DPR	• Economic/ social efficiency	• MEM/DPR	• Grid extension • Transfer to Concessionaire distribution companies or ADINELSA for operation	Outside of concession areas	15%
SPERAR (DPR)	• Social preference	• DPR • Local governments • Rural communities • Local micro enterprises	• Use of renewable energy • Bottom-up approach • Network for training and maintenance	Marginalized inhabitants	5%

* Figures in column “Coefficient” show approximate target coefficients of electrification.
* The coefficient of SPERAR is calculated with about 300,000 households to be electrified by renewable energies shown in the list of non-electrified villages provided by MEM/DPR in February 2008.
* The coefficient of grid extension by MEM/DPR is calculated from the target number of households about 800,000 based on the above list.
* The coefficient of grid extension by FONER is calculated with 150,000 households as target number of households for electrification.
* The coefficient of the National Interconnected System is adjusted in such a way that the total coefficient arrives at 93%, the target coefficient as of 2015.

I-7.2 Organization

The issues of organizational aspect are the lack of sustainable organizational system, information supporting system, and low capability of stakeholders.

The main responsible organization centered is Direccion de Proyectos (DPR) for the implementation of renewable energy electrification, and DPR is policy planning organization as well as implementing agency. However, DPR has to handle not only renewable energy but also all rural electrification issues, although it has no branches or local offices. Not many staff members are fulltime staff for renewable energy. Therefore, it has a capacity to make holistic evaluation and decision, but it does not always have sufficient ability to grasp the existing situation of remote places and plan which households to be covered actually and implement renewable energy projects. On the other hand, as the municipalities and local governments that have CANON have no need to rely on the central government, they make electrification by themselves, consequently the updated information on where exactly electrification has been done is not always sent to the central government periodically.

The more remote are the areas targeted, the less feasibility will be the electrification with the extension of existing grids, and thereby electrification with renewable energy resources is expected. However, such areas are scattered around across the country, and with the lack of adequate, updated, and precise information, DPR cannot grasp exactly in detail where to be electrified with the renewable energy, or it might obtain the needs, but it is impossible for DPR, being located only in capital, to make plans by themselves for every single household with renewable energy electrification system. Therefore, to realize the plans, regional governments or municipalities must undertake actual planning and implementation of the projects and cooperate with the central government. However, good exchange of information or cooperation among DPR, regional governments and municipalities are not well constructed and implemented.

At the planning stage, all the electrification projects financed by the central government should be within the PNER (Plan Nacional de Electrificacion Rural), which is a central government principle. However, this PNER is not actually elaborated alone. In fact, this PNER is based on PRER (Plan Regional de Electrificacion Rural), which is elaborated by the regional governments. And this PRER is supposed to be elaborated on the basis of PLER (Plan Local de Electrificacion Rural), and this PLER is ideally has to be formulated by the districts initiative. However, PLER has not been elaborated actually, and instead, Meza de Concertacion or hearings are alternatively done, since districts have no capability of elaboration of projects.

However, in the case of PAFE project, which is financed by Japanese Yen Loan, the central government plans, decides, and implements the plan. For operation and maintenance, ADINELSA is the main responsible agency.

In the case of renewable energy, as can be seen in the case of UNDP-GEF Project, one way of doing could be that DPR makes a basic plan and the supplier makes detail plans and install them on a full-turn-key basis (llave en mano) with full package type contract. In order to implement electrification of thousands of households scattered around in remote areas in a certain short period, such type may be necessary from the view point of massive installation of equipment. However, for suppliers, as support and maintenance of the SHS installed at various locations is costly, the suppliers have low incentive to undertake maintenance activities. Therefore, this UNDP-GEF implementation method is not the only alternative. From the viewpoint of operation and maintenance, it is rather expected to take a kind of participatory approach that the villagers operate and maintain by themselves. Yet such participatory approach cannot be expected, since people have no such capability of planning a feasible project. Regional governments are recently created, and not much experience in leading the implementation of plans they have.

As for electrification with renewable energy, the operational conditions of some of the projects implemented are recognized regarding their performance but the others are not. In those projects which are not recognized, it is supposed that the renewable energy equipment and system are simply distributed and given, and even in those which are recognized, there are some places where the performance of the projects is periodically recognized whereas others are only occasionally recognized.

Namely, it is difficult to say that periodic monitoring or follow-up are done, and updated information on whether the equipment are adequately operated is not always obtained. In other words, a situation exists where it is difficult to say that adequate monitoring system in order to support villagers after installation of equipment has been established thoroughly and firmly.

In addition, by introducing a system without establishing proper operation and maintenance system, there are some cases that equipment are utilized improperly and their product life is shortened, or power is supplied for only a shorter period than expected.

For instance, the solar panels and batteries should be connected through controller. But on the cloudy days it is not easy to recharge through controller, or the controller malfunctions if the batteries are located steadily and recharging difficulty comes out. In such cases people start connecting panels and batteries directly. In a very short run, with such mal-modification the daily operating hours could be longer and powerful brightness could be obtained. However, the batteries will be overcharged and overused, and consequently the product life of 3 to 5 years is shortened to be less than one year in the worst cases.

In other cases, due to lack of appropriate information, for replacement, users obtained short-life batteries by purchasing second-hand batteries because of the price, and with such short-life batteries users become more discontented and unhappy with the SHS and finally stopped undertaking the maintenance resulting in collapse of the entire electrification system.

The central government cannot intervene directly with local inhabitants under decentralization policy. Therefore, the organization which functions intermediately is lacking. In other words, a supporting system for introduction of renewable energy is lacking. It is a problem that there is no specific organization which serves fulltime to undertake the responsibility of the implementation at the central government level. In addition, it is necessary to establish intermediate organizations between the central government and local people in order to assist districts, municipalities and people for the planning and implementation, maintenance of renewable energy. Regional governments could assume such role, but as regional governments are recently created and they do not have much experience in energy sector implementation, other organizations could be considered. Such kind of supporting system that also provides intellectual information is necessary to be established; and improvement of policy formulation, planning and implementation of specific projects as well as improvement of sustainability of the projects are necessary .

In Peruvian system, all the government-financed projects must pass SNIP and be approved. In this renewable energy case, it is expected that the project as overall will be applied to SNIP with the DPR's initiative. However, each project must also pass SNIP in principle. However, in this case, it is unclear whether DPR will undertake all the necessary actions to obtain approval of every single project. If DPR has to do that, it will be difficult for DPR since DPR has not enough staff to be engaged in such procedure. Lack of fulltime staff for renewable energy, or lack of full time organization specifically handling the renewable energy will be the bottleneck.

The characteristics of renewable energy are that the power source is scattered, each source volume is small, and it has to be handled locally. Consequently, the power supply system will be different from traditional system with thermal power plant, or hydropower system of larger scale. In addition, since the areas which the renewable energy system is to be applied are basically located in remote places where access is not easy, self sustainability is required. In such circumstance, management by ordinary power supply companies is very costly, so involvement of residents and users is indispensable. Resident and users themselves must handle the operation and maintenance of the system. However, without any training, it is impossible for them to undertake such role. Training should be provided to the residents, users and maybe to the municipal staff, so that they will be able to know how to plan, how to operate and maintenance the system in order to execute the planning and implementation of the renewable system. Nevertheless, no countrywide systematic training system is available.

In addition, if people should bear the cost of replacement, they have to save money in long term to purchase the replacement, and saving mechanism is necessary in remote areas. Some specific mechanism should be created in order to save money specifically for the sustainability of the system. Training is necessary in order to set up such mechanism. The supporting system mentioned above should also assume such a role.

Provision of spare parts is another issue. Standard PV system requires replacement of battery every 2 to 3 years if normal battery is used. According to DPR, the installed places with GEF, no provision of spare parts is made. The users do not know the necessity of replacing batteries. Some areas are so remote that it is not easy to access periodically. However, such places are the most needed places for utilization of renewable energy. Therefore, supporting system is necessary so that the users can access so that they can understand and take action for sustaining the renewable energy system. Sustainability of the renewable energy relies on such backstopping supporting system.

To start from scratch requires tremendous effort and work. However, it is not the case in renewable energy in Peru. Universidad Nacional de Ingenieria (UNI) has a center for renewable energy (CER) and provides training. Also an NGO has already established training centers and has established sustainable renewable energy system. Only issue is that such a system is not widely recognized in the central government, and it is still nothing but a NGO's work. This could be a model for the Peruvian government in organizational aspect. However, there is neither effort nor aptitude for application of such system in the government.

I-7.3 Finance

1. Financial Sources

Development of a small hydro power plant requires a sizable sum of money. IDB and IBRD/GEF has contributed funding, however, the availability is limited to a certain period. At this moment, there is no fund available. Therefore, it is necessary to consider the source of funding.

2. CANON

The amount Canon distribution depends on the market price of natural resources and resource can be developed economically only for a limited period. This makes it difficult to rely on as a stable financial resources in the future.

The amount Canon distribution depends on the market price of natural resources and such resources can be developed economically only for a limited period. This makes it difficult to rely on as a stable financial resources in the future.

3. Electricity Tariff

Operation and maintenance cost is to be principally provided by the electricity tariff borne by the users. The level of the tariff may not necessarily correspond to that affordable by most of the users in the target village for electrification. Therefore, in order to promote further electrification of households, it is indispensable to apply certain measures to decrease tariff level to attract people with less income.

I-7.4 Technical Issues of Solar Energy

1. Used Battery Treatment

For the dissemination of the PV system, it is necessary to consider the establishment of used battery collection, treatment and recycle system to prevent environmental impact. As for the used battery in industrial section, solid waste treatment companies approved by the government are in charge of collection and treatment. The government issues the certification of the treatment. However, the treatment for used car battery is not carried out in appropriate method. According to DIGESA of Ministry of Health, only four companies fulfill the environmental standard of solid waste treatment, which means the capacity will not meet future need of treatment. If the treatment business is found profitable, more companies will be supposed to enter into this market.

Many used battery are treated by illegal process of treatment. The JICA study team observed that, in the illegal process, companies do not implement appropriate management of dilute sulfuric acid contained in the battery: they only diluted the acid in drum, discharged or flushed it into toilet. As legal framework for battery treatment (regulation on battery) has not been established yet, Ministry of Production (or MEM) shall give administrative direction to them.

Also, working condition of lead extraction factories was observed inappropriate: labourers work in the dust of sulfur and lead. There is a fear of air pollution caused by dust as the number of used batteries increases.

2. Decrease of Power Tariff for User

There are many people who cannot install PV system under UNDP/GEF because the monthly power tariff is not affordable. It is important to introduce power supply system with lower power tariff setting such as BCS.

3. Improvement of Technical Standards and Others

In Peru, technical standards for PV component with installed capacity over 500 Wp are not prepared. Therefore, technical standards for rural public facilities such as rural school or health clinic does not exist. Solar irradiation map is already prepared but there are no irradiation data by monitoring at ground level. And also wind map is being prepared but wind monitoring at ground level has not been carried out. That kind of data is necessary for estimation of power output. In the projects, performance test of imported PV components are carried out for the purpose of quality control. However, quality control activity such as putting certification mark on certified PV components has not been carried out in the market base.

I-7.5 Technical Issues of Mini/Micro Hydropower

1. Identification of Mini/Micro Hydro Potentials and Selection of Candidate Sites

The grasping mini/micro hydro potentials and selection work of detailed candidate sites are necessary to implement and promote rural electrification by mini/micro hydropower. It is important for confirmation of its feasibility to consolidate fundamental data, for example, the information of candidate sites to MEM/DPR. In particular, a feasibility of small hydro depends on river discharge; therefore, its feasibility should be studied firstly using isohyetal map or specific flow map. These data are being prepared in Peru and will be completed by FONER, etc. after from 6 to 12 months. These also should be made in consideration of applying it to identification of small hydropower. In addition, in the stage that data like the above is not prepared, river discharge data must be collected continually by site survey.

2. Design Criteria

Mini/micro hydropower stations less than 500 kW have not been developed by unified technical criteria or standards. Concretely speaking, in the case that MEM/DPR confirms a design of small hydropower that is studied by a local government (subcontracted from a local government to a local consultant), MEM/DPR sometimes find some functional defect on design drawings. This means that mini/micro hydropower stations developed by a local government may have some troubles after construction. It may be necessary that experiences and technical level of local consultants and governments should be improved and that unified technical standards should be prepared regarding mini/micro hydropower designs in order to solve those problems. In addition, in the case that a small hydropower developed with the corporation between a private and local government (an example case of NGO; ITDG), if a private organization has many experiences, there will be no problems on technical matters but there may happen differences between MEM/DPR and private organization regarding aspects of environment matters (environmental conservation).

I-7.6 Technical Issues of Transmission/Distribution Lines

Increase of Unit Cost of Electrification and Barrier against Rural Electrification Guideline

The unit cost for grid extension in those isolated areas that do not allow economically feasible grid extension is predicted to increase because the target area will be more and more isolated from existing grids. And electrification plan will be delayed because of lack of budget.

Though the rural electrification guideline should be modified from the existing technical standard for concession areas, it is still under discussion and has not been disseminated nationwide. Therefore, over-specified materials and standards are still applied in rural areas. And simplifying materials have not yet been promoted and new standards of power equipments especially for rural areas have not yet been created.

I-8 Situation and Issues of Socio-economic and Gender Aspects

I-8.1 General

I-8.1.1 Rural Electrification and Socio-economic and Gender Aspects

1. Importance of Grasping the Actual Situation

Inhabitants living in such remote area as electrification by renewable energy is implemented are generally on a lower income, at lower education level, and sometimes live in a traditional way of life including low gender equality. Because sustainable use of electricity is the overall goal of the electrification project, it is assumed that certain conditions shall be imposed on electrification projects by renewable energy to be implemented in remote area in order that the users of electricity could make use of it most conveniently. For achieving this goal, it is indispensable for rural electrification especially by renewable energy to understand user's living conditions by interview and to make plans according to them at the beginning of the project planning. The subjects of this investigation shall comprise main income sources, affordable amount of payment for electricity, intention of electrification, social relationship/social structure and gender issues in concerned community.

In this master plan study, community survey was executed in Pre-FS sites and neighboring non-electrified and electrified communities to obtain information relating to the use and impact of electricity, expectation of electricity as well as their socio-economic and gender conditions.

It must be noted that the sites of the survey were not chosen by statistical means but by recommendation of MEM and accessibility. Thus, the result does not represent rural communities statistically.

The general situation of rural communities in Peru is as described in the Section I-2, while the general situation of gender issues in Peru is described as follows.

2. The Situation of Gender Issues in Peru

(1) Gender Profile in Peru

The gender-related development index (GDI) of Peru is estimated at 0.759 in 2006, which is placed at the 67th of 136 countries that UNDP estimated GDI. Comparing with Latin America and Caribbean countries and lower middle income countries (Peru is one of those countries), female's literacy rate, both of adult and youth, is lower than other countries. Basic gender-related indicators in Peru are shown in Table I-8.1.1-1.

Table I-8.1.1-1 Basic Gender-related Indicators in Peru and Other Countries

Item	Peru 2004		Latin America and Caribbean countries 2004		Lower middle income countries 2004	
	Male	Female	Male	Female	Male	Female
Population ratio	50.3	49.7	49.4	50.6	50.6	49.4
Life expectancy at birth (years)	68	73	69	75	68	73
Adult literacy rate (% of people aged 15+)	93.5	82.1	91.0	89.5	93.3	85.9
Labor force (% of total labor force)	58	42	60	40	58	42
Unemployment rate – female		11.9		11.8		n.d.
Net primary school enrollment rate	100	100	n.d.	n.d.	n.d.	n.d.
Primary completion rates (% of relevant age group)	100	99	96	97	98	96
Youth literacy Rate (% of people aged 15-24)	97.8	95.7	96.3	97.0	97.7	96.6

Source: World Bank Database of Gender Statistics

(2) Policies of Gender Consideration in Development Projects in Peru

The basic legal background of gender consideration is the Law No 29083 "Law on Equal Opportunities between Women and Men (*Ley de Igualdad de Oportunidades entre Mujeres y Hombres*)" promulgated on 15 March 2007.

The principles of the law are:

1) The present law is based on the fundamental principles of equality, respect for the freedom, dignity, security, human life as well as the recognition of the character pluri-cultural and multilingual of the Peruvian nation (Art. 3.1).

2) The State encourages the equality of opportunities between women and men in consideration of (a) recognition of gender equality, (b) prevailing the integrated conception of human rights, (c) respect to the pluri-cultural, multilingual and multiethnic reality, and (d) recognition and respect to people of all generation with disabilities, or other kind of groups affected by discrimination (Art. 3.2).

The law prescribes the roles of the state, the legislature, administration and regional and local governments, judiciary and autonomous constitutional organisms. In short, government organizations have to guarantee equal participation and equal benefit of women and men from their activities. This means that, in electricity field, MEM as executing organization of electrification, is obliged to implement activities to guarantee them.

Direction General of Ministry of women and social development (*Directora general del ministerio de la mujer y desarrollo social*) who are in charge of gender main stream in Peru started to discuss gender mainstreaming but, according to them, MEM has not participated in it at the time of interview

(October 2007). The ministry said that they did not have a compiled data concerning gender issues and they did not have policies or guidelines of gender consideration in development projects including energy field. The outline of the roles of government organization is shown in Box I-8.1-1.

Box I-8.1-1 Law No 29083 (promulgated 15 March 2007)

Law on Equal Opportunities between Women and Men
(*Ley de Igualdad de Oportunidades entre Mujeres y Hombres*)

Roles of administration, regional and local governments (Article 6)

The executive council, regional governments and local governments, adopt political plans and programs integrating the principles of the present law in Gender Mainstreaming. Hereby, some guidelines are given:

a) To Promote and guarantee the complete and effective participation of women and men in the consolidation of the democratic system,
b) To guarantee the participation and development of mechanisms for the execution of policies of equal opportunities between women and men,
c) To develop policies, plans and programs for the prevention, attention and elimination of the violence in all their forms and in all the spaces, especially the one exercised against women,
d) To promote the accessibility to productive, financial, scientific-technological resources and loans for the production and land regularization particularly for women in situation of poverty,
e) To promote the economic, social and political participation of rural women as well as, their integration in the decision of the community, associations, organizations of production and others; guaranteeing their accessibility to a fair remuneration, compensations, labor benefits and social security,
f) To guarantee the right to a productive work exercised under conditions of freedom, equality, security and human dignity,
g) To promote the formalization of the workers of the informal economy in the urban and rural areas,
h) To guarantee non discriminatory treatment to the workers of the home (ex. maids),
i) To guarantee the right to the health,
j) To guarantee that the programs of health give integral covering to the population in situation of extreme poverty and poverty without discrimination according to Law, especially where there is high illness risks and maternity.
k) To guarantee the public education access and permanency in all the stages of the educational system under conditions of equality between women and men,
l) To promote the full and equal development of children, and teenagers, assuring them an integral sexual education with scientific quality and ethics,
m) To improve the official statistic system adding data of gender, geographical area, race, ethnos, disabilities and age.

I-8.1.2 Community Survey

In this master plan study, community survey(hereinafter referred to as the ‘survey’) was executed by the JICA study team and a contracted Peruvian company from August to October 2007 in the communities of Pre-Fs sites and non-electrified communities and electrified communities both being near to the Pre-Fs sites. The objective of the community survey is to collect basic social and economic information and data in several electrified and non-electrified communities in order to grasp actual social and economic conditions, energy use as well as gender issue of both electrified and non-electrified communities and the impact of electrification in electrified communities.

The compiled result of the survey in Pre-FS sites is shown in the chapter of Volume 2: 2 Sites of PV system and 2 sites of mini/micro hydropower.

Table I-8.1.2-1 shows the name, location and so on, of the eleven surveyed communities.

Table I-8.1.2-1 Communities of Survey Object

Electricity/ electricidad	Region/ departamento	Province/ provincia	District/ distrito	Community/ localidad	Number of cases	Pre-FS site
Nonelectrified community	Cajamarca	Cajamarca	Magdalena	Callatpampa	45	
	Cajamarca	Cajamarca	Encañada	Yerba Buena Grande	9	○
	Loreto	Alto Amazonas	Balsapuerto	Canoa Puerto	52	○
	Loreto	Maynas	Punchana	Centro Fuerte	43	
	Loreto	Maynas	Iquitos	Tarapoto	45	○
	Puno	Melgar	Antauta	Tulani	27	
	Puno	Melgar	Antauta	San Juan	48	○
			Total		**269**	
Electrified community	Cajamarca	San Miguel	Catilluc	Catilluc	55	
	Loreto	Alto Amazonas	Balsapuerto	Balsapuerto	53	○
	Loreto	Maynas	Fernando Lores	Gran Perú	40	
	Puno	Puno	Amantaní	Isla de Taquile	56	
			Total		**204**	

Source: JICA study team 2008

I-8.1.3 Social and Economic Condition of the Surveyed Community

Though these communities do not statistically represent rural communities of Peru, they show different ecology and subsistence types of high plateau (non agricultural but pastoral area), hilly area lower than the high plateau (agricultural and pastoral area), deep forest area at the foot of mountains (tropical forest products), and low and riverine land (tropical products). Also, the inhabitants belong to different ethnic group and under different cultural condition.

<Non-Electrified Community>

- Callatpampa is a community in a hilly area near to Cajamarca City. Its main income source is vegetable production but, according to inhabitants, they consume almost all products for their self consumption.

- Yerba Buena Grande is one of the Pre-FS sites of mini/micro hydropower. It is the centre of the area (*centro poblado*). The main income source is sale of milk and the number of cows is the criterion of wealth. Though the HDI rank of Encañada District that this community belongs to is 1,725th in all 1,831 districts of Peru, milk production of Yerba Buena brings daily cash income to the producers.

- Canoa Puerto is a remote and *nativo* community located at the eastern foot of the Andes. The inhabitants live in a traditional way of language, food and cultivation. Sometimes they suffer from shortage of food.
- Centro Fuerte is a village along the Rio Amazon. The main income source is sale of cassava and banana. Being near to Iquitos City, this community is involved in the touristic area (especially eco tourism) and welcomes foreign tourists, which brings a new income source to it.
- Tarapoto is a village along a tributary of the Amazon and is also near to Iquitos (16 km in the line of the crow). However, this area is not involved in a touristic industry and the main income source is agriculture and charcoal production.
- Tulani and San Juan are the communities in Puno, the most southeastern region of Peru. As they are located on the high plateau of more than 4,000 meters above sea level, almost all people are in charge of animal husbandry and fiber of alpaca and llama is the main income source.

<Electrified Community>

- Catilluc is a community on the plateau of Cajamarca whose main income source is sale of milk. This is similar to the Pre-Fs site of mini/micro hydropower central, Yerba Buena. Diesel generator supplies electricity to it and all interviewed families use the electricity.
- Balsapuerto town is the center of Balsapuerto District, where one of the mini/micro hydropower Pre-Fs sites is situated. The town is isolated from other towns and cities because of the bad accessibility. Inhabitants there gain income by selling tropical agricultural products, especially banana and corn. Cassava is planted for domestic use. Diesel generator supplies electricity to the town, but the service time is limited to four hours in the evening, 18:00 to 22:00, because of high diesel oil cost. Each user (household) pays 8 soles per month for it while shops and institutions pay 10 Soles monthly.
- Gran Perú is a community located along the Amazon River and near to Iquitos City. Inhabitants sell tropical agricultural products, corn, banana and cassava. PV system was introduced to the community and three-fourth of the interviewed families use it. Geographic condition is similar to Tarapoto, the Pre-Fs site of PV system.
- Communities lying in Taquile Island are the fourth place of the community survey. As it is inside the Lake Titicaca, agricultural products are only for domestic use and income comes from touristic works, especially selling folk crafts. PV system is installed in these communities.

It is generally difficult to understand the real amount of household income, especially that of non-salaried persons. Median of household monthly income was estimated by two means in this report: (i) direct answer of household gross income and (ii) the total of all products sale. However, a striking gap is found between two estimates in some communities, meaning the difficulty of grasping household income.

Main income sources and energy sources for lighting in the eleven surveyed communities are summarized in Table I-8.1.3-1.

Table I-8.1.3-1 Main Income Source and Actual Energy Source

Electricity	Localidad	Income sources	Monthly gross income on median (soles)	Amount of monthly products sale on median (soles)	Main energy for lighting
Non-electrified community	Callatpampa	Mainly agriculture for subsistence. Few people sell vegetables.	20.0	120.0	candles, kerosene lamp
	Yerba Buena Grande	Mainly milk, vegetable	(204.0)	204.0	candles, matches
	Canoapuerto	Sale of banana, rice, corn	100.0	478.5	kerosene lamp, flash light
	Centro Fuerte	Banana, rice, cassava, charcoal, handicrafts	300.0	600.0	kerosene lamp, flash light
	Tarapoto	Banana, cassava, corn, charcoal	45.0	52.0	kerosene lamp
	Tulani	Fiber and fur of alpaca and llama	200.0	340.0	Candles
	San Juan	Animal, fiber, (milk)	70.0	77.1	Candles
Electrified community	Catilluc	Milk, potato	300.0	10.0	Mini/micro hydro electric power
	Balsapuerto	Banana, rice, corn, cassava, public service and commerce	200.0	411.0	diesel generator
	Gran Perú	Banana, corn, cassava, charcoal	185.0	507.5	PV system
	Communities in Taquile Island	Tourism, handicrafts	62.5	72.5	PV system

Source: JICA study team 2008 based on the responses of interviewed households

I-8.2 Energy Usage

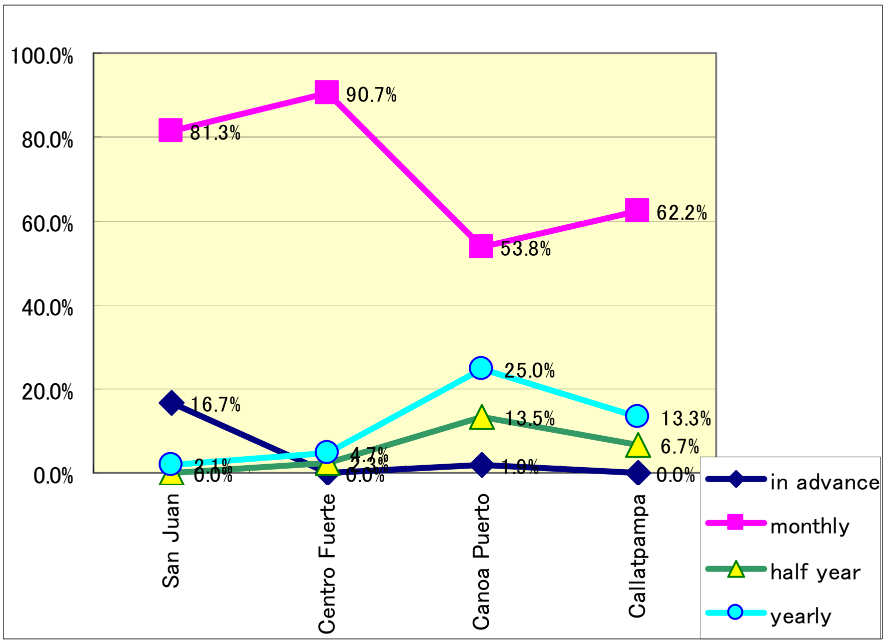
1. Payment for Energy

When electricity service started, users of four electrified communities paid for certain amount for installation of solar panel (Gran Perú) or leading line (Balsapuerto), purchase of meter (Catilluc) or solar panel (communities in Taquile). As this initial payment amounts to 800 US dollars in Taquile, not all households could afford to get PV system. Actually, users in Taquile do not pay for electricity constantly though they are charged on repair and purchase of spare parts. In other three communities, users pay fixed sum (Balsapuerto and Gran Perú) or depending on the amount of consumption (Catilluc). Table I-8.2-1 shows the mode of payment for electricity bill in electrified communities and Fig. I-8.2-1 shows preferable timing of payment of electricity bill.

Table I-8.2-1 Payment for Electricity

Community	Catilluc	Balsapuerto	Gran Perú	Taquile
Type	Mini/micro hydropower centre	Diesel generator	PV system	Solar system
Initial payment	S./ 200 for meter installation	S./10 for installation of leading line (within compound)	S/. 43.5 for facility installation	Purchase of solar panel: US$400 (smaller) to US$800 (bigger)
User payment	Depends on consumption	S./10.0 for salaried families and institutions, S./8.0 for others	S./16.2	No regular payment
Timing	Monthly	Monthly	Monthly	-

Source: JICA Study Team, 2008



Source: JICA Study Team, 2008

Fig. I-8.2-1 Preferable Mode of Payment

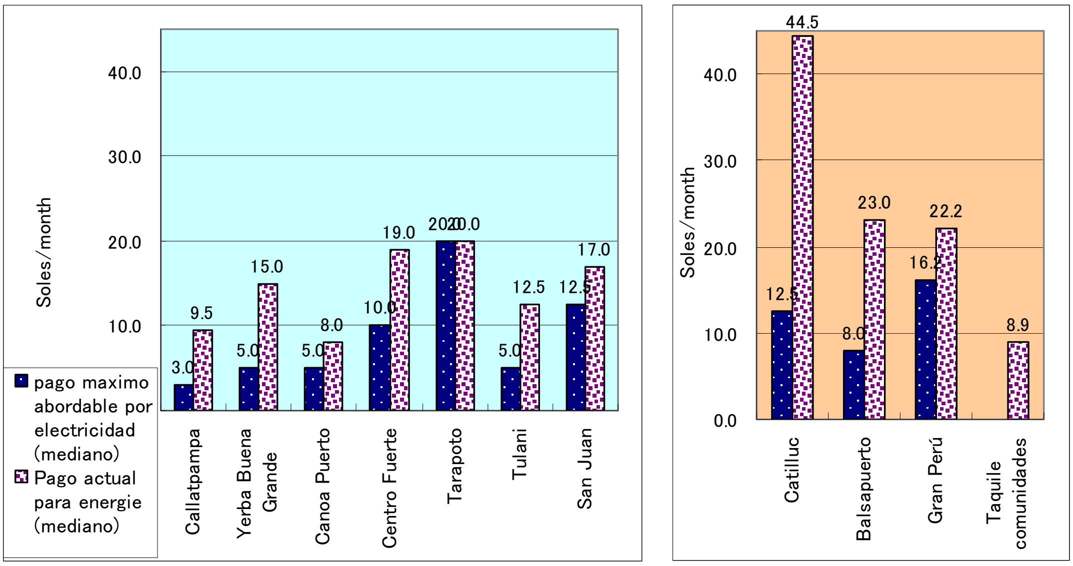
In non-electrified communities, most interviewed people prefer to pay electricity bill monthly. However, some people prefer to pay in advance, once a year or half year; this may depend on the production harvest time.

As mentioned in Table I-8.1.3-1, inhabitants of the surveyed non-electrified communities use kerosene lamp and candles as principal lighting device. The survey data indicates that kerosene lamp is used more frequently in the jungle area (communities in Loreto) than Andean area and candles vice versa.

The survey revealed that actual monthly payment for energy on median is between 9.5 soles and 20.0 soles in seven non-electrified communities and between 8.9 soles and 44.5 soles in four electrified communities. In the latter, payment for not only electricity but also candles, kerosene lamps and flash lights are also included. Because of insufficient service time or inconvenient service, inhabitants continue to use these energy sources apart from electricity.

Amount of maximum affordable payment for energy after electrification is between 3.0 soles and 20 soles in a month on median. Surveyed households in Callapampa replied the lowest amount of possible maximum payment, 3.0 soles per month, while Tarapoto (one of the Pre-Fs sites) answered 20.0 soles, the highest amount among all surveyed communities. Fig. I-8.2-2 shows the maximum affordable amount for energy and actual payment.

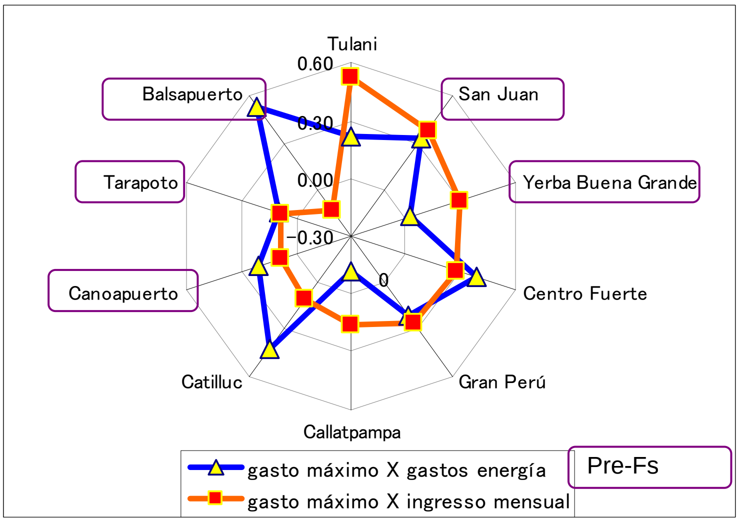
It should be mentioned that the means of interview bring different result of interview: if people are interviewed open to public, affordability tends to be higher than their true intention. Closed condition should be done in any kind of personal interview. As same as income, affordability should be repeatedly investigated by means of not only household interview but also by workshop (like PRA: Participatory Rural Appraisal) at the project planning stage.



Source: JICA Study Team 2008

Fig. I-8.2-2 Maximum Affordable Amount and Actual Payment for Energy Non-electrified Communities (left) and Electrified Communities (right)

Correlation among maximum affordable amount for electricity, actual energy cost and, though the data is not accurate, actual income was calculated. Balsapuerto has rather strong correlation between maximum affordable amount and actual cost (correlation coefficient is 0.5357), while Tulani in Puno Region has correlation between maximum affordable amount and monthly income (correlation coefficient is 0.5223). Tarapoto has not strong correlation among all these three elements, which may mean affordability hardly depends on both actual cost and income (refer to Fig. I-8.2-3).

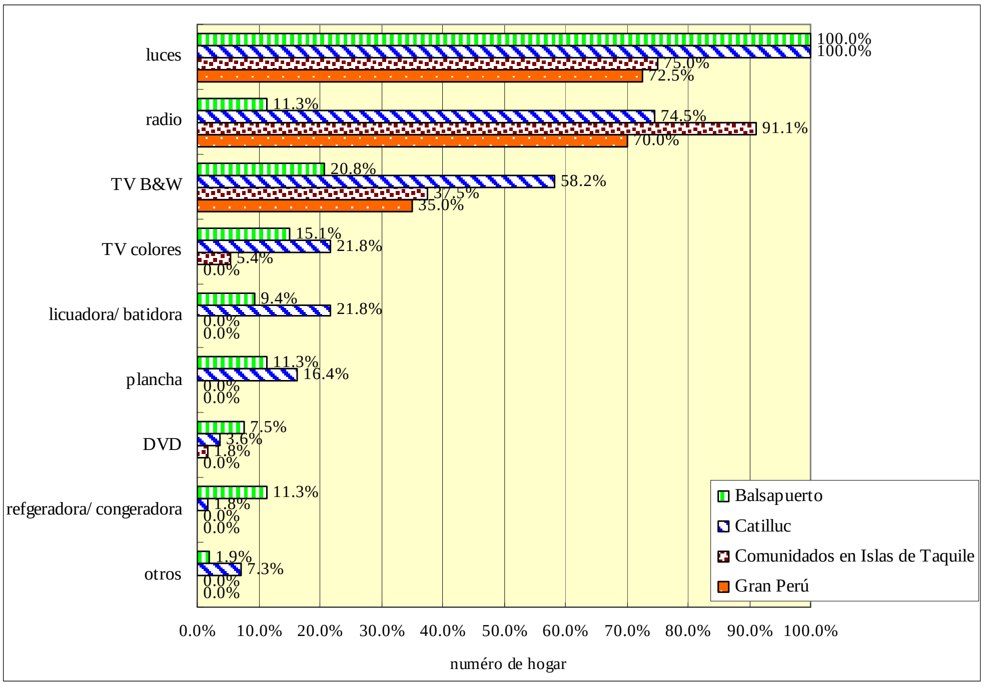


Source: JICA study team, 2008

Fig. I-8.2-3 Coefficient of Correlation of Maximum Affordable Amount with Actual Energy Cost and Income

2. Use of Electricity in Electrified Communities

Almost all households living in the electrified communities possess and use lights (bulbs or fluorescent light), and radio and black and white television set follow. Among these three appliances that are widely spread in the rural area, radio is possessed even by the households who do not use electricity while other two are exclusively for electrified families. Fig. I-8.2-4 shows percentage of possession of important electric appliances.



Source: JICA study team, 2008

Fig. I-8.2-4 Posesión de Artefactos Eléctrico (possession of electrical appliances)

I-8.3 Change of Social and Individual Life by Electrification

1. Range of Change and Impact[4]

Electrification gives change and impact to communities to a considerable extent. Three sectors are considered as being influenced such as individual and family issues, social issues, and finally, production and income generation issues.

In the individual and family sector, electrification is, above all, supposed to improve the quality of life by providing people lights that are cheaper, less polluted and more stably supplied. It is supposed that the life with light is itself a great improvement of living life and enhancement of pride and satisfaction of rural people. Lights increase time that they can use for living and production. Also, quality of leisure is improved by possessing electric appliances like TV, radio and DVD players. Therefore, stable supply chain of light bulbs and spare parts of solar panel or generator is the absolute condition of realization of the improvement.

In the social sector, three types of change and impact are thought to occur after electrification: expansion of social activities in the community as a whole, improvement of law and order of the community, and increase of opportunity to obtain information of other world. Light may increase the security in the night time, people can meet together and meeting of organizations can be held at night more easily. Especially, women are supposed to enjoy this impact. Information regarding the country and all over the world can be easily obtained through the news of radio and/or TV. As the dry batteries are relatively expensive, people living in non-electrified area may have difficulty to listen to radio or watch the TV all the day. To make more effective this change, it is social condition that lights must be installed in the public areas (road, meeting rooms...). Affordability to purchase TV and radio is the absolute condition for people to realize this impact.

People living in rural area where they have little change of income generation are thought to have vague but good expectation that they might receive opportunity by electrification. In the production and income generation sector, two types of change and impact are supposed to occur after electrification. One is improvement or commencement of work/business by using electric machines or by brighter lights and the other is extension of working time (effect of working after dark) by using light.

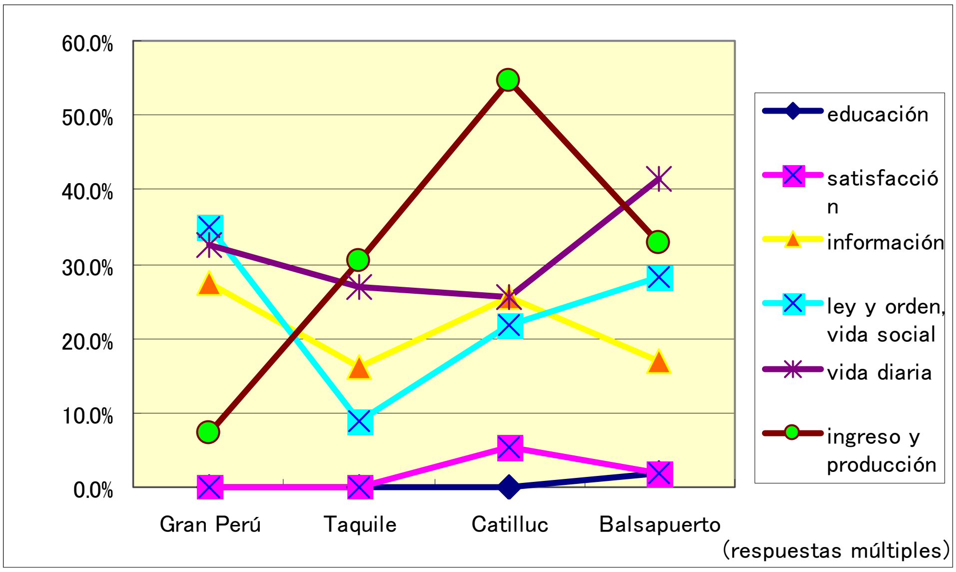
2. Change in Four Electrified Communities

Inhabitants of four electrified communities experienced direct changes and indirect impact by starting electrification. Changes and impact might be generally positive ones for inhabitants but negative to a

[4] Such words as direct ‘change’, indirect ‘impact’ and ‘effect’ in relation with cause may be used to explain the social difference before and after electrification. However, this report does not involve itself in that accuracy but apply the words impact or change.

certain extent. The interviewed persons said various types of answer, which were classified according to the above mentioned three aspects.

The positive changes and impact of electrification is, above all, improvement of production and income opportunity; it comes at the first important change in Catilluc and communities in Isla de Taquile while it is ranked at the second in Balsapuerto. Fig. I-8.3-1 shows the positive change in each community.



Source: JICA Study Team, 2008

Fig. I-8.3-1 Positive Changes and Impact of Electrification

In the aspect of production and income opportunity, changes occurred most often to the surveyed communities relates to weaving. Communities at Isla Taquile enjoy this benefit, where inhabitants cannot develop agriculture and livestock to larger scale because of land scarceness and tourism has become the main industry and textile is one of the main products to sell to visitors (expansion of working time). In Catilluc, on the other hand, installation of milk collection centre, where milk is reserved in the refrigerator, is considered as important change. Aside from specific production activities, in all communities, expansion of working time that people can work till night with lighting, is mentioned as the important change of production aspect.

In the aspect of improvement of quality of life, following changes are mentioned to have occurred most often:

- Go to bed later (increase of living time).
- Children can study at night (education).
- Can watch television (increase of entertainment and information).
- Now have electric light (convenience and satisfaction).
- More convenient to do matters with light (convenience and satisfaction).

Not only satisfaction but also reduction of cost for energy is considered as positive change.

In the aspect of social issues consisting of expansion of social life, improvement of law and order of the community and increase of information, following changes are mentioned to have most often occurred.

- Execute festivals continuing till night.
- Light provides security.
- Security has been increased.
- Can walk easily in the village at night.
- Social life has been increased.

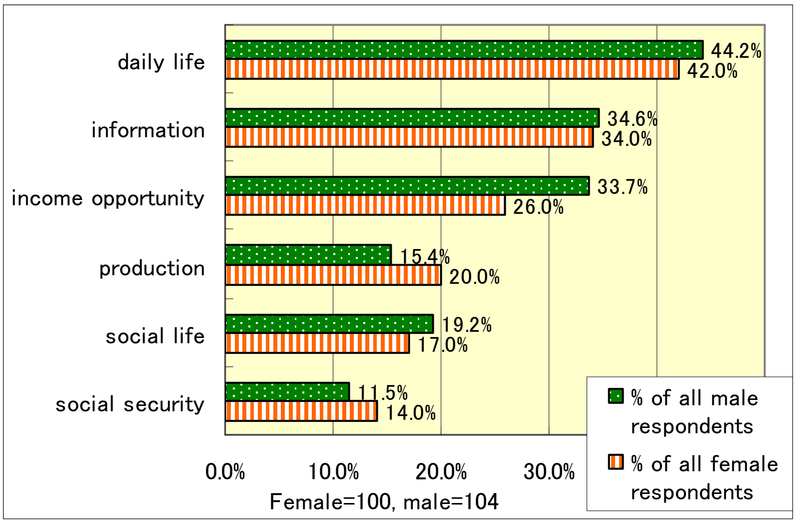
If a person says that their social life (party, meeting) has been extended, it means that the area and time of activity has been extended because of light in the house, buildings and street lights. However, though their number is very small, some person said that the community has become with more troubles, more delinquencies, and more thefts than before electrification, especially in Gran Perú and Catilluc.

Following changes are mentioned as the increase of information reception.

- Can listen to the news by radio longer time than before.
- Can watch news by television.
- Watch news of national level by television.
- Have more information through television.
- Being more informed than before.

Table 1 to Table 4 in Appendix 1 contain important answers of each aspect.

Different changes and impact are considered important between male and female respondents. Especially, more men replied that increase of income opportunity is important while more women thought that expansion of production is remarkable after electrification (refer to Fig. I-8.3-2).



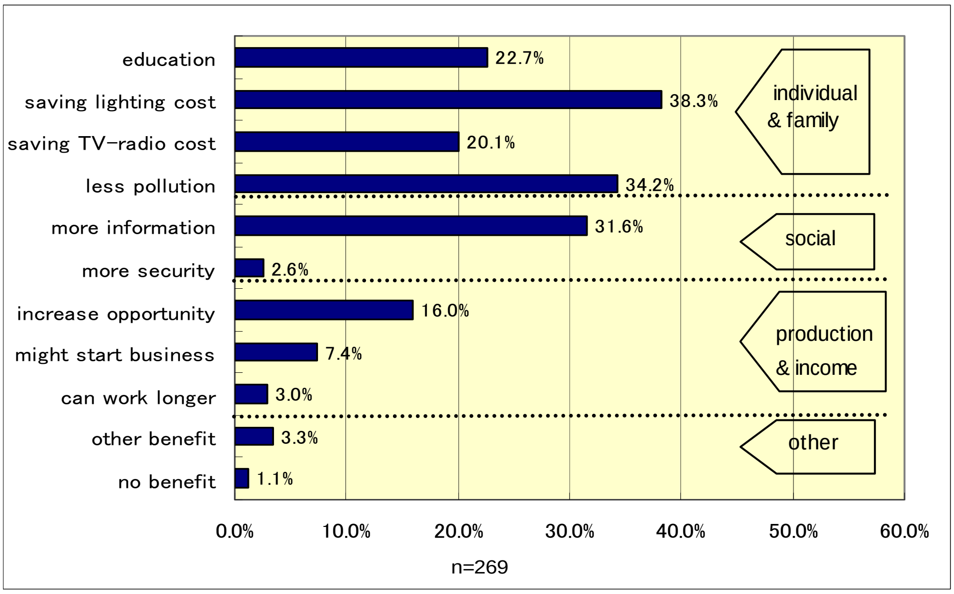
Source: JICA Study Team, 2008

Fig. I-8.3-2 Positive Changes and Impact by Gender

3. Expected Change

In non-electrified communities, inhabitants have much expectation for electricity. Many people feel that electricity is a kind of symbols that indicate the community has become modernized and open to the global area. Also, inhabitants feel that electricity will bring them opportunities of income generation of any kind. More realistic, in individual and family factor, reduction of payment for energy may be the most important expectation. They think the amount they spend on kerosene, candles and dry batteries is too expensive while many people know that the electricity bill supplied by whatever power source is less than it in almost all cases. In short, electricity for many people is a factor of more advanced society.

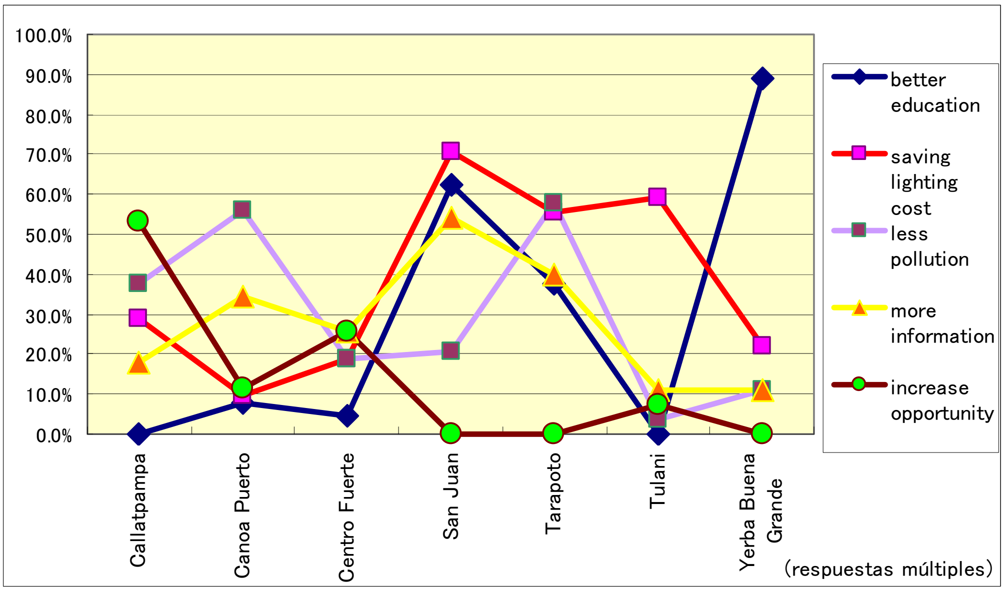
The interview in seven non-electrified communities reveals that the strongest expectation is, as supposed, reduction of actual cost for lighting. Reduction of air pollution caused by kerosene and candle smoke and increase of information are also strong expectations.



Source: JICA Study Team, 2008

Fig. I-8.3-3 Expected Change by Electrification in Non-electrified Communities

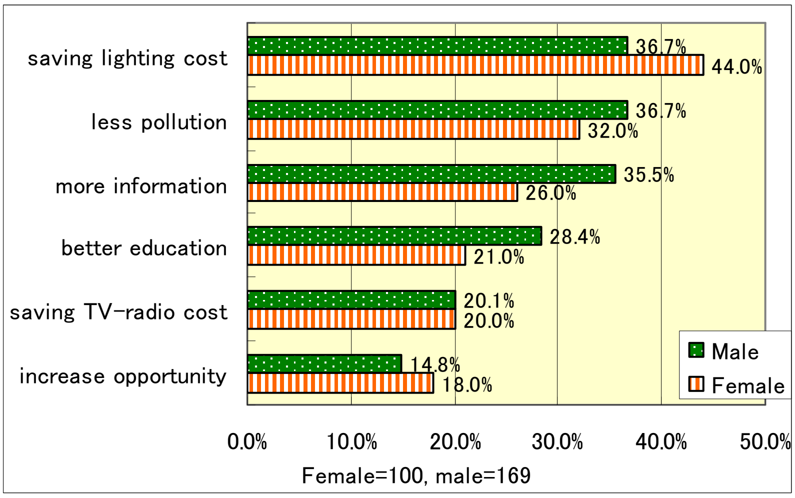
Most of expectations are in the individual and family sector, even though reduction of pollution is also considered as environmental issue. Improvement of law and order in community is not expected while increase of information (nation wide and global news) is the third strongest expectation mentioned by interviewed people. Expectation relating to production and income sector is rather low, but they think they will increase opportunity of something after electrification or they might start business using electricity. In many cases, respondents do not specify the kind of production or income generation activities. Though inhabitants of San Juan in Puno insist that they need production facilities using electricity, the result of interview does not reflect this intention (refer to Fig. I-8.3-3).



Source: JICA Study Team, 2008

Fig. I-8.3-4 Distribution of Five Important Expectations in Surveyed Communities

Importance varies each other when comparing percentage of important expectations among seven surveyed non-electrified communities: 'saving lighting cost' is relatively stronger in San Juan, Tarapoto and Tulani than in other communities; 'reduction of pollution' is low in Tulani and Yerba Buena Grande; 'better education' is rather high in San Juan, Tarapoto and Yerba Buena Grande. This fact is supposed to reflect actual social condition of each community (refer to Fig. I-8.3-4)



Source: JICA Study Team, 2008

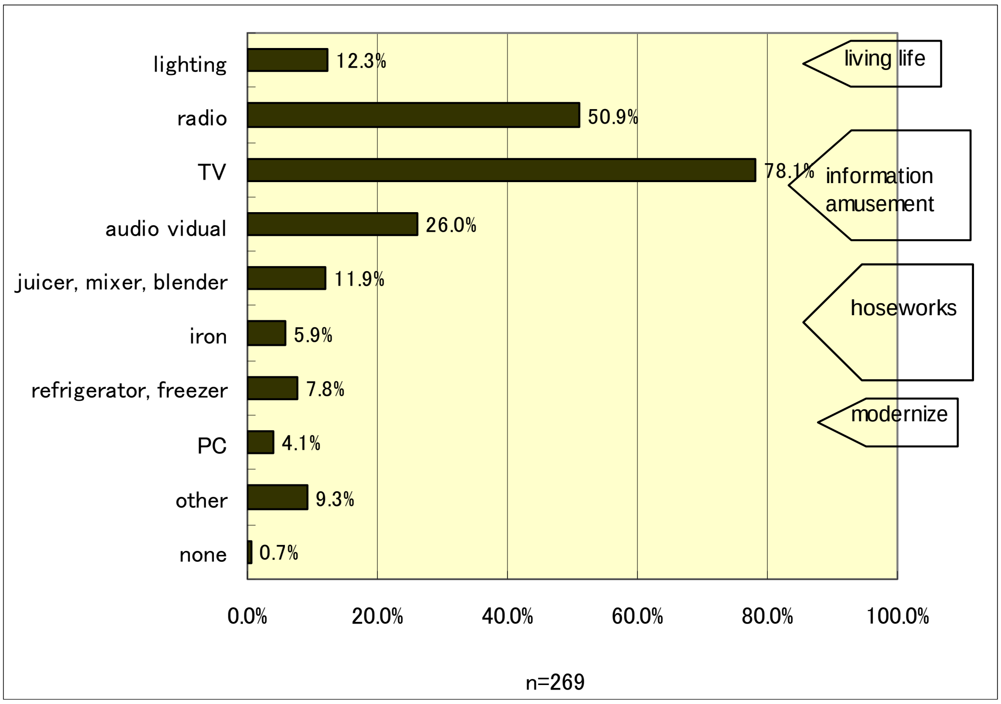
Fig. I-8.3-5 Expectations by Gender

From gender point of view, difference between male and female is found especially in saving lighting cost (female > male), more information and better education (female < male). Fig. I-8.3-5 shows difference expectation of electrification between both genders.

4. Desirable Electric Appliances

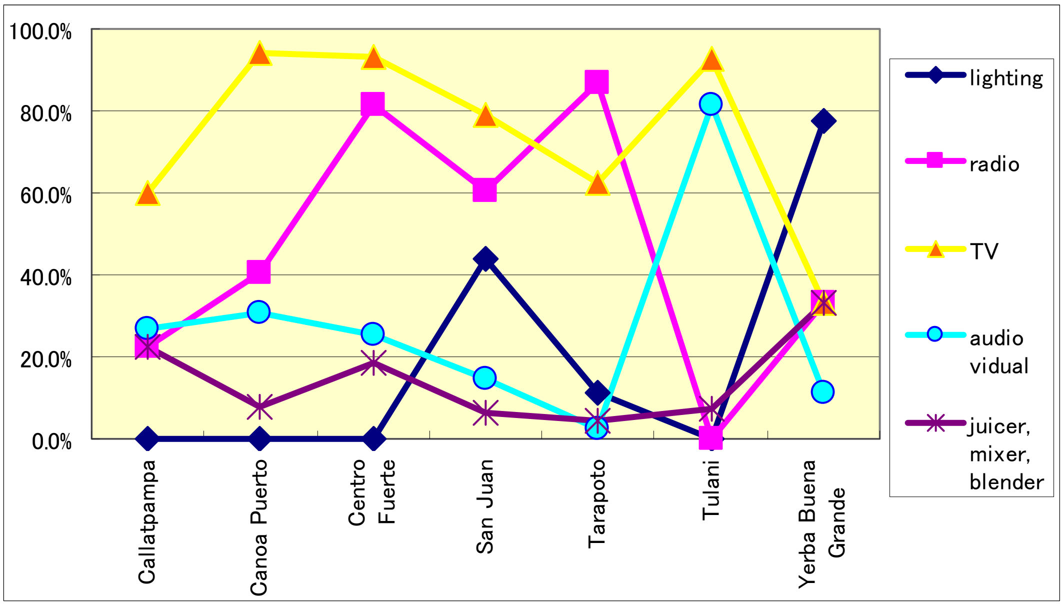
The electric appliance that the interviewed people most strongly want to use is television (both color and black & white): more than three-fourth answered. Radio set (50%) and audio-visual set including DVD player (26%) follow. These are the appliances to get world-wide information but also get amusement that they never are able to enjoy in actual condition. Domestic appliances like iron, mixer/blender, and refrigerator/freezer is another group of electric appliance that they want to use to reduce the burden of housework. Lighting appliance is mentioned in some communities (refer to Fig. I-8.3-6.) Preference varies site by site (Fig. I-8.3-7).

From gender point of view, Fig. I-8.3-8 shows female respondents want to use TV, audio-visual appliance and juicer/mixer more strongly than male respondents.



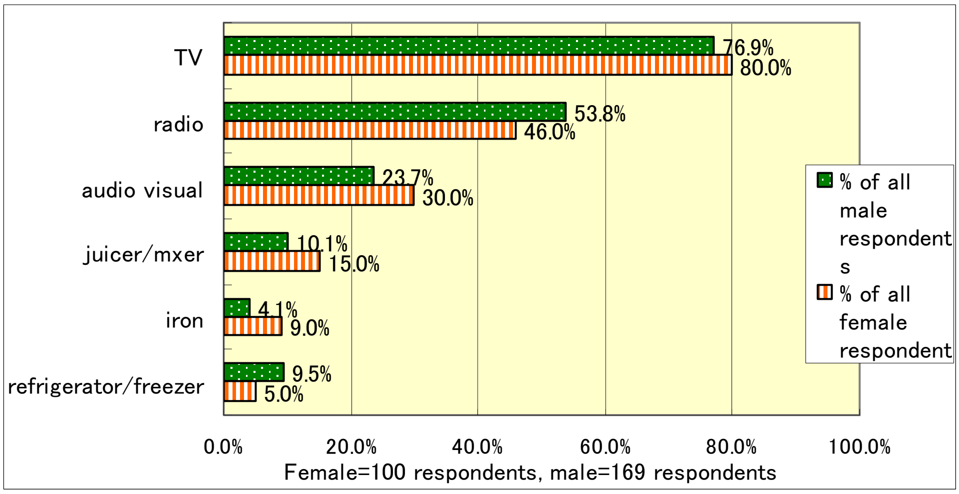
Source: JICA Study Team, 2008

Fig. I-8.3-6 Desirable Electric Appliances in Non-electrified Communities



Source: JICA Study Team, 2008

Fig. I-8.3-7 Distribution of Five Important Desirable Appliances in Surveyed Communities



Source: JICA Study Team, 2008

Fig. I-8.3-8 Difference between Genders in Desirable Appliances

I-8.4 Rural Electrification and Gender

1. Gender in Electrification Project and Electricity

The overall goal of electrification project is to maximize the benefit to all persons in concern, both women and men. Rural electrification by renewable energy is generally small scale and managed by household and community. Inhabitants are required to participate in project implementation and facility operation, maintenance and management. To enhance sustainability of the project, conditions of planning, project implementation, operation and maintenance, management as well as use of facilities should be accessible to all and be based on the community consensus.

The purpose of gender consideration in electrification is to achieve equitable participation in it by both sexes; that is, women and men have equal responsibility for electrification project and electric service, equal use of electricity and, finally, receive equal merit and effect from electrification. For having responsibility, participation in decision making of project implementation, organization establishment and receiving training on operation and maintenance are indispensable to users: for using electricity constantly, not only affordable amount of electricity bill but also basic knowledge of electricity and availability of spare parts are needed; and for getting benefit, intention of getting benefit adding to affordability of getting electric appliances are important.

In this context, achievement of gender equality in electrification relates to the capacity of community in self-sustainable project implementation, because self-sustainability comes from full participation of all inhabitants and stakeholders in the project and from equal benefit reception of the project.

Apart from this, it should be noted that electrification projects should not intervene, unless it is against gender equality, in peculiar mode of living, considered as factors of peculiar pattern of culture, relating to gender in particular ethnic group or culture; for example, way of (women's) cooking or (women's) production pattern.

In the community survey, several questions relating to gender issues were interviewed to understand the actual condition of gender equality. In non electrified pre-feasibility (Pre-FS) sites, information was collected about actual living life, social and production works and participation in social activities of men and women. In community survey done in electrified communities, questions about participation and impact of electrification were surveyed.

In the process of electrification, impact of electrification on women is discussed very often in rural electrification. UNDP report "Gender and Energy for Sustainable Development" (2004) says that rural electrification meets women's: (i) practical needs such as reduction of labour of women and children, (ii) productive needs such as possibility of extension of women's productive activities, and (iii) strategic needs such as improvement of security by installation of street lights and extension of women's participation in social activities and increase of information sources (refer to Table I-8.4-1).

Table I-8.4-1 Energy and Women's Needs

Practical needs	Productive needs	Strategic issues
• Pumping water supplies – reducing need to haul and carry • Mills for grinding • Lighting improves working conditions at home	• Increase possibility of activities during evening hours • Provide refrigeration for food production and sale • Power for specialized enterprises such as hairdressing and internet cafes	• Make streets safer allowing participation in other activities • Opening horizons through radio, TV and Internet

Source: Clancy, Skutsch and Batchelor (2003) cited to UNDP "Gender and energy for sustainable development"

These practical and productive needs are satisfied when (i) conventional fuel for cooking (firewood…) is replaced by new energy and (ii) women can use new energy for producing activities.

Electrification by renewable energy, the object of this Master Plan Study, supplies relatively small scale power, because inhabitant's low payment capacity for electricity bill limits the volume of electricity consumption and, in the case of photo-voltaic system, volume of generated power itself is small due to its generation mechanism. Power generated by renewable energy is used mainly for lighting and radio or television, while it is hardly difficult to be used for a constant heat source. Under these conditions, benefits of electrification by renewable energy are supposed to be mainly used for the improvement of quality of living and social life; such as, (i) low cost lighting, (ii) extension of social activity and information opportunity and (iii) improvement of social security (refer to Fig. I-8.3-3 and Table I-8.4-2).

Table I-8.4-2 Impact of Electrification by Renewable Energy

Practical needs	Productive needs	Strategic issues
• Lighting improves quality of life (satisfaction, relaxing) • Lighting improves working conditions at home • Reduction of expenditure for energy • Reduction of air pollution caused by kerosene/candles • Pumping water supplies – reducing need to haul and carry (if the community uses electricity for pumping)	• Increase possibility of activities during evening hours • Lighting of shops increases number of customers	• Make streets safer allowing participation in other activities • Opening horizons through radio, TV and Internet

Source: JICA Study Team 2007

Impact or benefit is, to a certain extent, genderless. Benefits mentioned in Fig. I-8.4-3 will be provided not only to women but also to men; for example, both men and women can enjoy the light. However, the different condition of male and female in their individual and social life makes the impact different importance on men and women. The difference is affected by the actual (or traditional) roll division of men and women in living life and production.

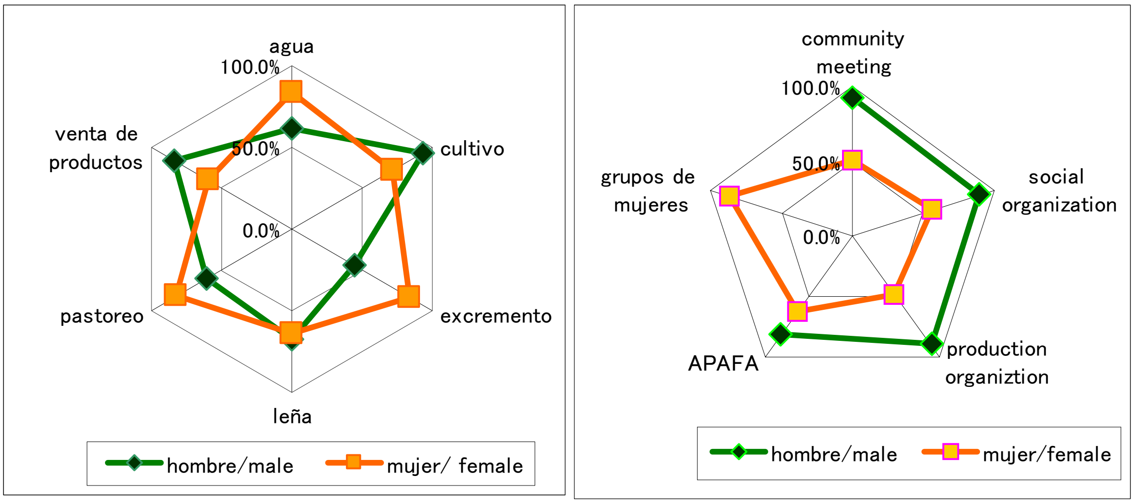
An impact analysis of ITDG's mini/micro hydropower centre project (2005) discusses if electrification reduced women's housekeeping burden or it extended women's working hours in the night. Cases collected in several electrification project sites show that:

- Housekeeping work burden reduced because of introduction of refrigerator, iron or juicer.
- If a woman works in a small scale enterprise like knitting, electrification may extend working hours but, on the other hand, it extends her income and working opportunity. Some women started to concentrate on their work by entrusting housekeeping work to other women.
- If a woman does not work independently, electrification may not directly bring income generation.

Thus, it can be said that electrification may reduce women's working time, but it may not increase women's income generation activity if the condition of division of work does not change.

2. Actual Condition of Difference and Equality in Gender in Social Life in the Surveyed Communities

The social survey in eleven communities shows that more men work for cultivation and sale of products than women while more women work for water pumping/fetching animal raising, and collection of animal excrement (for fuel).The division of labour between women and men differs by the cultural sphere. On the other hand, much more men participated in social organizations (community meeting, social organizations in the community, production organization and APAFA=organization of parents and families of education). Women participate in these organizations much weaker than men: almost half of men except participation in women's groups (86% on average of all eleven surveyed communities.)



Note: Percentage of respondents of 'every time' and 'often' among number of respondents who are in charge of the activity.

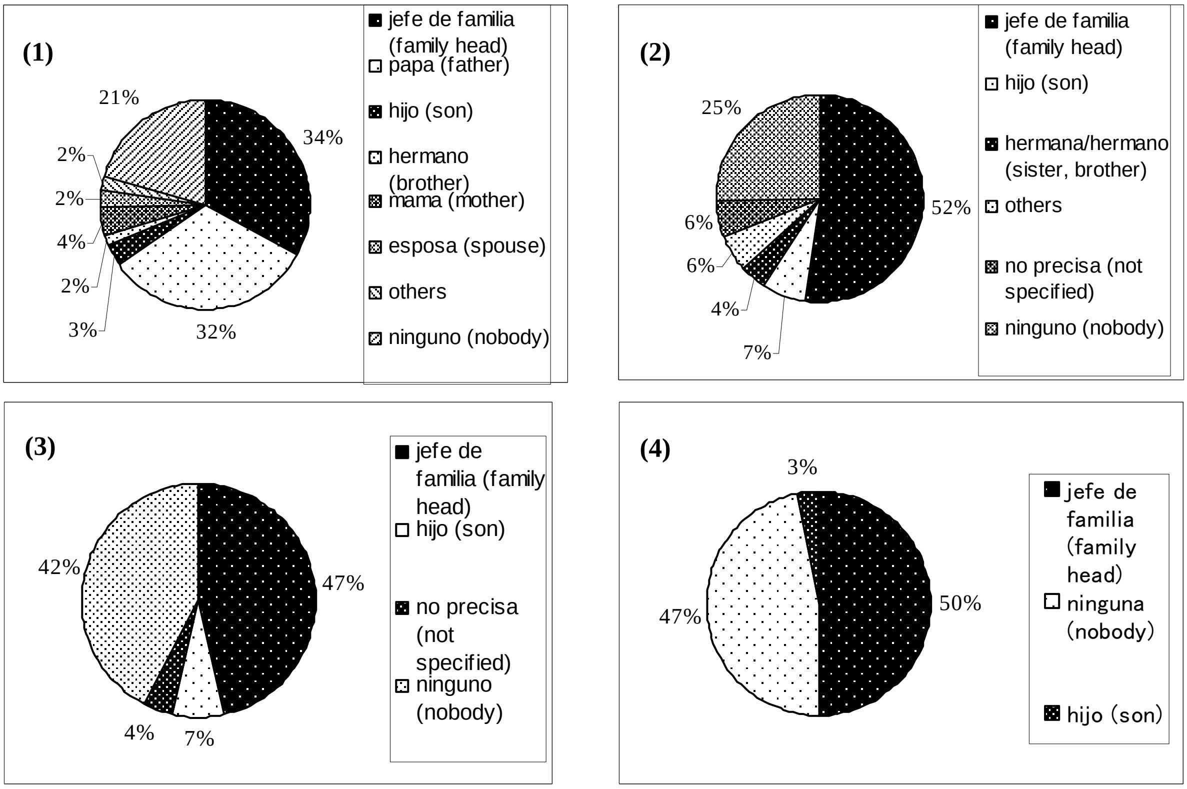
Source: JICA Study Team, 2008

Fig. I-8.4-1 Division of Labour (left) and Participation in Social Activity (right) by Gender

3. Gender with Electricity

Through almost all activities relating to electricity, women participate much less in these activities than men.

Decision of household electrification was made principally by men (head and father of family) composing more than two thirds of respondents of the interview. Only very few women (around 6%) participated in decision making. In PV system communities, it was family heads and sons who got training about usage of solar panels after the installation (59%). After starting electrification, very few (or almost no) women are in charge of preparation of distilled water for battery and cleansing the solar panel. It means that the panels and batteries are left without maintenance if the men are absent from their houses for long time and that other family members will lose the power of electricity. Adding to this, though it is not a gender issue, another problem is found from this data that no one was trained, no one either change distilled water or clean panels, which means the lack of constant maintenance of facilities (refer to four figures of Fig. I-8.4-2.)



Source: JICA Study Team, 2008

Fig. I-8.4-2
(1) Decision Maker of Household Electrification, (2) Receiver of Training of Electrical Facility, (3) Person who Changes Distilled Water, and (4) Person who Cleans Solar Panel

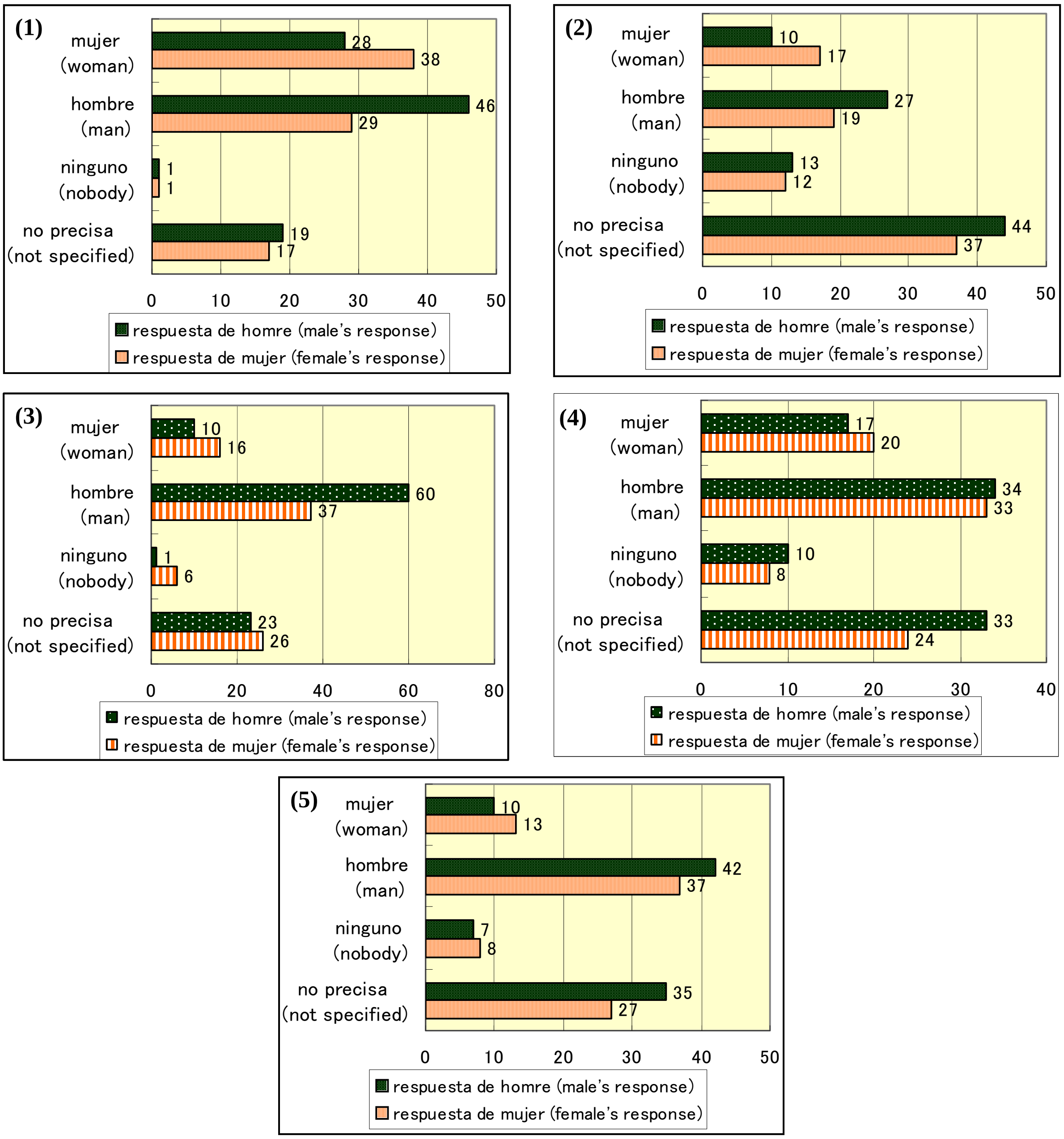
4. Impact of Electrification in Community

Electrification brings change and impact both on men and women living in the concerned community; however, the dimension and strength might be different between both sexes. Thus, results of the community survey in the electrified four communities are analyzed by above-mentioned (I-8.3) three aspects.

The answers to the questions about which gender got more benefit by electrification show that male respondents think their gender received more benefit while female respondents tend to that male person got more benefit than female except the question about the improvement of quality of life. As a result, in all aspects except this one, male is regarded as the gender who got more benefit by electrification.

These results imply that both genders, especially women, shall be involved in the electrification project from beginning: meeting of explanation, decision making, training, maintenance and repair. By participation of both genders, sustainable and stable use of electricity, especially PV system, will be realized. Then, as for the distribution of benefit, the biggest gap between female and male is feeling of information reception. It may be that women are so busy and so separated from social matters that they have little opportunity to listen to and use information coming from radio and TV.

Five figures in Fig. I-8.4-3 indicate the different answers between male and female respondents about the beneficiaries.



Source: JICA Study Team, 2008

Fig. I-8.4-3
(1) Gender who Get Benefit by Electrification in Daily Life, (2) Productive Activities, (3) Information, (4) Income Opportunity, and (5) Social Life and Security

I-8.5 Native Community and Ethnic Minorities

1. Communities in Peru

Communities in Peru are divided into native communities and peasant communities.

Native communities are those of tribal type (consisting of small, less developed ethnic groups), of pre-Hispanic origin or communities independently developed. These communities live in the jungle regions of Peru. People of each native community keep the same identity among them due to their same culture, language or dialect and also they live in the same territory. They recognize their own authorities in their way. They are supported by Peruvian laws in the article 8 of Ordinance Law DL N° 22175 “Native Communities and Agriculture Development in the jungle and low jungle” and also in the article 1 of the Agreement N° 169 about Indigenous towns and tribes of the International Labour Organization (1989).

Table I-8.5-1 Estimated Number of Native Communities by Region and Province

Department	Province	Num. of native communities	Region	Province	Num. of native communities
AMAZONAS	Bagua	56	LORETO	Ucayali	40
	Condorcanqui	112	MADRE DE DIOS	Manu	11
AYACUCHO	Huanta	1		Tahuamanu	1
CAJAMARCA	San Ignacio	9	PASCO	Tambopata	12
CUSCO	La Convención	48		Oxapampa	113
	Paucartambo	6	SAN MARTÍN	El Dorado	4
	Quispicanchis	1		Lamas	9
HUÁNUCO	Puerto Inca	9		Moyobamba	8
JUNÍN	Chanchamayo	50		Rioja	4
	Satipo	106		San Martín	1
LORETO	Alto Amazonas	197	UCAYALI	Atalaya	114
	Loreto	71		Coronel Portillo	83
	Mcal. Ramón Castilla	48		Padre Abad	7
	Maynas	120		Perús	21
	Requena	12			
	Total				**1,274**

Source: RENIEC (National Registration of Identification and Civil Status) and ONPE (National Office of Electoral Process)

2. Diagnostic Study about Indigenous Towns and Native Communities of Peruvian Amazon

A special Program of Native Communities, "Defensoría del Pueblo", supported technically and institutionally by ILO, CAAAP (Amazon Center of Anthropology and Practical Application) and financially USAID, executed the diagnostic study about indigenous towns and native communities of Peruvian Amazon.

The problem of land ownership in the native communities and their lands were considered as the most important problems for the development of their economic sustainability. However, the following problems are found as the obstacles, too.

Box I-8.5-1

<u>Problems found in the native communities by the Defensoría del Pueblo program</u>

a. Management Topic
- Delay in the official registration of the native communities
- Giving owner certification of indigenous lands to other persons who are not the owners
- There is not a clear and technical criterion for the determination of lands that must have been given to the communities
- Identification of native community with the human settlements, this matter generates that indigenous vision is limited to ethnic identity and for the management of their land.
- Delay to the requirements and reclaims of the indigenousness
- Giving contracts or licenses for natural resources exploitation to persons who are not indigenous into lands that are given to native communities.

b. Economic Topic
- Irregular occupation of indigenous land by other people.
- Absence of governmental control of increase of market that is formed and practiced by foreign people in the indigenous lands.
- Arrival and movement of foreign people to Peruvian Amazon that is associated to agriculture activities and coca procedure.

c. Political Topic
- Few governmental intervention in Amazon regions with authorities who are obliged to obey rules that protect rights of the indigenous towns.
- Dangerous groups provided with guns and thieves that sell and produce drugs disturb the peace of these communities.
- There is no State support to these indigenous towns in their organization process and providing legal resources, management and technical support in order to protect their lands.
- There is no coordination among the politics of land recognition of the Native Communities and the definition and creation of protected areas with the aim of environmental defend and protection of natural resources.

I-9 Situation and Issues on Environment

I-9.1 EIA and Environment Consideration in Peru

1. Executing Organization of EIA in the Field of Electrification

In Peru, there is no fundamental law of environment and it is each ministry who is in charge of Environmental Impact Assessment (EIA) at the study period. In May 2008, Ministry of Environment was established but this new ministry will start its function in January 2009.

The department being in charge of approval of EIA studies for electrification in MEM (Ministry of Energy and Mines) is General Department of Environmental Energy Issues (*Dirección General de Asuntos Ambientales Energéticos* - DGAAE); however, Department of Electrification (*Dirección General de Electricidad* - DGE) also plays a role to a certain degree.

Law 25844 mentions that DGAAE's function is to enact the main policies and guidelines, on the other hand, DGE's function is to supervise the rules given. In addition, DGE must supervise implementation of the rules, evaluate the infringements and penalize the institutions if it is the case.

DGAAE and DGE decide whether a project or plan (more than 500 kW) needs to receive following certificate or report after examining the letter sent by the petitioner.

- In the case that the project is implemented inside protected area or buffer zone, certificate issued by INRENA (National Institute of Natural Resources). Even in the case that the project implemented outside either protected area or buffer zone, if it causes damages to the natural resources or other physical impact, DGAAE will take initiative of protection of the nature.
- In the case that the project site is located near to the important archaeological place, CIRA (*Certificado de inexistencia de restos arqueológicos* or Certificate of insistence of archaeological remains) issued by INC (*Instituto nacional de cultura* or National Institute of Culture)
- Certificate issued by DIGESA (*Dirección general de salud ambiental* or General directorate of environmental health) of Ministry of Health concerning management of solid waste
- By examination of letters or documents, if the project implementation is found to give impact to the social matters like social capital of rural communities, DGE is in charge of the social environment management.

Apart from Law 25844, the national system of public investment, or SNIP, under the Ministry of Economy and Finance requires study on environmental impact even at the profile stage prior to the pre feasibility study. SNIP prescribes that the petitioner must mention the probably positive and negative impacts of the project on the environment and the general scheme of mitigation plans. Different from Law 25844, it is not according to the scale of the project but the study on environmental impact is required to all projects. However, according to the General Directive of the

National System of Public Investment or *Directiva General del Sistema Nacional de Inversión Publica: Directiva No. 004-2007*, it is decided by the estimated amount of investment to which level the implementer shall do the SNIP study (only profile study level or up to feasibility level study).

Amount of investment	Required study
- S/. 300,000	Simple profile level study
S/. 300,000 ～S/. 6,000,000	Up to profile level study
S/. 6,000,000～S/. 10,000,000	Up to pre feasibility level study
S/. 10,000,000 -	Up to feasibility level study

As the purpose of the profile study is to determine if a project will be done, study on environmental impact of this stage is preliminary prediction. By using secondary documents, petitioner must describes i) possible positive and negative impacts on environment and ii) general mitigation plan. Both mini/micro hydropower and PV system are the object of this study. At the pre feasibility study level, petitioner is obligated to submit some alternatives as well as the cost estimate of mitigation plan. Petitioner must describes i) Positive and negative impacts of project on environment, ii) mitigation plan, and iii) detail of the cost of mitigation plan. As field survey is not necessary for pre feasibility study and estimate data is accepted to the study of environmental impact, field survey is not done so often.

There is a discrepancy between the law concerning electrification and SNIP concerning the public investment in general, but MEM understands that the study relating to environmental is not necessary for projects less than 500 kW.

Apart from these organizations, CONAM (*Consejo Nacional del Medio Ambiente*, or National Council of Environment) works as the principal authority in environmental issues in Peru for giving policies of environment management. CONAM is said extremely political institution. Inside its responsibilities CONAM does not approve or check any EIA study concerning electrification and has no relation with the EIA procedure of electrification projects.

I-9.2 Legal Framework of Environmental Consideration

Volume of power generation determines if a project is required to develop EIA studies or not according to the Law 25844.

(1) When the study involves hydropower plants with capacity less than 20 MW, it is not required to prepare an EIA study. However, DGAAE can require to the implementer to submit means of environmental management if necessary, taking in consideration of the article 24 of the Law No. 28611 and the implementer must study EIA even the capacity is less than 20 MW if environmental impact may be supposed to occur. MEM/DGE gives authorization of the project implementation of hydropower plants having capacity between 10 MW and 20 MW; on the other hand, the regional government gives authorization of the project implementation of hydropower plants with capacity between 500 kW and 10 MW.

(2) When the study involves hydropower plants with capacity lower than 500 kW, which will be the main target of this Master Plan, DGE only requests a summary about the project, but it does not give any authorization.

(3) There are no environmental regulations in Peru concerning PV system for electrification.

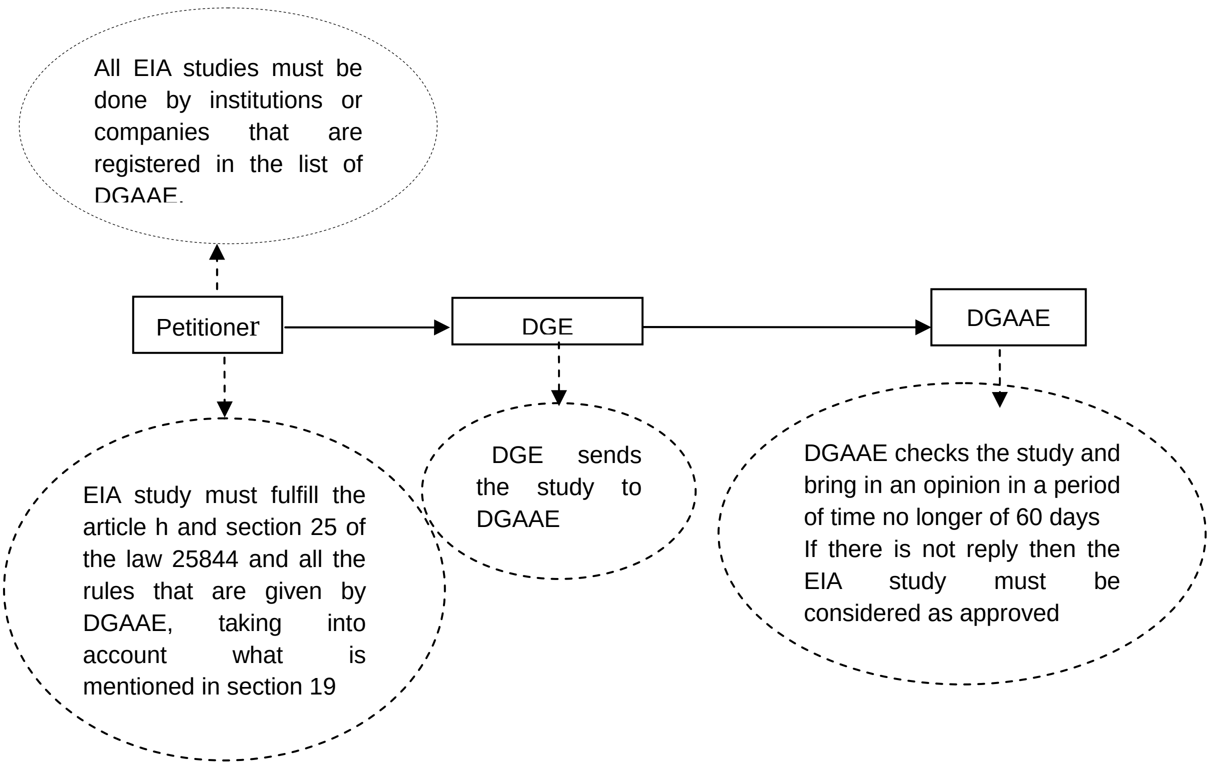
The relation between capacity of output and EIA is summarized in Table I-9.2-1.

Table I-9.2-1 Relation between Capacity of Power Generation and EIA

Generation type	Capacity of output			
	<=500kW	500kW< <=10MW	10MW< <=20MW	20MW<
Hydro power	Sending letter to MEM/DGE	Authorization by regional government	Authorization by MEM/DGE	EIA
	DGAAE may request the study of EIA regardless of the scale of power generation if serious damage is expected.			
PV system	No regulation			

Source: JICA Study Team 2008 based on the information from DGAAE-MEM.

However, there are two laws concerning EIA and two departments concerning EIA in MEM, and there are different understandings and instructions between these departments about the application of these laws. This seems one of most important problems of environmental and social consideration for electrification plan and project.



Source: JICA Study Team 2008

Fig. I-9.2-1 Procedure of EIA Mentioned in Law 25844

Box I-9.2-1 Text of Article h, Section 25 of the Law 25844

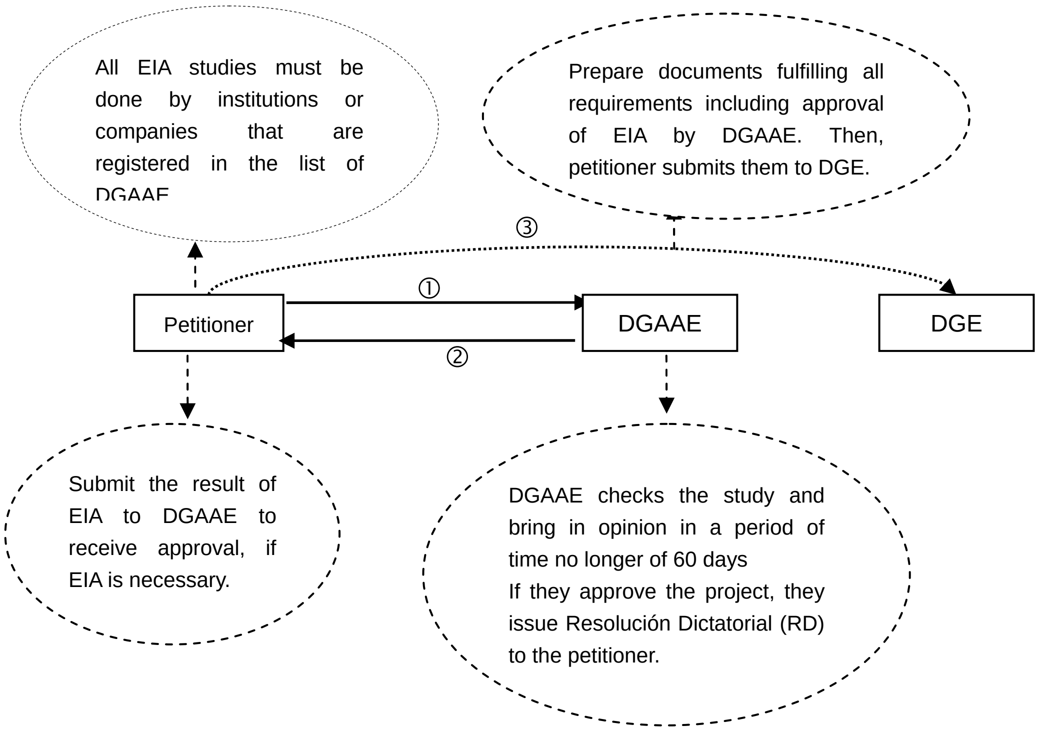
The implementer must submit an application to MEM-DGE with the following data: h) EIA study and Resolución Dictatorial (EIA-RD).

According to the explanation by interviews with *Dirección General de Asuntos Ambientales de Electridad* (DGAAE) and *Dirección General de Electricidad* (DGE), legal framework of EIA is as follows:

(1) The main laws that regulate the Environment Aspects are two. The first one called *Decreto Ley 25844: Ley de Concesiones Eléctricas* (Law 25844: Executive order in Electrical Concession Law), and the second one is Ley 28749: *Ley de General de Electrificación Rural* (Law No 28749: Rural Electrification Law).

(2) Law 25844 establishes the rules that regulate the activities of: generation, transmission, distribution and commercialization of electrical energy.

(3) In relation with Law 25844, the procedure to get the approval of the EIA study is shown in Fig. I-9.2-1. However, an officer of DGAAE says that this procedure is old and actually they directly receive EIA documents from implementers and send back the results to them. DGE receives all required documents including EIA result from the petitioner. Fig. I-9.2-2 shows this process.



Source: JICA Study Team 2008 based on the interview to DGAAE

Fig. I-9.2-2 Procedure of project approval including EIA taken by MEM

(4) The new Law 28749 establishes the regulatory framework for promotion, efficient development and sustainable electrification of rural areas, isolated communities and those communities that are bordering with other countries.

(5) Regulation of the Law 28749 was approved on May 3rd 2007. At the time of interview, the law 28749 has been promulgated but the details including formats are under preparation by DGAAE; therefore, at this time, there are no formats of declaration under oath, affidavit that are prescribed in the text.

Table I-9.2-2 shows the differences of the Order of Law 25844 and Law 28749 in terms of purposes and beneficiary.

Table I-9.2-2 Comparison of the Order of Law 25844 and Law 28749

Executive Order 25844 – Electrical Concession Law	**Law No 28749 - Rural Electrification Law**
Advantages: Economic point of view	Advantages: Social Point of view
• This law promotes free open markets	• This law promotes social comfort
• This law promotes competition	-
• This law promotes efficiency	• This law promotes rural electrification
• This law promotes investments	• This law does not consider the economical benefits
• This law promotes fair tariff	• Most of cases, the tariffs receive government subsidy.

Source: JICA Study Team 2008 based on the information from DGE-MEM.

(6) The order of Law 25844 prescribes that activities relating to environmental issues shall be taken in different ways according to the capacity of power generation. Section 7 of this law prescribe that the mini/micro hydropower plants with capacity 500 kW and below do not need EIA nor authorization but the petitioner have to submit a summary of the project to MEM.

The procedure of environmental issues by capacity of electrification is shown in Fig. I-9.2-3.

Activity/procedure	Type of project		Application to
Definitive Concession (*)	• Generation	:	Hydropower plant: capacity up to 20MW
	• Transmission	:	It is required easement
	• Distribution (maximum capacity 500kW-30MW regional wide) (**)	:	Public electrification service
Temporary Concession	• Generation • Transmission	}	Studies to determine the feasibility of the study
Authorization of operation of Hydropower Plants with capacity between 500kW and 20MW (**)	• Generation		Hydropower plant: capacity 500kW- 20MW Thermal power plant: capacity >500kW (*)
Reports (**)	• Generation • Transmission • Distribution	}	Hydropower plant: capacity <500kW When it is not required definitive concession neither authorization
Easement (Servidumbre)	• Right to the definitive or temporary concession		It allows to use the public and privates goods

If the electricity board wants to run its power lines over the land owned by individuals, it has to pay to that person for an easement so that it can access to its equipment on the land in question.

Legend:
(*) Phases that require EIA studies
(**) Regional governments are responsible to work on these fields

Source: JICA Study Team 2007 based on the information of DGE

Fig. I-9.2-3 Procedure of Environmental Issues by Capacity (Law 25844)

Box I-9.2-2 Text of Section 7, Law 25844

Generation, transmission and distribution activities that do not require concession or authorization could work without restriction if they satisfy the technical norms and recommendations given to protect the environment and cultural heritages of the Peruvian Nation. The petitioner must give details to MEM about the operation and technical characteristics of the infrastructure and equipment.

(7) Different from the prescription of the order of Law 25844, Law 28749 classifies rural electrification projects into: rural electrical concession, rural easement for electrification and rural electrical system (*Sistema Eléctrico Rural* = SER). The department in charge to determine if a project is or is not a SER is MEM/DPR.

The Law 28749 prescribes that a SER project must fulfill the requirements of Section No 11 -Supreme Decree 025-2007 EM Law 28749. If a project is decided a SER, then the environmental rules must follow as is given in Law 28749. Then, in relation with section 39, title IX, only transmission infrastructure of SER must have an EIA study. The generation capacity of mini/micro hydropower plants is low and they only need distribution lines; this fact means they are not required to do the EIA study.

However, as the details of this law have not been fixed yet, requirements are not determined for the electrification project. It needs to clarify the necessary procedure for a small scale but equipped with extension line facility, when it is considered as SER.

The typology of electrification project is shown in Fig. I-9.2-4.

System	Type of project		Application to
Rural Electrical Concession	• Generation	:	Renewable source Non renewable source
	• Transmission	:	When it affects public or private goods
	• Distribution	:	In relation with public and private goods
Rural Easement for Electrification	• Right to the definitive or temporary concession		
Rural Electrical System (SER)	• It must be approved by DPR		

Source: JICA Study Team 2007 based on the information of DGE

Fig. I-9.2-4 Typology of Electrification Project (Law 28749)

(8) It was found that the two institutions in charge of EIA for electrification projects have different understanding about application of the abovementioned two laws to rural electrification through non conventional systems, the objective of this master plan study. There is confusion and no approved procedure in MEM about environmental issues for small scale electrification by renewable energy. Different understanding is summarized in the Box I-9.2-3.

(9) As for projects between 500 kW and 20 MW that are judged unnecessary to do EIA study, implementer is obligated to submit the summary of the project including environmental management plan to DGAAE (more than 10 MW and below 20 MW) or regional government (more than 500 kW and below 10 MW) to receive the permission. As for the mini and micro scale hydropower projects are not required to get permission but project implementation shall be reported to DGE. However in reality, only a few power generation projects less than 500 kW done by funds on hand of districts, communities or individual persons are reported to DGE. Adding to this, in case of PV system, there is no legal framework of environmental management. In consequence, these small scale power generation projects are not known to MEM and not found on the database of MEM[5].

Also, though the Article 2 of Law 26734 prescribes that the problem of the management of solid waste to occur after the start of the service will be managed by OSINERGMIN as mentioned in I-9.5, this organization is the one who controls investment and financial matters and does not do technical management. As a matter of fact, no management of installation and operation of small scale power generation projects. The procedure of implementation of small scale power generation project is shown in Fig. I-9.2-5.

[5] Due to insufficient information of MEM about rural electrification projects, JICA study team wasted long time for deciding the sites for pre feasibility study because many candidate sites that MEM recommended had already done electrification project or had plan.

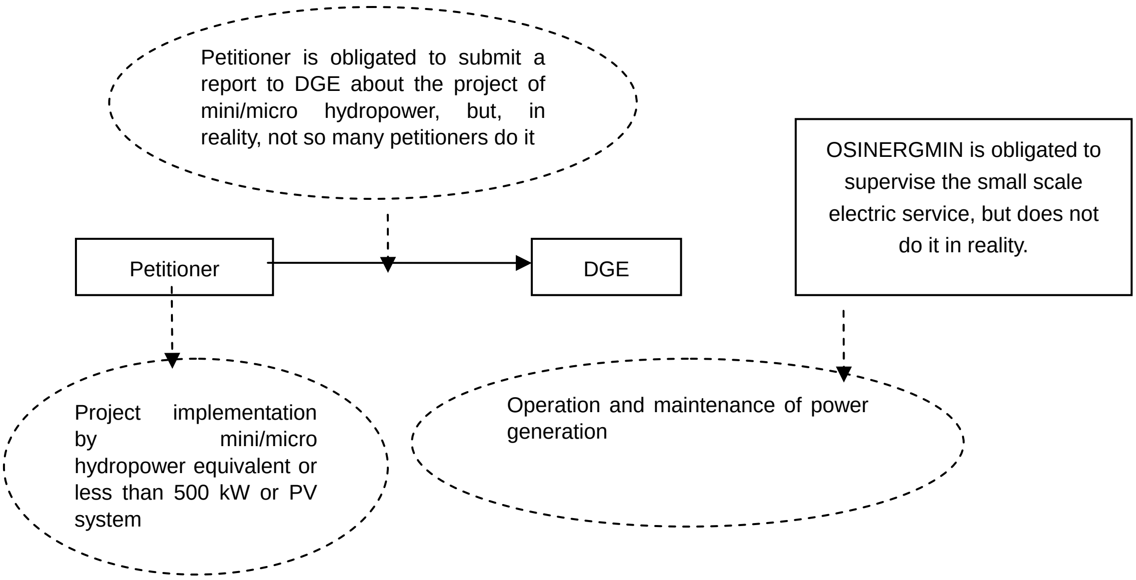


Fig. I-9.2-5 Procedure of Implementation of Small Scale Power Generation Project

(10) MEM has no staff members who work for environmental and social consideration of small scale projects whose generation capacity is 20 MW or less and that EIA is not applied to, though environmental consideration of the projects that EIA is applied to is under supervision of DGAAE. Absence of the staff, not only for social consideration but also for environmental consideration of small scale generation projects is another problem of MEM because negative impact of electrification by renewable energy is not considered.

Box I-9.2-3 Different Understanding between DGAAE and DGE

1) DGAAE recommended that:
   - Due to that the capacity of hydropower plant that the Master Plan considers is generally 500 kW or below, then studies of EIA are not required.
   - The engineer in charge recommends to consider the project prescribed in Law 25844 (concession law) and to take into account section 7 of the law, on the other hand, not to consider the text prescribed in Law 28749 (rural electrification law) for the project implementation because there are still many points that must be approved by the ministry.
   - At the same time, the engineer in charge said that it is recommended for JICA to send a letter to DGAAE in order to get a formal letter saying that the EIA study is not required due to the capacity of the hydropower plant and supply of electricity using PV system.
   - He also said that just in case a kind of study is requested considering EIA terms, then they can only ask for Environment Management Plan.
2) DGE recommended that:
   - Due to that the capacity of hydropower plant is generally 500 kW or below, then studies of EIA are not necessary.
   - Contrary to what the engineer of DGAAE told about Law 28749, the director of DGE said that this law has been approved and any petitioner could be in the right to submit all the papers he or she considers important, even though the formats are neither ready nor approved by the ministry.
3) In conclusion, implementer or planner of an electrification plan or project should send a letter regarding the plan or project to both DGAAE and DGE to inform the plan or project and wait for the decision of both directions.

I-9.3 Guideline for EIA Study

There is a guideline for the study of EIA. If an electrification project requires the EIA study, implementer must follow this guideline to prepare an environmental management plan. Institutions who can execute the study for EIA are required to get authorization by MEM (the number of authorized institution is 129 in July 2007).

The content of the environment management plan for electrical activities, such as generation, transmission and distribution, is to be based on a set of programmes and actions with the objective that the proposed study takes care of all the environment aspects. The plan must involve the following aspects: monitoring and environment control measures, environmental education (social aspects), contingency measures and project ending phase. Contents of the guideline for the study of EIA about the environment master plan are summarized in Box I-9.3-1.

Box I-9.3-1 Contents of the Guideline for the Study of EIA

1) Monitoring and Environment control measures

   The monitoring programme is based on the current situation in the concerned area and the analyses of the project impacts including predictions of impact in all the stages of the project. The monitoring requires measurements of many environmental parameters before, during the project implementation, operation and closing stages of the electrical facility.

2) Environmental Education - Social Aspects

   If the project is located close to an environmentally fragile area or to a natural reserve, then it is important that the persons in charge of the project get information to take measure to protect these natural resources. Then the study must propose the environmental education programme as well as the programmes in relation with social communication for the purpose of raising awareness of the community members about environmental protection.

3) Contingency Measures

   This study involves all the actions and measures to be taken in case of risk and emergency situations that could occur to the electrical facilities (generation, transmission and distribution), due to earthquakes, fire, explosion, spill of pollutant substances, and other reasons.

4) Project Ending Phase

   It is compulsory to have a plan in order to remove all the infrastructures when the project is abandoned. That project ending phase must follow all the security norms and environment rules.

Adding to the guideline for the study of EIA, MEM/DGAAE published the guideline of social environment study or *Guía de Relaciones Comunitarias* that refers to the socio-economic aspects of the electrification plans and projects. This guideline is applied to the projects/plans that require the study for EIA (large-scale project). The main objectives of the social environment study (EIS) are to analyze the effects that a project has over the inhabitants, social relations, economy and culture, as well as it mentions about the actions to increase the positive effects, reduce or eliminate the negative impacts.

I-9.4 Protected Area

1. Types of Protected Areas

Law of the Nature Protected Areas of Peru prescribes ten categories as nature protected areas or *Áreas naturales protegidas* (ANP) and the reduction/buffer zone or *las zonas de amortiguamiento* outside the ANP. The categories of the ANPs are:

1) Parque nacional (national park)
2) Santuario nacional (national sanctuary)
3) Santuario histórico (historical sanctuary)
4) Reserva paisajística (landscape reserve)
5) Refugio de vida silvestre (refuge of wild life)
6) Reserva nacional (national reserve)
7) Reserva comunal (communal reserve)
8) Bosque de protección (protected forest)
9) Coto de caza (place for hunting)
10) Zona reservada (reserved zone)

Explanation and regulation of these categories are summarized in the Box I-9.4-1.

Box I-9.4-1

1. National Park *Parques Nacionales*

A national park refers to a plot of land set aside by the central government and usually designated as the area free of development. National parks include pristine wilderness areas or other pieces of environmental heritage which the nation has deemed worthy of preservation.

These areas protect ecological integrity of one or more ecosystems, vegetal or animal species, for current and future generations.

2. National Sanctuary *Santuarios Nacionales*

A National Sanctuary is a place designated by INRENA where the habitat of a particular species as well as the landscape and natural formations is protected. This area is available primarily for scientific research and/or environmental monitoring.

3. Historical Heritage *Santuarios Históricos*

Historical Heritage is the area that implies nationally important stories about the Peruvian nation and is representative of the national experience through both the physical features that remain and the traditions that have evolved within them.

4. Protected Landscape *Reservas Paisajísticas*

Protected Landscape is the area where INRENA protects the harmonious relationship between nature and human beings. In this area, the interaction of men and nature over time has produced a distinct character with significant aesthetic, cultural and/or ecological value, and often with high biological diversity.

5. Wildlife Refuge *Refugios de vida silvestre*

   They are areas whose management needs an active intervention to guarantee the maintenance of the habitats, as well as to satisfy the particular necessities of certain species, as reproduction places and difficult places to recover or to maintain the populations of such species.

6. National Reserves *Reservas Nacionales*

   Natural Reserves are areas dedicated to the conservation of biological diversity and constant and sustainable use of vegetal species as well as aquatic or wild animals.

   In these areas commercial use of the natural resources is allowed according to the approved management plan. The commercial activity is supervised and controlled by the competent national authority. The person who intends to start commercial use must prepare the management plan and receive the permission of INRENA.

7. Communal Reserves *Reseervas comunales*

   Communal reserves are areas dedicated to the conservation of vegetal species and wild animals for the benefit of rural communities located in the neighbourhood zone. Use and commercialization of these resources will be made according to the approved management plans, supervised by the authority and leading by the same beneficiaries.

   Communal reserves can be established over arable lands, cattle, forest purposes or wetlands: natural or artificial, permanent or temporary, abandoned or used actually, including the surface of sea whose depth doesn't exceed 6 meters.

8. Protection Forest *Bosques de Protección*

   Protection Forest is established in order to guarantee the protection of erosion process of fragile lands. In this area it is allowed to develop activities that will not put the land and vegetation at risk.

9. Hunting Areas *Las Cotos de Caza*

   Hunting areas are areas where specific type of hunting is allowed according to the sport regulations.

10. Reserve Zone *Las zona reservada*

    Reserve Zones are the areas that gather some conditions to be considered as Natural Protected Areas but need complementary studies to determine among other things, their extension and category. These areas are also protected by the Peruvian State.

11. Reduction or transitional Zone (buffer zone) *Las zonas de amortiguamiento*

    The areas of transition are those neighboring or adjacent to the nature protected areas of the System due to their nature and location, which require a special treatment to guarantee the conservation of the protected area. The master plan of each area will define the extension. The activities in these areas should not put in risk the ends of the nature protected area.

2. Institution in Charge of Nature Protection

INRENA (*Instituto Nacional de Recursos Naturales* or National Institute of Natural Resources), one of organizations under the Ministry of Agriculture, is in charge of natural protection. In response to the fact that the establishment of the Ministry of Environment in mid May 2008, INRENA with its the function and competence will be transferred to the new ministry in September 2008, but at the time of the 5th Field Study, the first half of June 2008, INRENA keeps this function under the Ministry of Agriculture yet. As additional information, the new ministry is scheduled to start functioning in January 2009.

INRENA has an office called *Intendencia de Areas Protegidas*, or Direction of Protected Areas, who is in charge of two aspects: The first one, concerning the appropriate management of the protected areas that are recognized by the Peruvian National System of Natural Protected Areas (Sistema Nacional de Areas Naturales Protegidas por el Estado – SINANPE) and second one, the supervision of the areas that are not inside that system as: regional, municipality and private areas, including always the buffer areas. The main work of this office is to protect the biological diversity

The authority of protected areas of INRENA recommended that the implementer who want implement certain project or study shall send letters to that office requesting information about the type and characteristics to take into account in the area where the implementer intends to start study or project (only in the case that the communities are located close to any of the protected areas in relation with the map).

3. Use Regulations in the Protected Area

Both indirect and direct uses are permitted inside the ANP, only when the implementer follow the regulation according to the legal frame (Ley de Áreas Naturales Protegidas).

1) Indirect use regulation

   National Parks, National Sanctuary and Heritage Areas are considered as areas of indirect use regulation.

   These areas are mainly used for science studies and it is not allowed to acquire and to use the natural resources of these areas. There are certain areas where the use for recreation and tourism is allowed.

2) Direct use regulation

   National reserves, Protected Landscape, Wildlife refuge, Communal reserves, Protection Forest, and Hunting Areas are considered as the areas of direct use regulation.

   It is allowed to use natural resources inside the area according with the management plan. Other purposes or activities that someone wishes to develop must follow all the objectives of the area.

4. Environmental Impact Assessment of the Protected Areas

It is possible to electrify communities located in certain categories of the protected area by renewable energy under the condition of obtaining permission by INRENA. Implementer of development project must submit the letter explaining the project and problem mitigation plan to INRENA to get permission.

According to INRENA, electrification by PV system is allowed even inside the ANPs. In this case, municipality (district) has to inform the project implementation in written form to INRENA, describing name of localidades in concern with their UTM coordinates, and condition of getting electricity. INRENA favors the use of PV system and uses it in their area offices inside the ANP.

On the other hand, electrification by mini/micro hydro power plants at any scale requires IEE and EIA including possible environmental problems and their mitigation plan if they are located inside the ANP. INRENA regards mini/hydropower system as the cause of change of environment, landscape and bio-diversity.

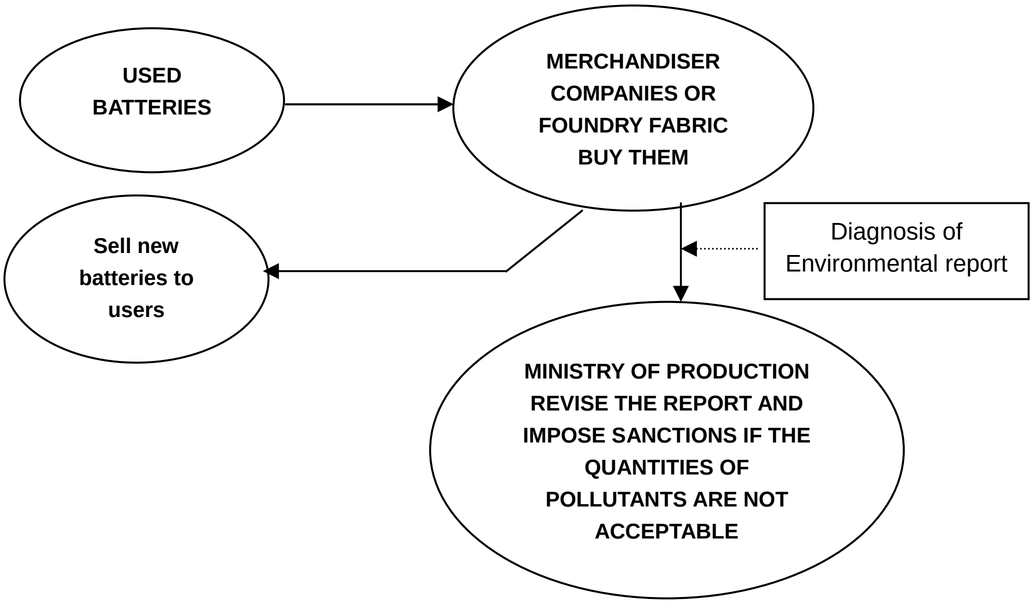
The environmental consideration of electrification projects to be done inside the buffer zone is the same as those inside the ANP. Implementer has to execute IEE at first and inform the result to DGAAE of MEM; MEM examines it and decide whether the project implementation is possible or not; then MEM transfer the cases that they approved implementation to INRENA; INRENA examines the document again and decide if the project implementation is possible or not. INRENA inform the result of screening to the implementer if they approve or ask the implementer some question about environment protection. As for the latter case, INRENA examines the answer again and does the final decision.

I-9.5 Management of Solid Waste

Management of used batteries is indispensable for PV system to avoid impact on environment. Law 27314 – General law of solid waste (*Ley General de Residuos Sólidos*) and Supreme decree (*Decreto supreme*) No 057-2004-PCM under the jurisdiction of Ministry of Health prescribes that the district and provincial government offices are in charge of disposal management. For the handling of the used batteries, these law and decree shall be fulfilled as well as the inspection of the execution of the legal norms concerning the conservation and protection of the environment; the management of solid waste relating to electricity is in charge of OSINERGMIN, in conformity with the articulate 2 of the Law 26734.

General Directorate of environmental health (*Dirección General de Salud Ambiental* or DIGESA) of Ministry of Health is in charge of registration of companies who merchandise used batteries. These companies submit environmental impact report every six months to *Dirección de Asuntos Ambientales de Industria* (Direction of environmental topics of industry) of Ministry of Production who work for the administration of industrial waste in general.

According to the information of DIGESA and *Dirección de Asuntos Ambientales de Industria*, they judge that four companies working for industrial waste satisfy the environmental standard by checking the EIA study reports prepared by the environment consulting companies. These companies buy used batteries, treat and/or recycle them and sell new products or new batteries to the market; it is confirmed that at least one of these companies does battery recycling and sells recycled ones to the market (Fig. I-9.5-1). However, there are many small companies, factories and shops who treat and recycle batteries without registration to DIGESA. Thus, it is difficult for DIGESA and *Dirección de Asuntos Ambientales de Industria* to control all of them due to lack of time and few personnel.



Source: JICA study team, 2008

Fig. I-9.5-1 Flow of Actual Situation of Battery Recycling

Ministry of Production has been preparing a regulation about the use of batteries including used batteries, for these four years; however, they are not ready to promulgate at the time of the interview. The draft of this regulation includes the matters shown in Box I-9.5-1.

Box I-9.5-1 Important Contents of the Draft of Regulation on the Used Battery

a. The rights and duties of manufacturers, importers, merchants and users once the period of life of the battery is finished. This regulation will be applied in all the Peruvian territory.
b. The Collection system of batteries with the purpose to avoid an inappropriate management
c. The duty to return the old battery if the user wants to buy a new one, or on the contrary to pay a fine if the user does not return the old battery
d. The technical criteria to deal with old batteries
e. Penalties

There are also another Peruvian Technical Regulation created by other independent public organism called INDECOPI or Defensa de la Competencia y del Protección de la Propiedad Privada (National Institute of Defense of the Competition and of the Protection of the copyright). It focuses on the management and treatment of used batteries from legal point of view, but their concrete activities are not known to the DIGESA and *Dirección de Asuntos Ambientales de Industria*. INDECOPI controls these companies so that they obey the laws and regulations. If INDECOPI finds illegal activity, they impose penalties to them.

II. Master Plan

II-1 Rural Electrification Plan by Renewable Energies

This Chapter in II-1.1 proposes measures for problems identified in each field: general, organization, finance, solar power, mini/micro hydropower and power transmission/distribution. From II-1.2 through II-1.4, proposal has been made on the points considered important for execution and diffusion of rural electrification by renewable energies: 'Planning of Electrification by Participatory Approach and Information System of Rural Electrification', 'Raising Awareness and Education of Inhabitants of Remote Villages through Rural School Electrification', 'Mechanism for Sustainability'. II-1.5 proposes action plans on the proposed measures to be taken by which organization and when.

On the condition that those proposed measures be realized, II-1.6 proposes an electrification plan of non-electrified villages.

II-1.1 Countermeasures for Problems of Rural Electrification

II-1.1.1 General

In order to tackle with the problems in execution and diffusion of rural electrification by renewable energies described in Chapter I, it is indispensable to have a systematic institutional design at national level l. Fig. II-1.1.1-2 shows a conceptual diagram of the proposed institutional scheme. This scheme incorporates the following mechanisms based on problems-measures analysis for electrification by renewable energies shown in Fig. II-1.1.1-1.

- Dialogues with local sides for strategic alliance to form agreements on roles and collaboration between central and local sides for electrification by renewable energies
- Raising awareness of inhabitants of remote villages on electrification by renewable energies
- Planning mechanism for electrification by initiative of inhabitants of remote villages and unified collection of information on rural electrification by MEM/DPR.
- Financial mechanism by SPERAR and subsidy mechanism by FOSE
- Capacity building for inhabitants of remote villages and local governments
- Supply chain for construction and operation and maintenance

In order to make effective the above institutional system, it is necessary to take some legal measures. If 'Law on Promotion of Non-conventional Renewable Energies' will be abolished and a new law will instead be established, it is proposed here to make such a law specialized for execution of the Master Plan, for example, 'Law of SPERAR', in which recommendations in this Master Plan Study are reflected and smooth execution of the Master Plan is considered. In creating a new law, the following points should be considered particularly.

- For electrification by renewable energies under decentralization of government, make clear in concrete terms the roles to be played by central government and regional/local governments regarding financial, technical and managerial aspects;
- Introduce such incentives as to allow regional/local governments to accept intervention by central government on account of the gap between central and regional/local governments and of the gaps between different levels of regional/local governments regarding information and decision-making process;
- Establish information system of rural electrification (target villages, potential, investigations, plan, finance, organization, existence of mini-grids, current situation of power supply, progress of individual electrification projects, etc.) and mechanism for collection of such information;
- Establish planning system of individual electrification projects by participatory initiative of beneficiary village inhabitants and incorporate supporting measures for such system;
- Incorporate a clause regarding establishment and administration of mechanism for sustainability;
- Incorporate a clause to secure funds, organization and personnel specialized in implementation of the Master Plan;
- Take legislative measures to introduce special tariff system and apply subsidy from FOSE, considering that target villages are located in poor areas with extremely low ability to pay; and,
- Make relevant procedures as simple as possible on account of insufficiency of personnel and capacity of local sides.

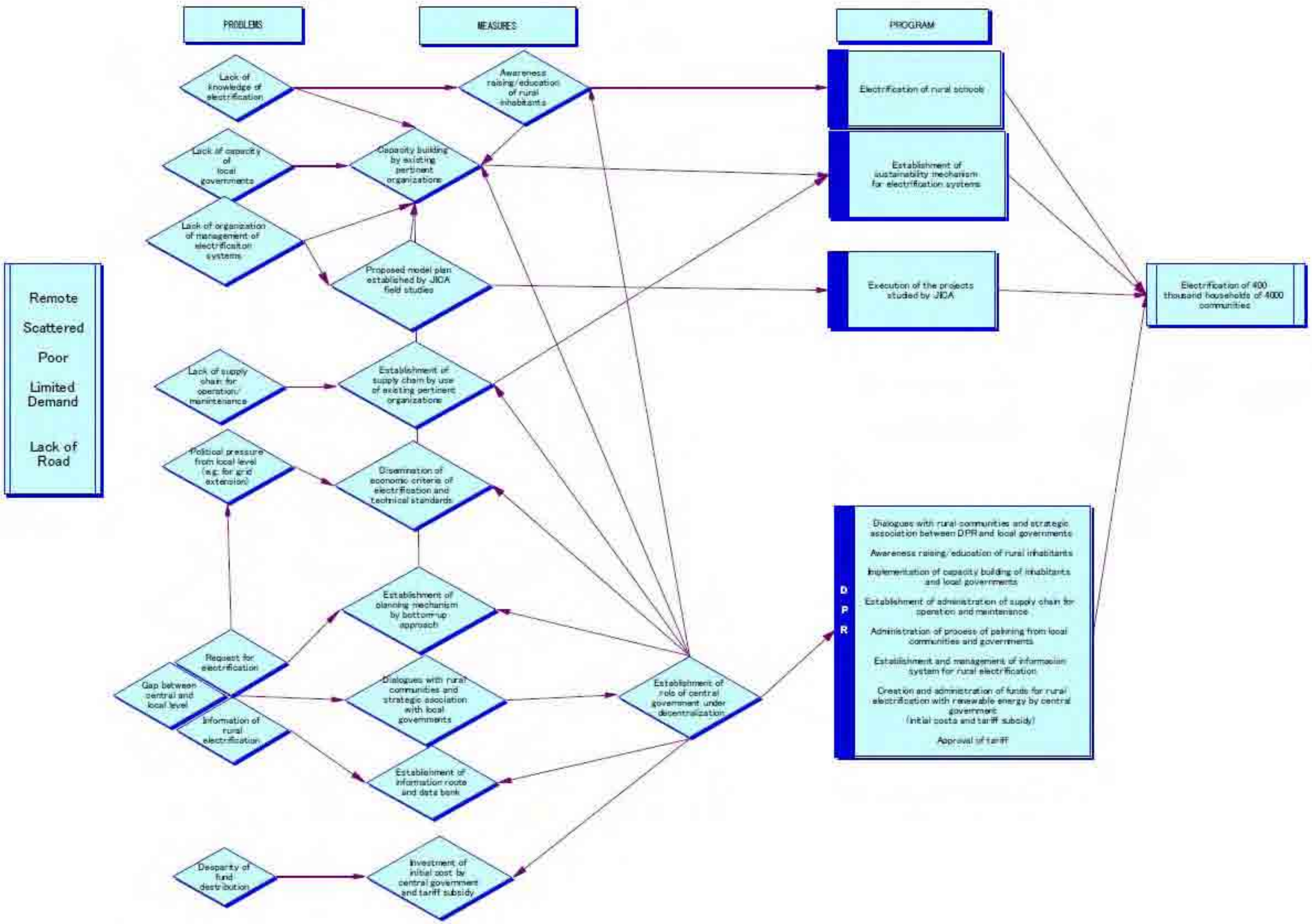


Fig. II-1.1.1-1 Problems-Measures Analysis for Electrification by Renewable Energy

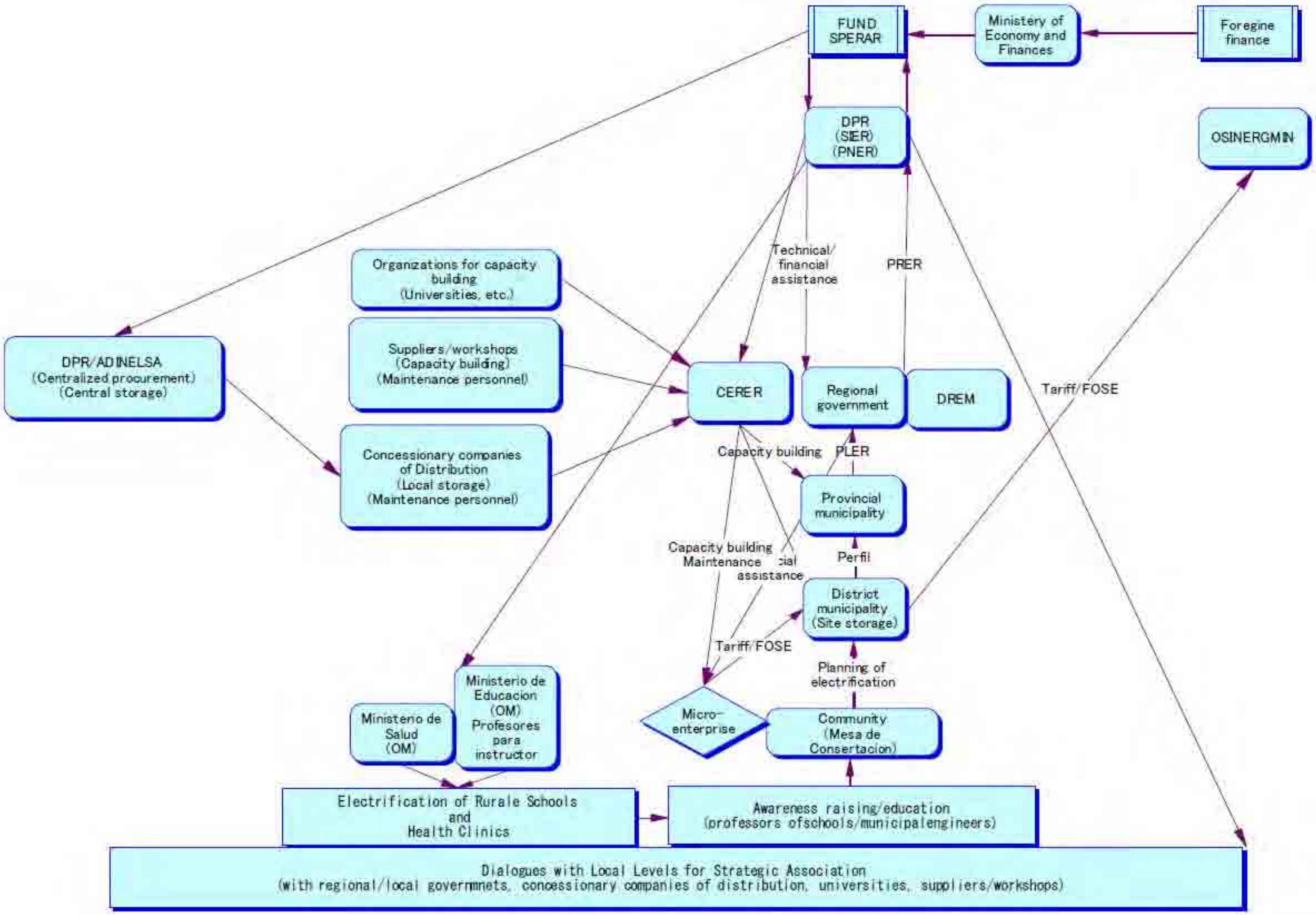


Fig. II-1.1.1-2 Conceptual Diagram of Institutional Design

From Chapter II-1.2 through Chapter II-1.4, explanations are made 'Planning of Electrification and Establishment of Information System of Rural Electrification (SIER)', 'Raising Awareness of Inhabitants of Remote Villages through Electrification of Rural Schools', and 'Sustainability Mechanism for Electrification Systems' according to the above conceptual diagram.

II-1.1.2 Organization

In order to solve the issues on the utilization of renewable energy, the following principles can be considered.

1) Organizing(networking) capacity-building institutions especially including universities and capacity building of villagers and municipalities
2) Strengthening of DPR
3) Creation of micro enterprise undertaken by villagers
4) Creation of one-stop center for renewable energy at regional government level

In remote areas, adequate information on renewable energy has not reached and they have no capacity for planning and implementation. On the other hand, universities including UNI and University of Cajamarca has established center for renewable energy and electrification by renewable energy has been implemented. By utilizing such existing resources effectively and organizing institutions especially including universities in each region, collection of information and training of villagers can be done as supporting system for implementation of renewable energy projects as well as back-stopping activities. In addition, by creating network of universities on renewable energy, universities can have linkages among them and every university can undertake supporting activities as a local center for renewable energy closer to villagers.

It is imperative condition to urge the participation of other institutions including NGOs or private institutions that have experience and knowledge. For example, ITDG is the NGO who has very extensive knowledge and experience in this sector. They are leading organization in rural electrification with renewable energy with sustainable system. Adoption and utilization of such knowledge which is existing in this country is the key to success. As not all universities have specialists and experiences, they have to learn from those who have expertise including NGOs and the private sector.

DPR has not enough ability of collecting information; and, such information on the necessity for renewable energy will not reach them as long as they just wait in the capital. In order to solve this issue, it is DPR who must take actions and they are the ones who must approach to get information. Therefore in order to strengthen the ability for collecting information, it is necessary to allocate more fulltime DPR staff in charge of renewable energy in regional governments, and through regional governments information collection ability should be reinforced.

Adequate information on renewable energy has not reached to villagers, and they have not enough capacity for planning and implementation. The areas where renewable energy is to be applied are basically located in remote areas and it is difficult to access, therefore such areas are required to have self sustainability. In such areas, villagers or users involvement is essential and villagers or users by themselves should undertake operation and management of the system. Therefore it is necessary to implement capacity building for strengthening ability on planning, management and operation, and governance.

In order to establish sustainability firmly, creation of enterprise is the best option, since the going concern of the enterprise is the limitless continuous operation of the enterprise. In addition, by creating an enterprise, ownership and management can be separated which occasionally have conflict of interest between them. In order to establish it, it must have appropriate revenue, management, and operation. In addition, in order to obtain power user charge or power user fee as revenue monthly, it is better to have a system operated by villagers where peer pressure exist by knowing each other. Therefore, micro enterprise for management and operation of renewable energy system should be established with the initiative of villagers and this enterprise will undertake the task. Ownership will be within the hands of government institutions including municipalities and a contract will be concluded between the owner and the enterprise, and the responsibility of the enterprise will be clearly demarcated by separation of ownership and management

Lastly, the leading organization at regional level is necessary. At this moment no region has bureau responsible for rural electrification by renewable energy. Without such bureau, no promotion on this sector can be realized. In addition, without such bureau, villagers or those who are interested cannot go and consult on this matter. Not only for promotion, but also for maintenance purpose, it is necessary. After installation or operation, the system may fail. In a case that villagers or trainers cannot solve, some window must be open for consultation. This bureau therefore must be a so-called one-stop center (Ventanilla Unica) where all issues on rural electrification with renewable energy can be solved, so that such window is necessary.

Table II-1.1.2-1 Principles for Solving the Issue

Principle	Main objective
Establishment of supporting organizations based on existing universities and networking them	Network on the renewable energy will be established based on existing universities and others in each region, aiming to be a supporting system for information collection, training, project implementation and backstopping on the issue.
Strengthening of DPR	In order to strengthen ability of information collection in regional base, DPR should be strengthened and their staff will be allocated in charge of renewable energy in regional government, and through regional government information collection ability should be reinforced
Capacity building for villagers and municipalities	Implement capacity building for villagers and municipalities in order to strengthen abilities of planning, management and operation, and governance.
Establishment of micro enterprise by the hands of villagers	Micro enterprise should be established by the hands of villagers for the purpose of management and operation of renewable energy, and ownership and management should be separated in order to demarcate the responsibility of the enterprise
Establishment of a bureau at regional government level for renewable energy (CERER)	CERER, a one-stop center (Ventanilla unica) should be created at regional government level who will be responsible for rural electrification with renewable energy in order to be able to handle all issues

To start with, it is necessary to create CERER (Renewable Energy Center for Rural Electrification) as one-stop center (Ventanilla Unica) at regional government level who will be responsible for rural electrification with renewable energy, and in addition, supporting network system based on existing universities, etc. They will be the main players who will undertake the capacity building of villagers and rural municipalities. Those universities who do not have expertise and experience should strengthen their capability with the assistance of others including NGOs and private sector. After then, they should start training the villagers for technical and management for the creation of micro enterprises by the villagers. And micro enterprises are to be established. In parallel, strengthening of DPR should be necessary to be implemented.

In order to implement the above method, lead-time, fund, human resources, and facilities will be required. It will take a certain period of time to create CERER, organize such organizations as universities for the implementation of capacity building, train the trainers, provide training to villagers, and then create micro enterprise and finally install the renewable energy equipment.

In theory, though, it is feasible to achieve the target of MEM with this method. For instance, in one region, if it is possible to establish 3 micro enterprises in one month, 30 micro enterprises can be established in one year (assuming 10 months in a year). If a micro enterprise covers 100 households, then 3,000 SHS can be established. So, if it can be implemented in 4 regions, more than 10,000 SHS can be realized and, if it is implemented in 12 regions, more than 30,000 SHS can be realized.

However, in order to realize the electrification in such a pace, it is difficult to have it unless efficient investment on human capital, goods, and financial capital are done. Therefore, as a compromise, the following method can be considered as one of tentative alternatives choice.

1) Install the equipment facilities with a massive method that DPR is executing. With the intervention of ADINELSA and regional governments, user association will be created, as can be seen at the operation of facilities of ADINELSA, with an average of 80 users per association and the management body of user association will assume the operation and maintenance activities including monthly user charge collection. User association will have a contract / agreement with ownership holder of the facilities for the use and management of them. ADINELSA and regional governments will be responsible for supporting activities including provision of spare parts.
2) At the same time, establish organizations mainly in universities for the implementation of capacity building, and train the trainers. The trainers training can be done with UNI's program.
3) The persons who are trained will instruct the villagers at each region, and regional governments together with municipalities enhance the transformation from users association to micro-enterprise. All the rights and obligations of the association will be transferred to the micro-enterprise.
4) The users association is inferior to micro enterprise from the viewpoint of sustainability due to its vulnerability. Therefore, early transformation is necessary. Thus, a time limit should be set for the transformation procedure: for instance half a year. In the case that a micro enterprise cannot be established within that period, the sustainability of facility would be in danger, so an agreement should be made with municipalities at the moment of installation that in the case of failure of keeping the time limit, the facilities and equipment will be removed.

II-1.1.3 Financing

1. SPERAR Fund

In this Master Plan, it is proposed to create the SPERAR Fund for electrification by solar power and small hydropower projects. As a part of this Fund, it is considered to establish a fund specifically for small hydropower development, according to the necessity. In this case, it may be established through financial assistance from donor countries / agencies, as well as setting aside certain amount from the annual budget of MEM for rural electrification to create a revolving found.

2. CANON

It is a requisite to carry out pre-investment study in implementing rural electrification project. It is necessary to formulate a framework to make it possible to carry out the studies with the budget of the regional/local government (CANON). This may include the modification of the existing laws and regulations. It is expected, however, that a smooth linkage to the project implementation should be sought, so as not to allow making studies in vain, considering the limited financial resources.

3. Level of Electricity Tariff

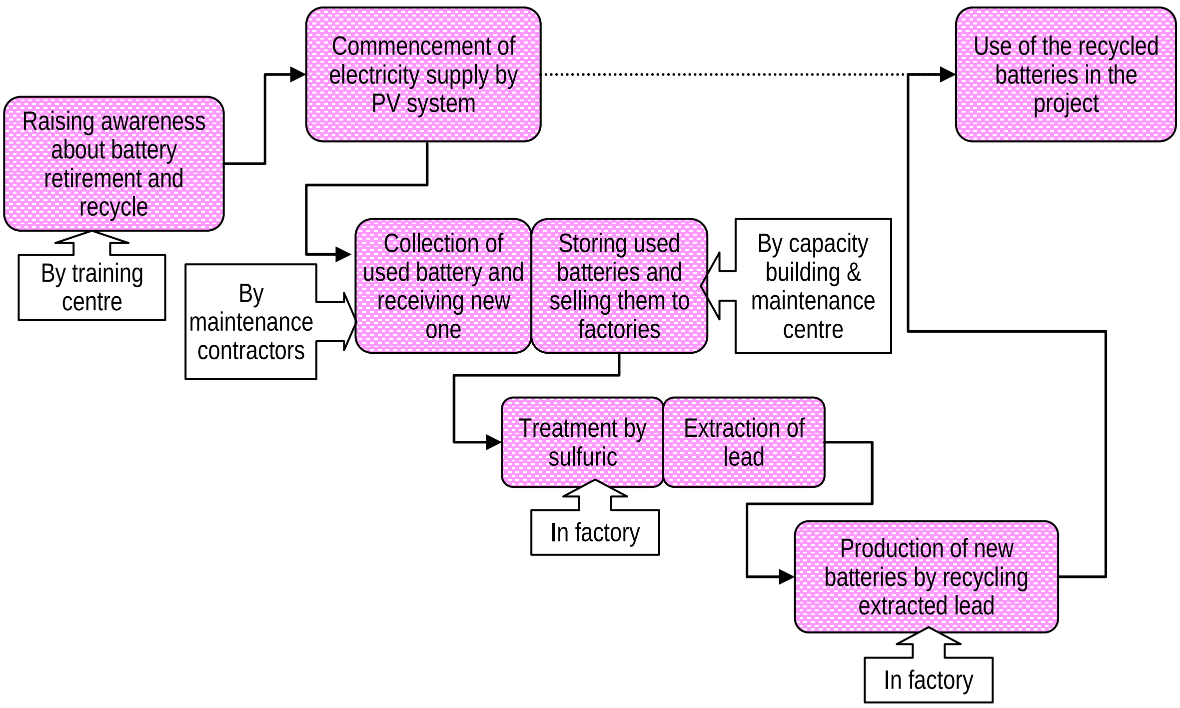
In order to decrease the electricity tariff level, it is necessary to apply two existing tariff adjustment systems: one is FOSE which aims at adjusting the electricity tariff among users, and the other is the Compensation Mechanism, which intends to adjust the difference of generation/transmission cost among power companies. It is desirable to take measures to simplify the procedures of registration at MEM and the periodical report thereafter, so that the micro enterprises to be established for rural electrification may have easy access to such benefit. Especially, it is indispensable to lay down regulations of Compensation Mechanism for solar power system as soon as practicable.

II-1.1.4 Technical Countermeasures of PV System

1. Used Battery Treatment

It is recommended to cooperate with existing battery recycle companies for used battery treatment. It is necessary for DPR to prepare the plan for used battery treatment in Phase 1 of Action Plan. In addition, it is important to recommend the recycle company to increase the capacity of used battery treatment and re-examination of the working process from both of safety and environmental aspects.

The JICA study team proposes the system of treatment and recycle of used batteries as follows (refer to Fig. II-1.1.4-1).



Note: JICA Study Team, 2008

Fig. II-1.1.4-1 Image of Recycle Flow of Used Battery

Raising awareness

Necessity of collection and recycle of used batteries shall be the content of public awareness program and shall be given in the training program to users, so that they will return the used batteries to the recycling system.

Collection of used batteries

Maintenance contractors collect used batteries when they supply new batteries and store old ones at storehouses that the Master Plan proposes to build in the site of government offices of each department. CERER proposed in the Master Plan will manage them.

Chemical treatment and production of new battery

CERER of each department sells the used batteries stored in the storehouse to the battery recycling factories. The battery factories treat them by sulfuric acid; then, they send treated batteries to lead treatment factories where lead is extracted from them. The battery factories produce new batteries by recycling the extracted lead.

Re-use of recycled battery

These new recycled batteries shall be used in the electrification projects by PV system (purchased by ADINELSA by SPERAR fund, stored in the storehouse managed by CERER). As this recycle system is not local or regional level, but nationwide one due to concentration of treatment factories and centralized acquisition of equipment and materials, centralized management is indispensable. In this context, organization in charge of centralized acquisition, ADINELSA or MEM, is proposed as the proper organization for the battery recycling management.

2. Educational Campaign

JICA study team has prepared manual on PV system for local government in this study. The purpose of the manual is dissemination of the basic information on PV system. The content of the manual is not only technical but general aspect. In Phase 1 of Action Plan, DPR will conduct educational campaign for rural electrification by renewables to rural population by using Video prepared in this study.

3. Lower Power Tariff Setting for Users

JICA study team considers the use of BCS as optimum system for household affordable to pay small power tariff. In addition, electrification for public facilities such as school or health clinic should be considered for the households that can not use electricity but receive benefit through public services.

4. Improvement of Technical Standard and the Others

It is necessary to develop technical standards over 500 Wp of installed capacity that is appropriate for power supply system at public facility. Technical standard under 500 Wp is already developed in Peru.

It is necessary to monitor solar irradiation where PV electrification is planning because there are no irradiation data for estimation of power output. And also, technology on wind monitoring and the analysis have to be transferred to clarify the wind potential for power generation in Peru. Improvement of quality of PV component in market base is important for general users. It is necessary to develop certification system on PV components, for example, certification mark on certified PV components.

II-1.1.5 Technical Countermeasures of Mini/Micro Hydropower

In rural electrification by mini/micro hydropower the following three prominent items shall be given due attention.

1. Identification of Mini/Micro Hydropower Potentials and Selection of Candidate Sites for Pre-F/S

The grasping mini/micro hydro potentials and selection work of detailed candidate sites are necessary to implement and promote rural electrification by mini/micro hydropower. It is important for confirmation of its feasibility to consolidate fundamental data, for example, the information of candidate sites to MEM/DPR. In particular, a feasibility of small hydro depends on river discharge; therefore, its feasibility should be studied firstly using isohyetal map or specific flow map. Identification of candidate sites should adopt the following methods in consideration of the above data being prepared and advantage of proposed bottom-up approach for rural electrification in Peru.

- Continuing implementation of questionnaire and interview survey
- Utilization of geographical information system (GIS)

2. Enlightenment of Electrification by Mini/Micro Hydropower

Fundamental knowledge of hydropower such as “What is Hydropower” is needed to disseminate at local level in order to carry out the above (1) efficiently. As a matter of course, finally data of target villages and hydropower potentials are necessary for consolidation to central governments, therefore, a study for organization and mechanism are needed separately so as to get great performance out of consolidation of the above information between local and central governments. However, before then in the case of identification of hydropower potentials or candidate sites being carried out by questionnaire and inquiring survey, recognition of rural electrification by mini/micro hydropower must be improved so as to realize bottom-up approach at local level. It seems that Video and pamphlet which have been made as educational materials in this study is available for dissemination of mini/micro hydropower.

3. Technical Standard (Design Criteria)

Mini/micro hydropower stations less than 500 kW have not been developed by unified technical criteria or standards. Concretely speaking, in the case that MEM/DPR confirms a design of small hydropower that is studied by a local government (subcontracted from a local government to a local consultant), MEM/DPR sometimes find some functional defect on design drawings. This means that mini/micro hydropower stations developed by a local government may have some troubles after construction. A local government or consultant may need improvement of their technical ability and experience as well as unified technical criteria regarding mini/micro hydropower designs in order to solve those problems. In addition, in the case that a small hydropower developed with the cooperation between a private and local government (an example case of NGO; ITDG), if a private organization has many experiences, there will be no problems on technical matters but there may occur differences between MEM/DPR and private organization regarding aspects of environment matters (environmental conservation).

On the other hand, construction cost will not be constant because features of mini/micro hydropower are different site by site (for example; a difference of water way and penstock length). Construction cost of mini/micro hydropower also depends on technical standard/design criteria which are adopted in its study. In addition, mini/micro hydropower is economically inefficient compared with small and medium hydropower and its trend prominently appears according to a small degree of output capacity.

Therefore, in the case of preparing of design criteria in the future the following contents of Table II-1.1.5-1 should be considered.

Table II-1.1.5-1 Item to Be Considered in Design Criteria

STAGE	Implementation Items	Study Items	Study Contents and Collection Data
Preliminary Survey	Collection of fundamental data (Mainly desk study)	• Collection of hydrological data	• Rainfall, River discharge, Temperature, Geology
		• Collection of topographical data	• Geology (Head, River gradient), Access road, Distance from the nearest city
		• Collection of demand data	• The number of villages and households, Population, etc.
Site Survey	Collection and evaluation of fundamental data (Mainly site survey)	• Collection and evaluation of hydrological data	• Rainfall, River discharge, Temperature, Geology
		• Collection and evaluation of topographical data	• Geology (Head, River gradient), Access road, Distance from the nearest city
		• Collection of demand data	• The number of villages and households, Population, Use of electricity demand, Necessary demand
		• Collection and evaluation of environmental data	• Alteration area, Rare animal and plant, Water quality, Change of water quantity, Sedimentation supply, etc.
		• Determination of fundamental data	• Plant discharge, Design flood, Head, Sedimentation, Electricity demand, Environment impact assessment

STAGE	Implementation Items	Study Items	Study Contents and Collection Data
Design	Design of structure and machinery	• Weir • Settling Basin • Headrace • Head Tank	• Type, Material quality, Figure, Necessary strength, Selection of type of turbine and generator
	Cost	• Penstock • Powerhouse • Turbine/Generator • Tailrace	• Unit cost of materials, Unit cost of machinery, Price trends, etc.
	Environment consideration	• Outlet	• Consideration of structures landscape (Adoption of Buried structures), Noise measures, etc.
Construction	Plant construction	• Construction work/ Quality control	• Concrete mix proportion, Strength, Reinforcement, Figure, Safety measures, Environment measures, etc.
Operation & Maintenance	Plant operation	• Operation and maintenance	• Operation method • Inspection method, points and frequency • Handling of accidents, Maintenance and management method

II-1.1.6 Technical Countermeasures of Transmission/Distribution Lines

The National Electrical Code was the only standard used across the nation several years ago; therefore, the designers of distribution facilities use their own manual at every site in Peru. This result is a high spec and high cost distribution facility similar to urban areas despite being located in remote rural areas.

MEM/DGE established rural technical standards to design the most appropriate facilities considering local conditions. And MEM also aims to reduce costs by standardizations. All the standards in Peru follow IEC or ANSI.

MEM understands and cares about the fact that supplying cost per household in rural electrification is rising because of difficulties in accessing the grid. They are also trying to raise additional capital and introduce cost reducing techniques. Shown below are the examples of cost-down executed after the introduction of Rural Electrification Technical Standards in 2003.

- Standardization of Poles

  The most influential part of distribution facilities cost is poles. In rural electrification projects, this cost involves the appropriate material of poles (wood, concrete, steel), length and span of each pole depending on design load, cost of transportation and soil situation. Domestic eucalyptus wooden poles are the most reasonable, followed by wood from Canada and Chile. Distributors were recommended to use these cheap wooden poles as much as possible because these woods are easy to transport even in the remote areas.

  Another cost cutting measure is simplifying the stock materials and reducing pole support to reexamine the span of each pole by making the most of the pulling strength of electricity lines.

The costs of distribution systems are the building, operation and maintenance of the poles, power lines and transformers. The largest cost-cutting item is the poles and the minimum conductor height from the ground. National Electric Code separates its regulations between urban and rural areas. For example, low voltage lines should be kept more than five meters distance from the ground, but it deregulated to four meters in rural areas where there are no vehicles.
In this way, the cost reduction of poles which cost accounts largely in distribution facilities is the most effective. There is ample scope for reducing the cost of rural distribution facilities in Peru.

- Standardization and Simplification of Pole Accessories
  One of the most important aspects of electrification in Peru is street lighting to maintain safety at night. MEM regulates the necessity of street lighting in accordance with the number of households. Cost reduction measures are being studied to combine the street light device with wire and switch box on top of the pole. Where power lines do not have high strain, simplification of pole accessories such as reducing strain poles, should be practiced.

- Earth Returning System
  To minimize infrastructure cost in communities with small demand, a grounding system was introduced to low voltage lines. This method can be adopted as a model with the cooperation with Brazil and Australia. It is possible to reduce the cost of power conductor of distribution line to adopt this method

- Reliability in Rural Areas
  Quality Standards regulate supply reliability. In these standards there are many categories that are dependent on the number of the households supplied and the reliability level is then classified according to the level of demand. Voltage drop limit of the second distribution, for example, is deregulated to 7.5% in rural area to compare with 5.9% in urban area. Additionally, these quality standards are not applicable in Non-Concession area.
  The cost reduction can be expected to deregulate such reliability rule in rural area.

II-1.1.7 Measures in Social Consideration

The purpose of social consideration is to reduce negative impact and to maximize positive effect of the project on beneficiaries. In this section, social consideration, gender consideration and measures to increase inhabitant’s incentives are mentioned.

1. Social Consideration

It is indispensable for electrification projects to understand the social conditions of beneficiaries and beneficial communities in order to enhance the effect of electrification most effectively and to avoid unnecessary conflict between implementer and users as well as among users in the process of planning, implementation planning and implementation,.

One of the most important problems that the JICA Study Team faced during the study period is that there are no staff members who work for social consideration in MEM/DPR. As a result, they have no experience of grasping social condition of the project area and reflecting it on the plan. Thus, it is strongly recommended that MEM/DPR employ competent expert of social development. Also, JICA study team proposes that implementers, MEM and local governments put the activities mentioned in Table II-1.1.7-1 into practice.

Table II-1.1.7-1 Social Consideration Necessary for Electrification Project

Process	Item	Explanation
1	Collection of social and economic data of the target community	On-site confirmation and collection of the social factors to be considered at the implementation such as, boundary of the project area, information necessary for estimate of electricity demand, protected area, ethnic minority, water rights.
2	Information exchange	Informing draft plan; obtaining intention of electrification and opinion about project implementation from inhabitants through public hearing
3	Taking account of reduction of negative impact on community	Formulation of implementation plan that reflects inhabitant’s intention, opinions and propositions as much as possible. By this, equity of benefit and sustainability will be strengthened.
4	Examination of measure to deal with problems	Through the processes 1-3, social condition and maybe cause of negative impact on community can be found. The supposed problems are: land ownership, operation and management system, possibility of uneven distribution of benefit of electrification, electricity charges, minority within the community and so on. Implementer shall make measures to solve or mitigate each problem.
5	Raising public awareness and capacity building	As mentioned in II-1.4.2, capacity building is planned to be given to the inhabitants before project implementation. By this, they obtain capacity of operation of generation facilities of renewable energy, maintenance and management.
6	Monitoring	Every stakeholder shall do monitoring of facility management and benefit distribution after the electricity service starts. Micro enterprise who is in charge of operation and management of each site does monitoring and submit the result to CERER. CERER checks the report and takes immediate action if they find problem. Also, MEM/DPR is the highest supervisor of the project management and shall cope with the large scale problems.

SNIP requires social consideration. It explains that implementer shall collect information at each stage of profile, pre feasibility and feasibility study, about energy use, problems and actual situation relating to them, and to specify main factors that may influence on the demand.

2. Gender Consideration

One of the important problems of electrification project of participatory management type, including electrification by renewable energy, is that women can receive very few information of electrification and technical training and have very few chance to participate in operation and management. However, this type of electrification project can be regarded as a good opportunity for acceleration of women’s participation in social development.

Women must be involved in an electrification project from the fist step (collection of basic community information), by which women can understand the electrification project and feel it familiar to them. Then can increase their potential of participation in the project at the implementation and operation stages. Through this process, women can more effect from electrification than the case they are not involved in it. Implementer shall consider following matters concerning gender issues.

1) Interview not only to men but also to women at the social survey to understand actual social, economic and gender condition of the community in concern at the beginning of the project,
2) Calling not only male but also female household members to the public hearing so that both men and women can understand renewable energy and the project and can offer own opinions,
3) Giving training to both male and female users in facility operation and maintenance,
4) Facilitating users to select women members for the management organization to be established, and,
5) Monitoring of gender equality after the start of electricity service whether both men and women participate in management and receive benefit from electricity.

According to the Poverty Map of FONCODES, female’s illiteracy rate differs greatly by district: as for the community being object of the master plan, lowest is 1% (Pacocha District of Moquegua Department) and highest is 69% (Quillo District of Ancash Department). On one hand, women’s group does social activity in Yerba Buena, one of the sites for field study at pre-feasibility level; on the other hand, almost all women cannot understand Spanish and forced to follow men by tradition in Balsapuerto, another site for field study at pre-feasibility level. Thus, when the above mentioned process is taken, actual gender condition must be understood at first; and then, measures shall be prepared corresponding to the area-specific condition with exchanging among inhabitants.

In consideration on the fact that MEM and local government (district) have no staff members who are in charge of gender and social development, it is advisable that gender consideration in electrification project should be done in collaboration of MEM and Ministry of Women and Social Development in charge of gender.

SNIP does not clearly require the study concerning gender related issues; but gender should be studied as a part of sustainability analysis.

3. Maximization of Positive Effect of Electrification

Social consideration and gender consideration mentioned above reduces negative impact of electrification on beneficiaries and beneficial communities. It is necessary to propose the means of maximizing positive effect of electrification. It will be the incentive to enhance inhabitant’s intention of participation in electrification project.

(1) Increase of Expected Effects in Social Life

Community survey reveals that inhabitants living in rural communities without electricity desire to improve their living life and social life by using house lights and street lights, television and radio. In order to realize and ensure this ‘candle to computer’ revolution, bulbs and spare parts must be supplied when they are needed inside the community or near town. The supply chain that the master plan proposes will guarantee user’s satisfaction and sustainability. On the other hand, as for the realization of expect of information reception, users are required to be affordable to pay for these electrical appliances.

(2) Production / Income Generation

Community survey shows that inhabitants living in rural communities without electricity know that they can produce something by using electricity and extend working time thanks to light. However, not many of them understand what they should do to generate income.

According to the result of the survey in electrified communities, inhabitants there seem to think that they have increased production or income because their community had had the condition of production: tourism in Taquile and Canoapuerto, milk production network of big milk companies in Catilluc (refer to I-8). Lessons of these communities show the following prerequisite conditions are required especially for starting new production or business.

1) New production will not be successful if inhabitants do not have capacity in technical matter and maintenance/management. At least, experience in commercialization of the concerned product must be required.

2) In the case of new product, it is indispensable to build inhabitant’s technical capability simultaneously with the production project. Also, the implementer of the project (inhabitants or supporter) needs to find the rural development scheme other than electrification project of, for example, the Ministry of Agriculture to receive training or subsidy.

3) Even though inhabitants have the experience of production in concern, they cannot sell the product of increased amount without market. Adding to this, development of transportation system is also indispensable to carry the product to the market. Market research and development of new markets must be executed before commencement of the new production.

4) On the other hand, electricity or electric power should be used if it can reduce work load that people actually do by human power (example: pumping water). However, this does not directly mean increase of production unless production techniques and/or production facilities are improved. And, in the case that the production increases, it is the same condition as mentioned in 3). Thus, use of electric power is considered as the dimension of ‘improvement of quality of life’, if above-mentioned conditions are not satisfied.

It is not easy to increase income by productive use of electricity as mentioned here. However, if inhabitants have keen intention and potential, implementer must do market research and try to find financial and technical supports of relating governmental and/or non governmental organization before project implementation. Further, implementer needs to prepare training opportunity.

MEM thinks examination productive use of electricity is important and started a pilot project of the productive use of electricity by PV system in Puno in October 2007. It was at the training step when the JICA study team visited there. The lessons of productive use will be obtained from this project through monitoring when members of the production group start to try to sell their products. The field report on this pilot project for the productive use is attached in Appendix.

II-1.2 Planning of Electrification by Participatory Approach and Information System of Rural Electrification

The number of personnel of MEM/DPR is not sufficient to implement rural electrification plan by renewable energies by top-down approach from central government, considering that such plan covers all of the 24 regions of the country and that target villages are located remotely. On the other hand, under decentralization of government, there are gaps between MEM/DPR and regional/local governments and local communities due to lack of effective system for information sharing and decision-making process, which causes lack of information to MEM/DPR and may hinder preparation of 10-year plan of rural electrification and, eventually, attainment of target coefficient of electrification.

In the meantime, target villages for electrification by renewable energies are located remotely and small in power demand and low in income level, which make it difficult for private sector to enter business of electrification of non-electrified villages. As for information on needs and potential of electrification of villages as well, it is difficult for central government to make such information collection. Hence, a bottom-up approach is considered to be appropriate in such that inhabitants of non-electrified villages should be primary players in identifying needs and potential of electrification and make plans for electrification projects.

Being indispensable to take a participatory approach for inhabitants of villages to be primary placer, they lack knowledge of renewable energies. It is therefore necessary to educate inhabitants of villages.

For such purposes, it is proposed here to electrify rural schools and make use of them as education center. Chapter II-1.3 refers to this idea of electrification of rural schools.

In order to fill the abovementioned gaps between central and local levels, it is necessary to form agreement regarding demarcation of roles and collaborative system of central and local sides to promote electrification by renewable energies. To that effect, it is proposed to conduct dialogues between central and local sides for strategic alliance. In this connection, FITEL Program by Ministry of Transportation and Communications is informative and inspirational.

FITEL Program is aimed to provide telecommunications services for remote villages, having so far installed telecommunications facilities mainly with solar power in some 1,500 villages since 2000. This Program was started with dialogues between central and local sides from 1998 through 1999 by making the rounds of regions of the country, holding meetings with local sides, some 8 times for each region, to grasp needs for telecommunications and form agreements for roles of both sides.

‘Planning of Electrification by Participatory Approach’ and ‘Information System of Rural Electrification’ corresponds to yellow parts in the conceptual diagram of institutional design in Fig. II-1.2-1. ‘Raising Awareness and Education of Inhabitants of Villages’ and ‘Dialogues between Central and Local Sides for Strategic Alliance’ should function as infrastructure for promotion of electrification by renewable energies by participatory approach.

‘Planning of Electrification by Participatory Approach’ will be explained below in line with yellow parts of the conceptual diagram of institutional design of Fig. II-1.2-1.

Inhabitants of villages who have taken capacity building as mentioned in II-1.4.1 will form consensus on electrification needs and potential as well as power demand and other points by community assembly (mesa de concertación) and will make plans for electrification in line with such consensus. This electrification plan will be submitted to district municipality, who will, in turn, examine the plan and make profile according to SNIP format to ask OPI of district or provincial level for approval. It is considered to be enough to have examination according to SNIP format by OPI at local level on account of small scale of individual electrification projects.

Provincial municipalities will compile electrification plans from district municipalities and also gather information on actual conditions and plans of electrification by grid extension from district municipalities to eventually prepare PLER (Local Plan of Rural Electrification) for submission to regional governments. Regional governments will compile PLERs from provincial municipalities to prepare PRER (Regional Plan of Rural Electrification) for submission to MEM/DPR.

MEM/DPR will compile PRERs to prepare PNER (National Plan of Rural Electrification) incorporating grid extension projects by MEM/DPR. PRERs from regional governments are to include information on actual conditions and plans of grid extension by local initiative. Such information should be incorporated in a unified way into SIER (Information System of Rural Electrification) to be built by MEM/DPR and be updated annually in the same process.

On the other hand, MEM/DPR will apply for necessary funds to SPERAR Funds in order to finance electrification projects by renewable energies included in PRER from regional governments. Chapter II-2.3 will describe SPERAR Funds.

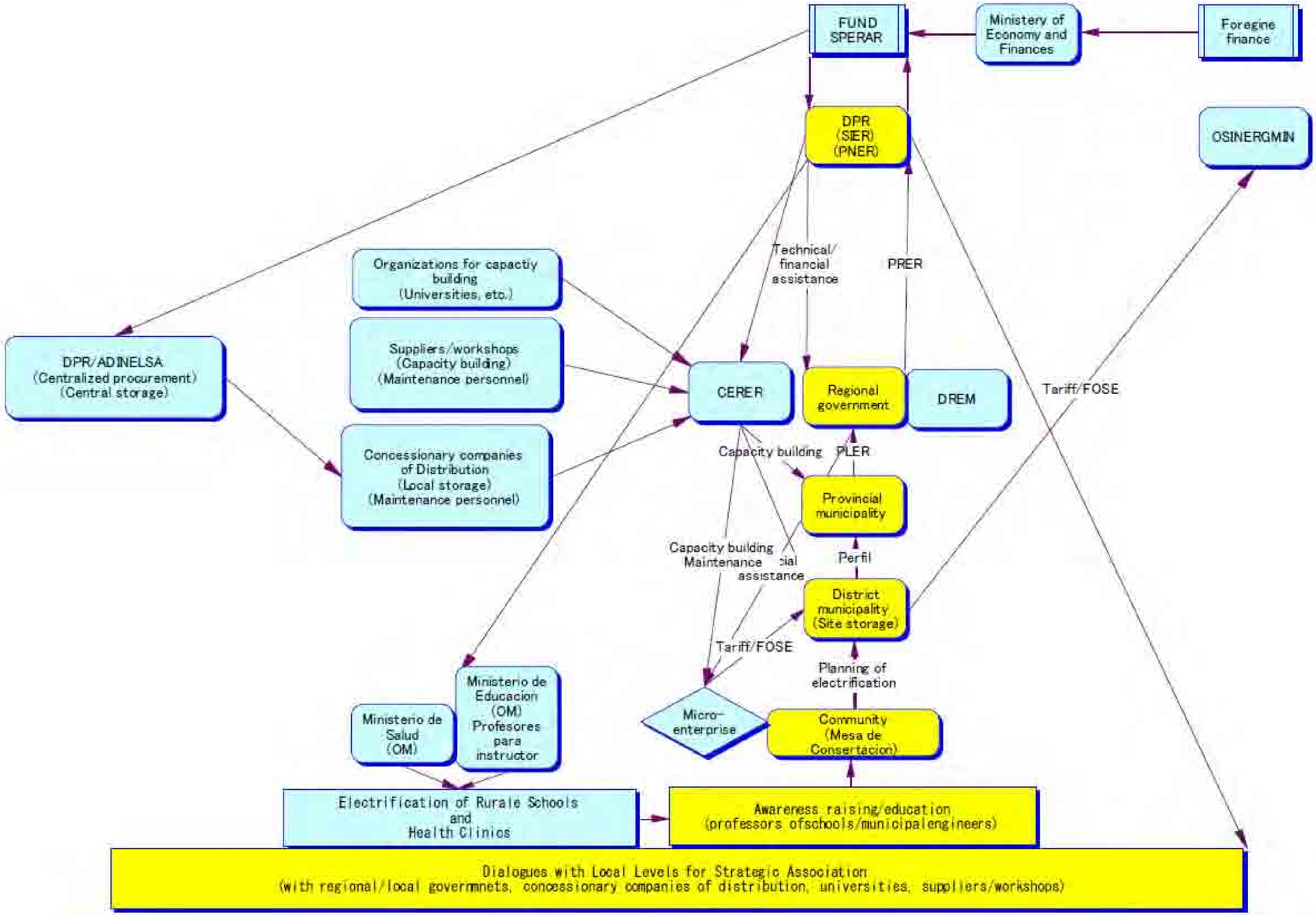


Fig. II-1.2-1 Conceptual Diagram of Institutional Design (Planning and SIER)

II-1.3 Enlightenment of Electrification by Renewable Energy

In Peru, rural electrification is being implemented by extension of power grid lines. One of the reasons is isolated power generation system using renewable energies are not recognized in general. For example, even in the case of economical feasibility of rural electrification by isolated generation system is higher than that of gird extension project at remote area, economical feasibility of both type of projects is not compared. In most of the cases, grid extension projects are selected for the project. For isolated generation system, participation of rural people for management, operation and maintenance are necessary because PV system and mini/micro hydro generation are using indigenous source of energies. In addition, users of isolated generation system have to understand DSM (Demand Side Management) to adjust their power consumption with generation pattern. Therefore, it is necessary to obtain the understanding of the residents for the sustainable electrification project by isolated power generation system.

In the Master Plan, electrification for public facility such as rural school and health clinic is proposed to disseminate the information on PV system to rural people at initial stage. The purpose is dissemination of the information on isolated power system using renewable energies to neighbor communities through actual power system at public facilities. At the electrified public facility, educational activity will be carried out using educational materials such as Video for rural electrification using renewable energies prepared in this study.

This electrification of rural schools needs the initiative of DPR under cooperation with regional/local governments. It is necessary to maintain close coordination with the Ministry of Education and the Ministry of Health, in charge of schools and health clinics, respectively.

The list of educational activities with using Video at public facilities is shown below.

- Improvement of living conditions by electrification
- Renewable energy technology
- Management group and institution for operation and maintenance
- Economical aspect of rural energy
- Environmental impact

Example selection criteria of candidate communities for rural school electrification are shown below.

1)	Community with no electrification plan:		40,760
2)	Households in community:	30 and over:	3,820
		30 and over + rural school:	1,761
3)	Prioritized region:	Cajamarca, San Martin, Loreto, Madre de Dios, Puno, Ucayali:	895
4)	Geographical distribution:	Select 5 communities from each region as minimum number.	
		Total 30 from 6 regions	865

5) According to the number of candidate communities in each region, 120 communities will be selected from 6 regions. Priority for the selection criteria is the number of households. Adjust the total number of communities under 150.

Table II-1.3-1 shows the candidate communities. Totally, 147 communities are selected by the selection criteria. In Cajamarca, 57 communities are selected for candidate. In Loreto 50 communities, in Puno and Ucayali 13 communities each, in San Martin 9 communities and 5 communities are selected in Madre de Dios. Table II-1.3-2 and Table II-1.3-3 show candidate communities for rural school electrification.

Table II-1.3-1 Number of Communities for Rural School Electrification

Regions	Community	Base	Target	Ratio	Add	Total	Adjustment	
Cajamarca	377	5	372	43%	52	57	>70	57
Loreto	346	5	341	39%	47	52	>70	50
Madre de Dios	10	5	5	1%	1	6	>40	5
Puno	61	5	56	6%	8	13	>75	13
San martin	35	5	30	3%	4	9	>45	9
Ucayali	66	5	61	7%	8	13	>95	13
	895	**30**	**865**		**120**			**147**

Table II-1.3-2 Candidate Community for Rural School Electrification (1)

No.	DEPARTAMENTO	PROVINCIA	DISTRITO	LOCALIDAD	VIVIENDAS
1	UCAYALI	ATALAYA	SEPAHUA	BUFEO POZO	250
2	UCAYALI	CORONEL PORTILLO	CALLERIA	SAN JOSE ALTO UTUQUINIA	172
3	UCAYALI	ATALAYA	RAYMONDI	PAUTI	150
4	UCAYALI	ATALAYA	SEPAHUA	PUIJA	132
5	UCAYALI	CORONEL PORTILLO	MASISEA	NUEVO HORIZONTE	116
6	UCAYALI	CORONEL PORTILLO	MASISEA	CAIMETO	110
7	UCAYALI	CORONEL PORTILLO	MASISEA	SANTA ROSA DINAMARCA	108
8	UCAYALI	CORONEL PORTILLO	CALLERIA	MAZARAY	106
9	UCAYALI	CORONEL PORTILLO	CALLERIA	JOSE OLAYA	105
10	UCAYALI	CORONEL PORTILLO	NUEVA REQUENA	SAN PABLO DE JUANTIA	98
11	UCAYALI	CORONEL PORTILLO	CALLERIA	SANTA ISABEL	98
12	UCAYALI	CORONEL PORTILLO	MASISEA	VISTA ALEGRE DE BOCA DEL PACHITEA	97
13	UCAYALI	CORONEL PORTILLO	CALLERIA	ABUJAO	96
14	SAN MARTIN	SAN MARTIN	HUIMBAYOC	LECHE	71
15	SAN MARTIN	MARISCAL CACERES	HUICUNGO	SHEPTE	70
16	SAN MARTIN	MARISCAL CACERES	HUICUNGO	MIRAFLORES	65
17	SAN MARTIN	BELLAVISTA	SAN RAFAEL	SAN JOSE	65
18	SAN MARTIN	EL DORADO	SAN MARTIN	ALTO ROQUE	63
19	SAN MARTIN	LAMAS	CAYNARACHI	ALFONSO UGARTE	60
20	SAN MARTIN	TOCACHE	TOCACHE	NUEVA LIBERTAD	58
21	SAN MARTIN	LAMAS	ALONSO DE ALVARADO	PERLA MAYO	52
22	SAN MARTIN	SAN MARTIN	HUIMBAYOC	SAN JOSE DE YANAYACU (YANAYACU)	51
23	PUNO	YUNGUYO	COPANI	CCOPANI	700
24	PUNO	CHUCUITO	ZEPITA	PATACCOLLO	500
25	PUNO	CHUCUITO	POMATA	TICARAYA	285
26	PUNO	PUNO	AMANTANI	SAN CAYANO	150
27	PUNO	CHUCUITO	KELLUYO	CHUNCARCOLLO	130
28	PUNO	EL COLLAO	PILCUYO	QUISPE MAQUERCOTA (QUISPEMAQUERA)	100
29	PUNO	PUNO	ACORA	CHECCACHATA	100
30	PUNO	AZANGARO	ARAPA	CAJSANI	100
31	PUNO	PUNO	AMANTANI	OCOSUYO	97
32	PUNO	PUNO	AMANTANI	LAMPAYUNI	90
33	PUNO	CARABAYA	USICAYOS	PUSCA	90
34	PUNO	PUNO	AMANTANI	VILLA ORINOJON	85
35	PUNO	CARABAYA	USICAYOS	USCURUQUI	80
36	MADRE DE DIOS	MANU	MADRE DE DIOS	SAN JUAN GRANDE	80
37	MADRE DE DIOS	MANU	MADRE DE DIOS	PUERTO LUZ	70
38	MADRE DE DIOS	TAMBOPATA	TAMBOPATA	PUERTO PARDO	45
39	MADRE DE DIOS	MANU	FITZCARRALD	YOMIBATO	45
40	MADRE DE DIOS	TAHUAMANU	IBERIA	PACAHUARA	42
41	LORETO	UCAYALI	SARAYACU	JUANCITO	294
42	LORETO	UCAYALI	SARAYACU	TIERRA BLANCA	235
43	LORETO	LORETO	PARINARI	SANTA RITA DE CASTILLA	191
44	LORETO	MARISCAL RAMON CASTILLA	RAMON CASTILLA	BELLAVISTA CALLARU	165
45	LORETO	ALTO AMAZONAS	LAGUNAS	ARAHUANTE	159
46	LORETO	REQUENA	PUINAHUA	HUACRACHIRO	136
47	LORETO	LORETO	URARINAS	MAYPUCO	134
48	LORETO	UCAYALI	PADRE MARQUEZ	ROABOYA	128
49	LORETO	MAYNAS	LAS AMAZONAS	ORAN	125
50	LORETO	REQUENA	MAQUIA	VICTORIA	120
51	LORETO	UCAYALI	SARAYACU	MONTE BELLO	110
52	LORETO	MARISCAL RAMON CASTILLA	RAMON CASTILLA	ISLA SANTA ROSA "AMAZONAS"	110
53	LORETO	LORETO	URARINAS	SAN JOSE DE SARAMURO	109
54	LORETO	MAYNAS	IQUITOS	LIBERTAD	105
55	LORETO	MAYNAS	LAS AMAZONAS	NAZARIA	105
56	LORETO	LORETO	TROMPETEROS	PAMPA HERMOSA	98
57	LORETO	ALTO AMAZONAS	PASTAZA	NUEVO ANDOAS	98
58	LORETO	UCAYALI	CONTAMANA	NUEVO EDEN	95
59	LORETO	UCAYALI	PAMPA HERMOSA	CANELOS	94
60	LORETO	UCAYALI	PAMPA HERMOSA	ALTO PERILLO	94
61	LORETO	LORETO	TROMPETEROS	SAN JUAN DE TROMPETEROS	93
62	LORETO	ALTO AMAZONAS	PASTAZA	ULLPAYACU	92
63	LORETO	MAYNAS	IQUITOS	SHIRIARA	90
64	LORETO	MAYNAS	PUNCHANA	SAN LUIS DE VISTA ALEGRE	90
65	LORETO	ALTO AMAZONAS	YURIMAGUAS	LAS MALVINAS	88
66	LORETO	MAYNAS	NAPO	SAN LUIS TACSHA CURARAY	87
67	LORETO	UCAYALI	SARAYACU	BOLIVAR	85
68	LORETO	REQUENA	MAQUIA	OBRERO I ZONA	85
69	LORETO	UCAYALI	SARAYACU	SAMAN	85
70	LORETO	MAYNAS	IQUITOS	TARAPOTO	83
71	LORETO	UCAYALI	SARAYACU	MAHUIZA	82
72	LORETO	LORETO	PARINARI	SAN MARTIN DEL TIPISHCA	81
73	LORETO	ALTO AMAZONAS	PASTAZA	CHARUPA	80
74	LORETO	LORETO	TIGRE	LIBERTAD	80

Table II-1.3-3 Candidate Community for Rural School Electrification (2)

No.	DEPARTAMENTO	PROVINCIA	DISTRITO	LOCALIDAD	VIVIENDAS
75	LORETO	MAYNAS	FERNANDO LORES	TAPIRA CHICO	80
76	LORETO	LORETO	PARINARI	LEONCIO PRADO	79
77	LORETO	REQUENA	EMILIO SAN MARTIN	ZAPATILLA I ZONA	79
78	LORETO	LORETO	PARINARI	SAN JOSE DE PARINARI	78
79	LORETO	MAYNAS	LAS AMAZONAS	SAN JOSE DE YANASHI	78
80	LORETO	UCAYALI	SARAYACU	TRES UNIDOS	76
81	LORETO	LORETO	URARINAS	REFORMA	76
82	LORETO	LORETO	PARINARI	NUEVA FORTUNA	75
83	LORETO	LORETO	TROMPETEROS	SAN JOSE DE NUEVA ESPERANZA	74
84	LORETO	MAYNAS	FERNANDO LORES	SANTA ANA I ZONA	74
85	LORETO	LORETO	NAUTA	SAN JUAN DE LAGUNILLAS	73
86	LORETO	UCAYALI	SARAYACU	NUEVO DOS DE MAYO	73
87	LORETO	UCAYALI	SARAYACU	SAN CRISTOBAL	72
88	LORETO	ALTO AMAZONAS	BARRANCA	ESTRELLA	72
89	LORETO	ALTO AMAZONAS	MANSERICHE	SAN JUAN	72
90	LORETO	REQUENA	PUINAHUA	MANCO CAPAC	71
91	CAJAMARCA	CHOTA	CHOTA	YURACYACU	380
92	CAJAMARCA	CHOTA	TACABAMBA	LA PUCARA	350
93	CAJAMARCA	SAN IGNACIO	HUARANGO	HUARANDOZA	246
94	CAJAMARCA	SAN IGNACIO	TABACONAS	TAMBORAPA PUEBLO	200
95	CAJAMARCA	SAN PABLO	SAN BERNARDINO	TUÐAD	200
96	CAJAMARCA	HUALGAYOC	BAMBAMARCA	CASHAPAMPA BAJO	190
97	CAJAMARCA	CAJAMARCA	ENCAðADA	SAN ANTONIO DE PACHACHACA	178
98	CAJAMARCA	CHOTA	CHALAMARCA	HUAYRASITANA	170
99	CAJAMARCA	SAN MARCOS	PEDRO GALVEZ	PATIÐICO	166
100	CAJAMARCA	CHOTA	PACCHA	UÐIGAN	158
101	CAJAMARCA	CHOTA	CHOTA	NUEVO ORIENTE	155
102	CAJAMARCA	CUTERVO	CUTERVO	LANCHE CONGA	150
103	CAJAMARCA	SAN MIGUEL	SAN MIGUEL	QUINDEN BAJO	150
104	CAJAMARCA	SAN MIGUEL	NIEPOS	MIRAVALLES	150
105	CAJAMARCA	CELENDIN	CELENDIN	BELLAVISTA	130
106	CAJAMARCA	SAN PABLO	SAN PABLO	JANCOS	130
107	CAJAMARCA	SAN MIGUEL	CALQUIS	EL CEDRO	130
108	CAJAMARCA	CAJAMARCA	ENCAðADA	YANACANCHA GRANDE	122
109	CAJAMARCA	CHOTA	CHOTA	PINGOBAMBA BAJO	120
110	CAJAMARCA	SAN MIGUEL	CALQUIS	LOS TRES RIOS	120
111	CAJAMARCA	SAN MARCOS	PEDRO GALVEZ	MONTESORCO	120
112	CAJAMARCA	CAJAMARCA	JESUS	LLIMBE	117
113	CAJAMARCA	CHOTA	CHOTA	EL LIRIO	112
114	CAJAMARCA	JAEN	HUABAL	SAN RAMON BAJO	100
115	CAJAMARCA	CHOTA	TACABAMBA	LA LAGUNA	100
116	CAJAMARCA	SAN MARCOS	ICHOCAN	PORO PORO	100
117	CAJAMARCA	JAEN	JAEN	LA PALMA	98
118	CAJAMARCA	CELENDIN	JOSE GALVEZ	PARAISO	95
119	CAJAMARCA	SAN PABLO	TUMBADEN	EL SURO	91
120	CAJAMARCA	JAEN	LAS PIRIAS	EL LAUREL	90
121	CAJAMARCA	SAN MARCOS	EDUARDO VILLANUEVA	HUACACORRAL	89
122	CAJAMARCA	CAJAMARCA	ENCAðADA	SAN LUIS DE POLLOQUITO	88
123	CAJAMARCA	CUTERVO	CUTERVO	NUEVO PORVENIR DE AFILIACO	84
124	CAJAMARCA	CUTERVO	CUTERVO	NUEVO ORIENTE	83
125	CAJAMARCA	SAN MIGUEL	TONGOD	CHILAL DE LA MERCED	83
126	CAJAMARCA	CONTUMAZA	CONTUMAZA	CORRALES DE CHANTA	81
127	CAJAMARCA	CELENDIN	SUCRE	VIGASPAMPA	80
128	CAJAMARCA	CELENDIN	CELENDIN	HUAÐAMBRA	80
129	CAJAMARCA	CUTERVO	CUTERVO	ANGURRA	80
130	CAJAMARCA	CHOTA	TACABAMBA	PILCO	80
131	CAJAMARCA	CHOTA	CHIMBAN	SUSANGATE	80
132	CAJAMARCA	SAN PABLO	SAN BERNARDINO	POQUISH	80
133	CAJAMARCA	SAN PABLO	SAN BERNARDINO	LICLIPAMPA	80
134	CAJAMARCA	SAN PABLO	SAN PABLO	LLOQUE	80
135	CAJAMARCA	CONTUMAZA	TANTARICA	CHOLOL ALTO	80
136	CAJAMARCA	SAN MIGUEL	LA FLORIDA	EL LIMONCITO	80
137	CAJAMARCA	CAJAMARCA	LOS BAðOS DEL INCA	CARHUAQUERO	80
138	CAJAMARCA	SAN IGNACIO	TABACONAS	PAMPA DE LIMON	78
139	CAJAMARCA	CAJABAMBA	SITACOCHA	JALCAHUASI	78
140	CAJAMARCA	SAN PABLO	TUMBADEN	VISTA ALEGRE	77
141	CAJAMARCA	SANTA CRUZ	SANTA CRUZ	EL SAUCE	76
142	CAJAMARCA	CHOTA	CHOTA	LA PAUCA	76
143	CAJAMARCA	CHOTA	CHALAMARCA	ALTO VERDE	74
144	CAJAMARCA	CUTERVO	CUTERVO	ALTO TRIUNFO	73
145	CAJAMARCA	SAN IGNACIO	HUARANGO	BUENOS AIRES	72
146	CAJAMARCA	SAN IGNACIO	HUARANGO	NUEVO SANTA ROSA	72
147	CAJAMARCA	CHOTA	CHOROPAMPA	LA PAZA	71

II-1.4 Mechanism for Sustainability

II-1.4.1 Scheme of Mechanism for Sustainability

There are lots of needs for capacity building on investigation, planning, design and management. Meanwhile, it is indispensable to establish supply chain for construction and operation and maintenance in order to promote rural electrification by renewable energies at national level and secure sustainability. This section will propose some mechanism of how to provide capacity building and supply chain.

In establishing the mechanism of capacity building and supply chain, MEM/DPR should take initiative to make strategic alliance with local sides, making clear the roles to be played by central and local sides through dialogues with local sides as described in Chapter II-1.2. Renewable Energy Center for Rural Electrification (CERER) should be established in each region to take charges of monitoring of electrification systems implemented by regional/local governments, contracts with locally available organizations necessary to establish capacity building and supply chain and their contractual administration, planning of capacity building and execution and administration of such plans and inspection and trouble shootings.

In order to realize the above mechanisms, MEM/DPR should take initiative to talk with regional/local governments. Regional governments now have their own Regional Diretorate of Energy and Mines (DREM : Dirección Regional de Energía y Minas). Table II-1.4.1-1 shows actual numbers of personnel of DREMs, which are not considered to be sufficient. It is wise to explore the possibility of utilizing DREMs to function as CERER by reinforcing those organizations.

Table II-1.4.1-1 Number of Personnel of DREM by Region

PERSONAL DE LAS DIRECCIONES REGIONALES DE ENERGIA Y MINAS POR REGIONES

ITEM	DIRECCION REGIONAL DE ENERGIA Y MINAS	N° DEL PERSONAL ADMINISTRATIVO	N° DEL PERSONAL TECNICO (INGENIEROS)	N° DE PERSONAS DEDICADAS A ELECTRIFICACION RURAL	N° DE PERSONAS DE PLANTA (C.A.P.)	N° PERSONAS CONTRATADOS POR N.S.P.	TOTAL
1	AMAZONAS	4	5	3	2	7	9
2	ANCASH	5	3	0	2	6	8
3	APURIMAC	2	5	4	4	3	7
4	AREQUIPA	3	4	0	7	0	7
5	AYACUCHO	5	4	1	9	1	10
6	CAJAMARCA	1	3	1	1	3	4
7	CUSCO	4	5	0	11	2	13
8	HUANCAVELICA	5	8	0	3	10	13
9	HUANUCO	4	4	1	1	8	9
10	ICA	0	4	0	6	4	10
11	JUNIN	5	7	1	3	10	13
12	LA LIBERTAD	5	9	1	3	12	15
13	LAMBAYEQUE	2	1	1	4	0	4
14	LIMA	2	2	1	0	5	5
16	MADRE DE DIOS	2	6	0	5	7	12
17	MOQUEGUA	3	5	0	8	0	8
18	PASCO	3	3	1	1	6	7
19	PIURA	4	6	1	3	8	11
20	PUNO (**)	3	3	0	6	4	10
21	SAN MARTIN	4	7	5	4	7	11
22	TACNA	3	4	0	7	0	7
23	TUMBES	3	3	1	3	3	6
24	UCAYALI	7	5	1	8	4	12

Source: MEM/DPR

1. Capacity Building

As for capacity building, CERER will be in charge of contracts and their contractual administration with organizations providing capacity building, planning of capacity building and monitoring of execution of such plans. To be concrete in implementing capacity building, it is proposed to establish network, which will be described Chapter II-1.4.2. Networks with UNI (National University of Engineering) at Lima as center and regional universities, NGOs, local dealers and other available local organizations will be built for capacity building. To build such networks, MEM/DPR will provide technical assistance to regional governments (CERER) for educational curriculum and materials based on the results of this Master Plan Study.

Those who will take capacity building are considered to include beneficiary inhabitants with electrification, staff of microenterprizes and staff in charge of electrification of regional/local governments. CERER will prepare implementation plan for capacity building tailored to each group of those to be capacitated by making use of the above network.

Activities for raising awareness and education of inhabitants of remote villages by means of electrified rural schools as described in Chapter II-1.3 are to function as infrastructure for promotion of electrification by renewable energies and considered to be a starting point for capacity building.

Fig. II-1.4.1-1 shows the organizations related with capacity building as marked in yellow.

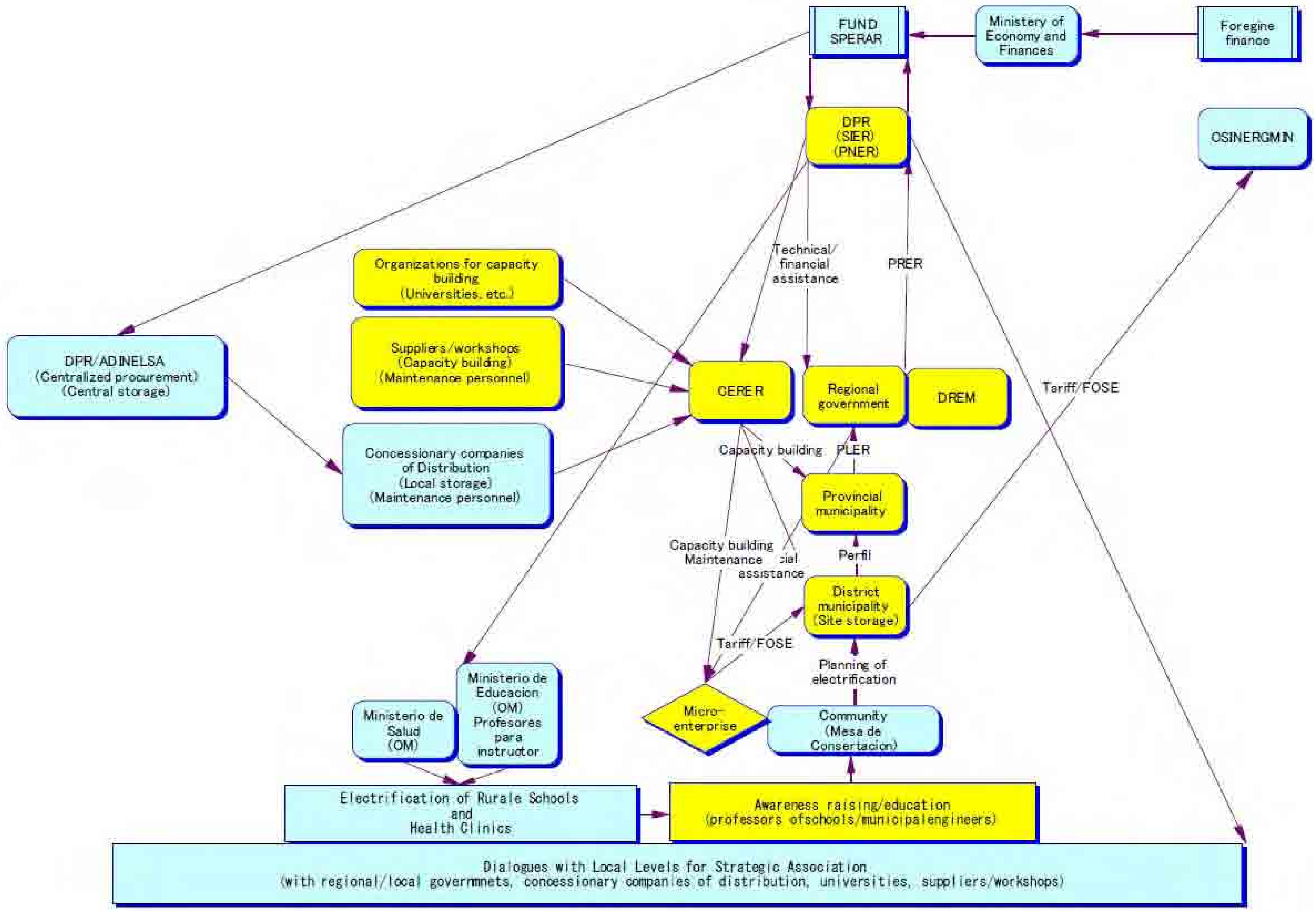


Fig. II-1.4.1-1 Conceptual Diagram of Institutional Design (Capacity Building)

2. Supply Chain for Construction and Operation and Maintenance

For construction and operation and maintenance of electrification systems, 'supply chain' is indispensable to provide funds, construction equipment and materials, operation and maintenance materials and maintenance personnel. The following mechanism for supply chain is suggested and the detail will be described in II-1.4.3.

- For fund provision, create SPERAR Fund, special funds for rural electrification with renewable energies;
- For equipment and materials for construction and operation and maintenance, a central organization such as MEM/DPR or ADINELSA make centralized purchases and warehouses of regional concessionary companies of power distribution and those of district governments are to be utilized as local warehouse of the purchased equipment and materials;
- For maintenance personnel, daily inspection is to be conducted by microenterprise, while repairs and trouble-shootings are to be done by maintenance companies contracted by CERER.

Fig. I-4.2-1 shows the organizations relevant to supply chain as marked in yellow

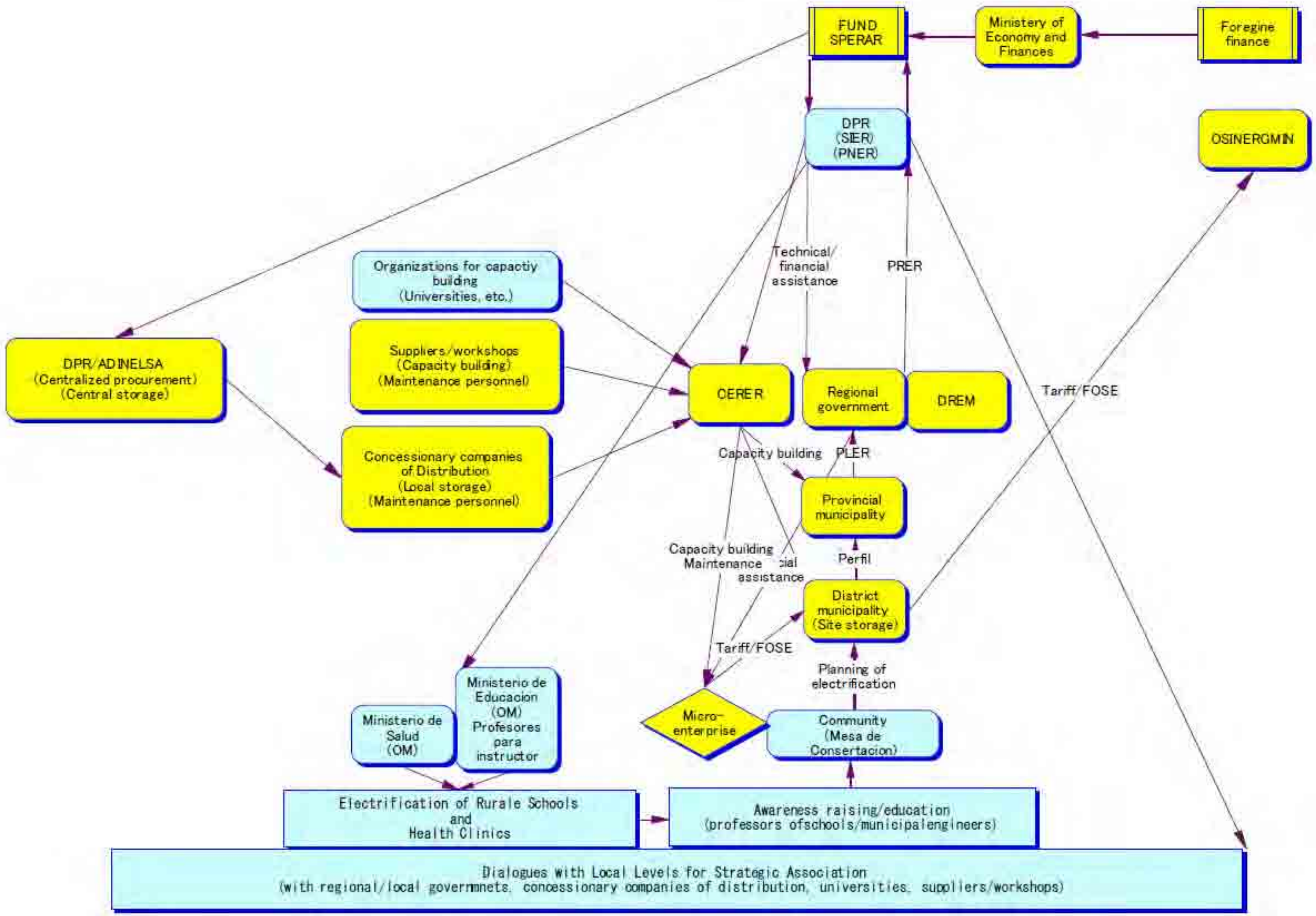


Fig. II-1.4.1-2 Conceptual Diagram of Institutional Design (Supply Chain)

II-1.4.2 Capacity Building

1. CERER and Implementing Organizations for Capacity Building

At the regional government level, a Renewable Energy Center for Rural Electrification CERER (Centro de Energías Renovables para Electrificación Rural) will be established as an organization of each region as mentioned in II-1.4.1. This center will function as one-stop center of regional government for renewable energy, and will be opened to villagers and the general public. Therefore, actual training or support to villagers will be done by capacity-building implementing organizations as mentioned below; for example, support and training for creation of micro enterprises will be done by capacity building implementing organizations, while supplying batteries and other parts for maintenance will be done by supply chain of suppliers and other concerned organizations as described in II-1.4.3. On the other hand, the management of contract of concession of micro enterprises, management of supply chain system and handling inquiries from villagers on this matter will be handled by CERER.

When they desire electrification with renewable energy, villagers can consult with CERER, and in the case of having some problems at operation and maintenance stage, villagers can also ask CERER, along with capacity-building implementing organization or supply chain.

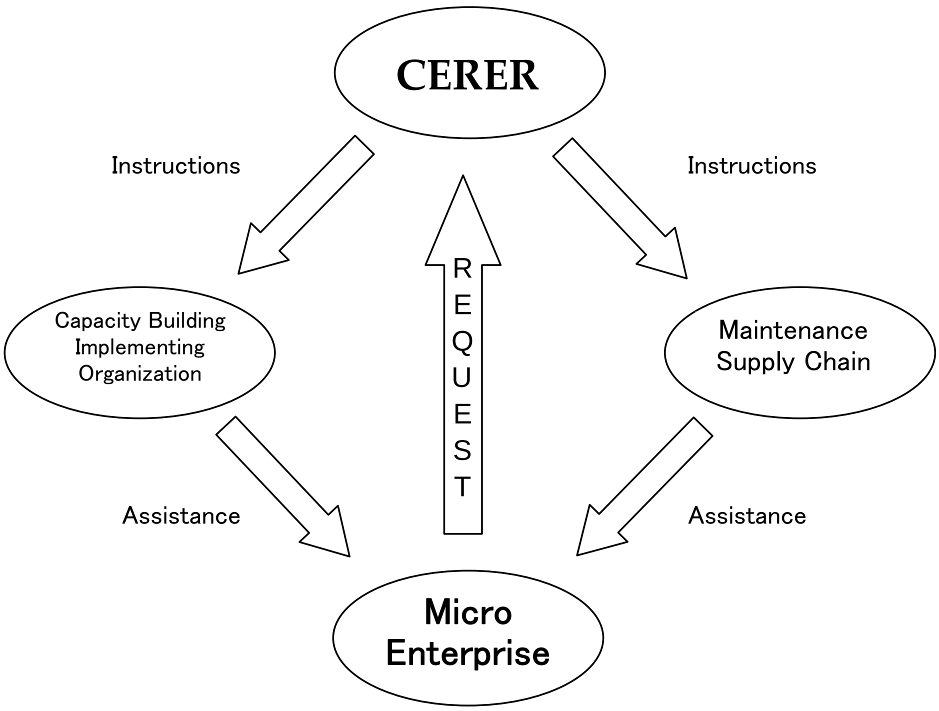


Fig. II-1.4.2-1 Relation of CERER and Micro Enterprise

2. Implementing Organizations of Capacity Building

Capacity-building implementing organizations are to have such roles as distribution of information, introduction of technical information, collection of information and needs, and training of users. In order to function properly, it is necessary to train people who provide information and train end-users. It means that capacity-building implementing organizations should be a training center for trainers as well as users. Educational institution is appropriate to undertake such training.

As some universities including Universidad Nacional de Ingeniería (UNI), or Universidad de Cajamarca have already established center for renewable resources. However their development should not be left and isolated since it would not be efficient without taking advantage of the accumulation of knowledge or utilizing know-how that has been developed. As they have been making efforts to promote renewable energy, it is better to incorporate and utilize effectively. By networking those existing centers, effective utilization of knowledge, experience, human resources can be realized. Not only universities, but also private companies and NGOs have people, knowledge, and experiences. Not excluding such human resources but including them, it would enable to have more effective information diffusion, distribution of technical information, and establishment of the capacity-building system. Therefore, by establishing open resource network, it would be possible to organize more effective capacity-building implementing organizations by use of scattered knowledge and experience.

Capacity-building implementing organizations should have the following functions:

1) Dissemination of information and promotion of renewable energy (technical introduction)

Dissemination of information, promotion of renewable energy with technical introduction are necessary. It is often observed that villagers lack information on renewable energy system. Without such information, when electrification is requested, electrification by grid extension, which is not efficient method in isolated areas, tends to be requested. Therefore information distribution is necessary through the training or through campaigns by university students or other means.

2) Technical training

Specific technical training on renewable energy system is also necessary. Those villagers who are interested in undertaking the operation and management in future are selected and are going to be trained to make them accustomed to the equipment. It is necessary to train them technically, so that they will be able to actually operate and manage the system daily. By training several candidates from the same village, it is necessary to desseminate the technical information in village so that, in case that the undertaking responsible person will not be able to be engaged, somebody else can take over.

3) Training for planning

Training for planning should be extended to those who will be trained under technical training. What kind of technology should be selected depends on specific cases, so it is necessary to train how to select the method of electrification, how to identify renewable energy and how to plan electrification project. With this training, villagers will be able to make plans to some extent by themselves. Even though villagers are not able to plan in detail and the plan is prepared by outside experts, the villagers will be able to deepen the ownership of the renewable energy by understanding the contents of the plan as a result of the training.

4) Training for users organization

Training for formulation of users' organization is necessary from the view point of establishing and strengthening corporate governance. It is necessary to formulate an evaluation system by the entire village of the activities of the micro enterprise, along with the training of the technical and operational experts. Through this mechanism, users will be able to understand the operational and administrative conditions of the renewable energy system, and evaluate the performance. The corporate governance of the end-users on this micro enterprise will be secured by this activity.

5) Training for administration of micro enterprise

Training for administration of micro enterprise will be provided for the candidates who are interested in management of renewable energy system. In order to have the system sustainable, it is necessary to make sure who must be responsible for not only technically but also administratively. In this course it will be taught how to make transparent operation and management of the company and how to save money for future expenses of replacement parts, etc. It will also include how to make records of the revenues and expenses with simple accounting system, how to collect monthly payment and how to make sure the record of the payment of the end-users, and how to solve problems of delayed payment or default. In addition, how to deposit and withdraw the money will be taught.

6) Trainers' training for capacity building of villagers

Training for those who will promote the renewable energy system to villagers will be done as well. This is a kind of trainers training. In order that villagers raise their hands for request, it is necessary to materialize a project idea and to put it to a project profile. However the more remote, the less ability of villagers are likely in processing such procedures, so it is necessary to provide some assistance to the villagers such as dissemination of information, promotion of renewable energy, needs assessment, training of planning, etc. and to visit sometimes remote villages to assist villagers. In order to undertake these kinds of service, the university students will be best fitted, especially who are interested in renewable energies and improvement of QOL as well as poverty alleviation. Such students have vitality to overcome the difficulties to implement as they are young and enthusiastic. The public sector has a lack of human and financial resources, while the private sector will put high cost in order to hedge the risk. In order to fill the gap, utilization of university students with enough knowledge and less cost can be considered. As a part of education of university students, field survey with some academic credits will be incentives for students, and thereby students can be secured for that purpose and human resources development will be realized. The training of the students is significant since enhancement of renewable energy utilization can be expected.

7) Networking of institutions and people related and exchange of people

Still another expected role is networking of the concerned organizations and people and exchange of such people. As governments, universities, NGOs, private companies have experiences in renewable energy projects, a central organization among the capacity-building organizations is necessary to network and exchange the people and the information they have. Such a central organization should be established in the universiy of each region. It is because they are closer to the people who needs, and the university students are easier to access to those villages. If no instructors are available, they should invite instructors of other universities, specialists from private companies and NGOs. To that effect, such a central orgnization should be open and take advantage of open resource network. The leader among them will be UNI. They have not only actual records of projects of renewable energy, but also they provide courses on renewable energy. As they are in Lima, close collaboration with DPR can be expected.

Those universities who are not ready to train people due to shortage of instructors, they can take external assistance from those who have already experienced. UNI or ITDG are important institutions who can provide training and assist the universities for institution building of the universities. Through this, it is expected to exchange information, to share the knowledge, deepen individual knowledge and increase institutional memory

8) Project Supervision

Even if the villagers take the above capacity building, it is still necessary for such villager who will assume project implementation to have opportune guidance and assistance regarding planning, execution and management in order to make electrification project sustainable.

Table II-1.4.2-1 Main Activities of Capacity-Building Implementing Organizations

Activities	Contents
1) Information dissemination	Dissemination of information and promotion of renewable energy with general information towards remote villagers.
2) Technical training	Technical training towards villagers according to system to be introduced, with contents of necessary daily operation and maintenance
3) Training for planning	Training in order to strengthen ability of planning for making plans with selecting system to be introduced.
4) Training for users' organization	Training in order to secure monitoring and governance by creation of users' association
5) Training for administration of micro enterprise	In order to secure sustainability of the system by training who will undertake the administration of the operation, who will control the financial operation in order to prepare for future repair activities, etc
6) Training for instructors	Trainers' training towards university students with provision of academic credits for the field activities to assist villagers.
7) Networking of institutions	Make the centers to be the hubs of the renewable energy, where people can exchange information to share the knowledge, deepen individuals' knowledge, and increase institutional memory through networking
8) Project Supervision	Assistance for project implementation of villagers, in terms of planning, execution, and operation and management for sustainable use..

3. Main Curricula of Capacity Building

(1) Organization

As for capacity building regarding organization, the target will basically be the villagers. It is because the villagers are those who will implement a project, and after completion they are the ones who will operate and manage the system. The key of success to implementation of renewable energy is the strengthening of villagers. In addition to the villagers, staff of municpalities can be targeted since they will undertake the budget procedure and allocation of funds. However it is not necessary to have the same contents as villagers have.

Curriculum necessary in the field of organization is as follows. The curriculum for villagers is mainly for those who will undertake the micro enterprise. For villagers in general, basic contents are necessary in terms of understanding the rights and obligations and the role of enterprise, however it is not necessary to provide them in depth, so it can be a simpler version.

Subject	Trainee	Curriculum
Organization	Local inhabitants	➢ Significance of electrification ➢ Conditions for electrification ➢ Cooperation of villagers, responsibility and rights ➢ Electrification plan and power supply service ➢ Role of micro enterprise, responsibility and rights ➢ Establishment procedure of micro enterprise ➢ Binding contracts (micro enterprise with residents and municipalities) ➢ Accounting records with revenues and costs, etc ➢ Creation of users organization (Junta de Usuarios) ➢ Open information with reporting to users on the activities and financial results of micro enterprise ➢ Case study
	Local governments	➢ What is renewable energy? ➢ Introduction of renewable energy and development ➢ Laws, institutions and organizations related to renewable energy ➢ Issues for introducing renewable energy in remote areas ➢ Sustainable organization: Explanation of micro enterprise ➢ Renewable energy and participatory development ➢ Necessity of fund assistance ➢ Case study

(2) Finance

It is indispensable to obtain knowledge on financing to maintain the sustainability of rural electrification. The curriculum by target for introduction of various contents for financing with its advantage/disadvantage, as well as the items required for each stage of planning, construction and operation, is shown below. The contents should be arranged according to the level of understanding of the target people, but it is desirable to cover all the items.

As to the solar power, in order to promote its diffusion from the financial aspect, enlightenment of financial institutions, especially those which have rural micro-financing facilities shall be incorporated.

Subject	Trainee	Curriculum
Finance	Local inhabitants Local governments	➢ Contents and necessity of initial investment cost and O&M cost ➢ Information on items for cost estimation ➢ Information on financing sources ➢ Comparison of financial cost by financing sources ➢ Information on financing procedures ➢ Explanation on tariff setting ➢ Explanation on tariff collection ➢ Explanation on accounting book ➢ Explanation of financial management
	Financial organizations NGOs	➢ Explanation of solar power system ➢ Information on solar power industry ➢ Business model, financial demand and cash flow ➢ Explanation on good practice in other countries ➢ Information on rural electrification by solar power by the government and donor countries

(3) Solar Power

The target of capacity building for solar power are considered to be the following three categories:

- Expert on PV Project Planning

  There are only few or nonexistent of experts who can find PV project and make a proposal to regional governments in Peru. Capacity building is necessary for the project finding and planning stage to implement PV electrification project by participatory approach. The target of this capacity building will be staff of regional government and local university.

- Engineer for PV Project Supervisor

  There are only few technicians who can supervise PV project at rural area. In Peru, there are technical training course on renewable energy in UNI-CER. This kind of educational opportunity for engineers who graduated from electrical or mechanical department of university is important for the capacity building of the supervisor. The target of the capacity building will be staff of private company and university.

- Technician for Installation of PV System

  There are a few small PV relating companies in local regions of Peru. Therefore, supporting system for training on PV installation through practice will be necessary for technician. To that effect, it is necessary to transfer the technology on PV system installation to local technician before implementation of PV project.

Subject	Trainee	Curriculum
Solar power	Expert on PV project planning	➢ Project plan and application ➢ Comparison of economic aspect on different types of rural electrification ➢ Procedure of site survey
	Engineer for PV project supervisor	➢ Estimation of power output and demand ➢ System design of PV system ➢ Training on management institution and O&M
	Technician for installation of PV system	➢ Installation of SHS ➢ Installation of PV system at public facilities ➢ Training of individual user for O&M

(4) Mini/micro Hydropower

The target of capacity building for mini/micro hydropower is considered to be the following 2 categories.

- Local Residents (Basic Level: Capacity Building for Realizing Bottom-up Approach)
  Fundamental knowledge of hydropower should be disseminated at local resident level in order to realize bottom-up approach which is necessary for identification and selection of candidate sites. For this reason, enlightenment and education for hydropower based on the following contents should be carried out by using the brochure which was prepared in this Study.
  Mini/micro hydropower must be adequately operated and managed. Local residents have been playing a role in operation and management in the many past results. Technicians who are to be in charge of operation and maintenance should be brought up from among local residents before starting the project or according to progress of project because early response is needed to operate hydropower stations in the case of trouble.

- Employees of Local Government and Municipality (Specialistic Level 1)
  A specialist in planning of mini/micro hydropower should be brought up in order to materialize mini/micro hydropower projects. There are few specialists who investigate and propose projects to the government in Peru. These specialists should be brought up in order to incarnate requests of project promotion by bottom-up approach. The staff of the central and local government are expected to play the role of specialists. For this reason, Employees of local and municipality should be educated by the hydropower manual which was prepared in this Study. In addition, it is valid for actual site surveys to collaborate with local residents who have been educated and enlightened.

Design and construction engineers who have experiences of feasibility study, design and construction should be assured in order to promote without delay from planning to implementation phase in mini/micro hydropower project. Consulting firms and general construction contractors should play such a role at this level because special knowledge to carry out their works is needed. However, local consultants and general contractors can not cope sufficiently with this matter because many capable engineers who have good experiences in the central area of Peru. Although these consultants and general contractors which should be in charge of these detailed surveys, design and construction are not necessarily confined to local firms, this matter is an issue in the future because disseminating experience and knowledge of hydropower to local areas is useful to rural electrification. In addition, local residents are expected to make active efforts at the construction stage.

Required technical knowledge for the consultants and general contractors are too specialistic (Specialistic Level 2), so they are out of the target of the capacity building and the curriculum for them is not mentioned here.

Subject	Trainee	Curriculum
Mini/micro hydropower	Local inhabitants	➢ Mechanism of mini/micro hydropower ➢ How to identify mini/micro hydropower ➢ How to operate and maintenance of mini/micro hydropower
	Local governments	➢ Investigation (desk and site) ➢ Preliminary study for facilities of mini/micro hydropower ➢ Rough cost estimation for facilities of mini/micro hydropower ➢ Operation and maintenance method ➢ Economic and financial analysis

(5) Mini-Grid

As for transmission/distribution facilities, it is important to build up technicians who can conduct a series of design, construction and maintenance. So, the target for capacity building is basically technicians and it is necessary to build a curricula combining the basic course for learning basic knowledge and technics and the practical course for learning construction planning and maintenance skills.

Subject	Trainee	Curriculum
Mini-grid	Technician (Basic course)	➢ Configuration and function ➢ Construction and operation ➢ Maintenance and inspection ➢ Law and guidelines of power distribution
	Technician (Practical course)	➢ Design and planning ➢ Operation of switchgears ➢ Operation and maintenance (periodical inspection) ➢ How to use the test tools and measuring devices ➢ Workers and public safety

(6) Scio-economic Conditions, Environment and Gender

The section of 'Curriculum for Organization' of this chapter mentions the curricula for (i) inhabitant (management body) of issues relating to understanding of electrification plan and management and (ii) local government about support of inhabitants and participatory development. Following are the subjects to be added to the abovementioned curricula prepared for both stakeholders from gender and environmental points of view.

Subject	Trainee	Curriculum
Scio-economic conditions, environment and gender	Local inhabitants Local governments	➢ Gender equality in planning, implementation and operation/management ➢ Environmental consideration (mitigation/preparedness planning) ➢ Monitoring of operation/management regarding gender and environmental issues

II-1.4.3 Supply Chain for Construction and Operation & Maintenance

1. Funds

Financial needs include funds for construction and for management and operation and maintenance. As for construction funds, they will be provided by SPERAR Funds to be created by MEM/DPR. SPERAR Funds, which will be explained in Chapter II-2.3, are to be basically composed of central government budget for rural electrification and may be supplemented with overseas assistance if necessary. Financial contributions from the above Funds should be determined considering the size of available funds of regional/local governments (e.g. CANON) and the rest should be borne by regional/local governments. Share of financial burdens is another important point for dialogues with local sides.

MEM/DPR will apply to SPERAR Funds for financial contribution based on project lists of rural electrification by renewable energies included in PNER. SPERAR Funds will examine such application and determine the share of financial contribution between the Funds and regional/local governments. Regional/local governments will make financial contribution to SPERAR Funds according to such determined share. SPERAR Funds will make payments for construction with those contributed funds according to invoices from such an organization as MEM/DPR or ADINELSA in charge of centralized acquisition of equipment and materials. Expenses for construction and labor costs and other local expenses are to be borne by regional/local governments, who will make direct payments.

For management and operation and maintenance from the point of view of sustainability of electrification systems, it is vital to make reasonable tariff setting. Nevertheless, remote villages are considered to be low in income level and accordingly scarce of financial ability to bear management and operation and maintenance costs, let alone construction costs. For such households as require tariff subsidy, it is therefore proposed to make use of FOSE subsidy system as mentioned in Chapter

II-2.3. Electrification systems are conceived to be managed by organizations established by initiative of inhabitants such as micro-enterprize. Those organizations will apply to OSINERGMIN for subsidy from FOSE once rural electrical concession is acquired through district municipalities.

2. Construction Equipment and Materials

Electrification by renewable energies is considered to be mainly composed of solar power, so that it is wise to secure bargaining power in price and quality by centralized acquisition of necessary equipment and materials. To that effect, an appropriate organization such as MEM/DPR or ADINELSA will be in charge of such centralized acquisition, storage until transportation to local destinations and dispatch of necessary equipment and materials to regional governments according to schedules of individual electrification projects. Regional governments (CERER) will beforehand make contract with regional concessionary companies of power distribution for temporary storage. Regional governments (CERER) will deliver those equipment and materials to contractors, who will, in turn, commence construction.

3. Operation and Maintenance Materials

Once electrification systems are constructed, CERER created in regions will take charge of necessary actions for operation and maintenance. For parts decided as necessary to replace and parts necessary of periodical replacement such as battery for solar power, storage space should be provided in the premises of district municipalities as local storage, which will store a certain level of quantities of parts.

CERER will make delivery of required parts and other materials to maintenance contractors according to their requests or communications from micro-enterprizes for trouble shootings. Daily inspection will be conducted by technical staff of micro-enterprizes, who will inform CERER of malfunction or trouble. CERER will make request for repairs from maintenance contractors. As for parts necessary of periodical replacement such as battery for solar power, CERER will make instruction to district municipalities for delivery to micro-enterprizes.

4. Personnel for Operation and Maintenance

As described above, technical staff of micro-enterprizes or other community-based organizations will be in charge of daily inspection, while for repairs and trouble shootings, it is necessary for regional governments (CERER) to select beforehand maintenance contractors and make contracts with them. Possible maintenance contractors can include regional concessionary companies of power distribution, dealers of solar panel and turbine and generator of mini/micro hydropower and factories of car maintenance services.

The following are necessary considerations regarding supply chain in each section:

(1) PV System

It is necessary to create supply chain for distribution of consumable parts and collection of used equipments for dissemination of rural electrification.

At local regions, it is necessary to store consumable spare parts in warehouse. As for SHS, DC light is necessary to be stored in the warehouse because it is difficult to obtain in general market. Also, battery and controller are consumables and both of them need to be replaced every few years. The life time of deep cycle battery is around 5 to 7 years, and that of controller is 10 years. The supporting structure of PV system should be stored in the warehouse for new users. The following shows approximate years for replacement.

PV module	:	20 years
Controller	:	10 years
Battery (Deep cycle)	:	5-7 years
Battery (Car)	:	2-3 years
Supporting structure	:	20 years
Fluorescent light	:	2-3 years
LED	:	20 years

As for used equipments, collection of used battery is important. In local regions, used batteries collected by private business are not treated by appropriate methods in many cases. Therefore, used batteries have to be collected and kept in the warehouse in local regions. And the collected used batteries reaches some amount, it is possible to ask for battery recycle companies in Lima city for collection and treatment or recycle by appropriate methods.

(2) Mini/Micro Hydropower

The procurement of necessary materials and equipment for hydropower project is generally easy, because cements, sand and stone for civil works are common used materials anywhere. However, as for equipment such as steel pipes (or PVC pipes) for penstock, gates and turbines/generators, it is expected that the way and route of procurement is different by region.

Two turbine/generator manufacturers exist in Cajamarca where the JICA study team carried out site surveys and these manufacturers can supply some parts in the case of breakdown. If there are no manufacturer and supplier for hydropower in the capital of regions or nearby, the supply chain with CERER as its center is required to play the role of supplier.

In 29 project sites that are shown as mini/micro hydropower potentials in this Master Plan, the following cities shown below in Table II-1.4.3-1 are assumed to be lodgments of supply chain. Each access route from its lodgment city to the project site is shown in Appendix.

Table II-1.4.3-1 Lodgment Cities of Supply Chain for Mini/Micro Hydropower

Region	City
Amazonas	Chachapoyas
Ancash	Huaraz
Arequipa	Arequipa
Cajamarca	Cajamarca
Cusco	Cusco
Huanuco	Huanuco
Ica	Ica
Junin	Huancayo
La Libertad	Trujillo
Lima	Lima
Loreto	Yurimaguas, Iquitos
Puno	Juliaca
San Martin	Tarapoto
Ucayali	Pucallpa

(3) Use of Regional Concessionary Companies of Power Distribution

To examine the possibility of use of regional concessionary companies of power distribution as local warehouse, an important part of supply chain, Hidrandina in Cajamarca was surveyed as an example.

Hidrandina Company, responsible for supplying electricity to Cajamarca (Southern Part), Ancash, and La Libertad, has five offices in northern part such as Cajamarca, La Libertad Norte, Trujillo, Chimbote, and Huaraz.

The headquarters purchase the distribution material based on branch offices' request and its annual schedule. The branch office in Cajamarca purchases it from small-size suppliers in Cajamarca and large-size suppliers in Lima and Trujillo. Moreover, the branch office in Cajamarca has three warehouses, which store pole, electric meter box, transformer, concrete pole, wire and cable.

<Picture 1>

<Warehouse>

<Lamp>

<Electric meter Box>

<Connecting terminal>

<Picture 2>

<Bolt and Nut>

<Protective equipment (1)>

<Protective equipment (2)>

<Current Transformer>

<Picture 3>

<Transformer>

<Pole (High Voltage)>

<Pole (Low voltage)>

<Wire and Cable>

Edelnor Company that has concession area in northern part of Lima does not stock any poles in warehouse because the storage of them costs lots. But they keep accessory of poles and insulators because they do not take large space.

The above situation that regional distribution companies stock poles, accessories, wires and other materials in their warehouses is common to distribution companies in other regions. Therefore, regional distribution companies can be utilized as important part of the supply chain for rural electrification.

II-1.5 Action Plan

This section proposes an Action Plan as shown in Fig. II-1.5-1 comprising the measures proposed in each discipline (general, organization, finance, solar energy, mini/micro hydropower, transmission/distribution lines) described in II-1.1, planning by participatory approach, information system of rural electrification, education of rural electrification by renewable energies, mechanism for sustainability and actions to implement the long-term rural electrification by renewable energies.

Fig. II-1.5-1 shows the Action Plan in line with Table II-1.6.6-1, which proposes the long-term rural electrification plan by renewable energies staging in four phases mentioned in II-1.6.6. This Action Plan shows when and what actions to be conducted by which organization, so that these actions should be mainly implemented in Phase I, the period for infrastructure.

In order to implement those actions, it is desirable to have direction and supervision by a third party; for example, the government of Japan has a means of technical cooperation such as dispatch of government expert and senior volunteer. Such a technical cooperation can be requested from an international development organization.

At the same time, it is necessary to strengthen organizational capability of MEM/DPR, DREM and other relevant organizations in order to implement the above Action Plan and the long-term rural electrification by renewable energies. If it is difficult to recruit the necessary personnel from within the organization, it is necessary to augment the personnel by hiring definite-time staff or individual consultants. It is desirable for those personnel as well to have capacity building by the said third party expert.

In order to implement electrification of rural schools for education of residents of remote villages, it is necessary to make consultation and coordination fully with the Ministry of Education and the Ministry of Health about how the objective schools and health posts should be equipped and how electrification systems should be maintained.

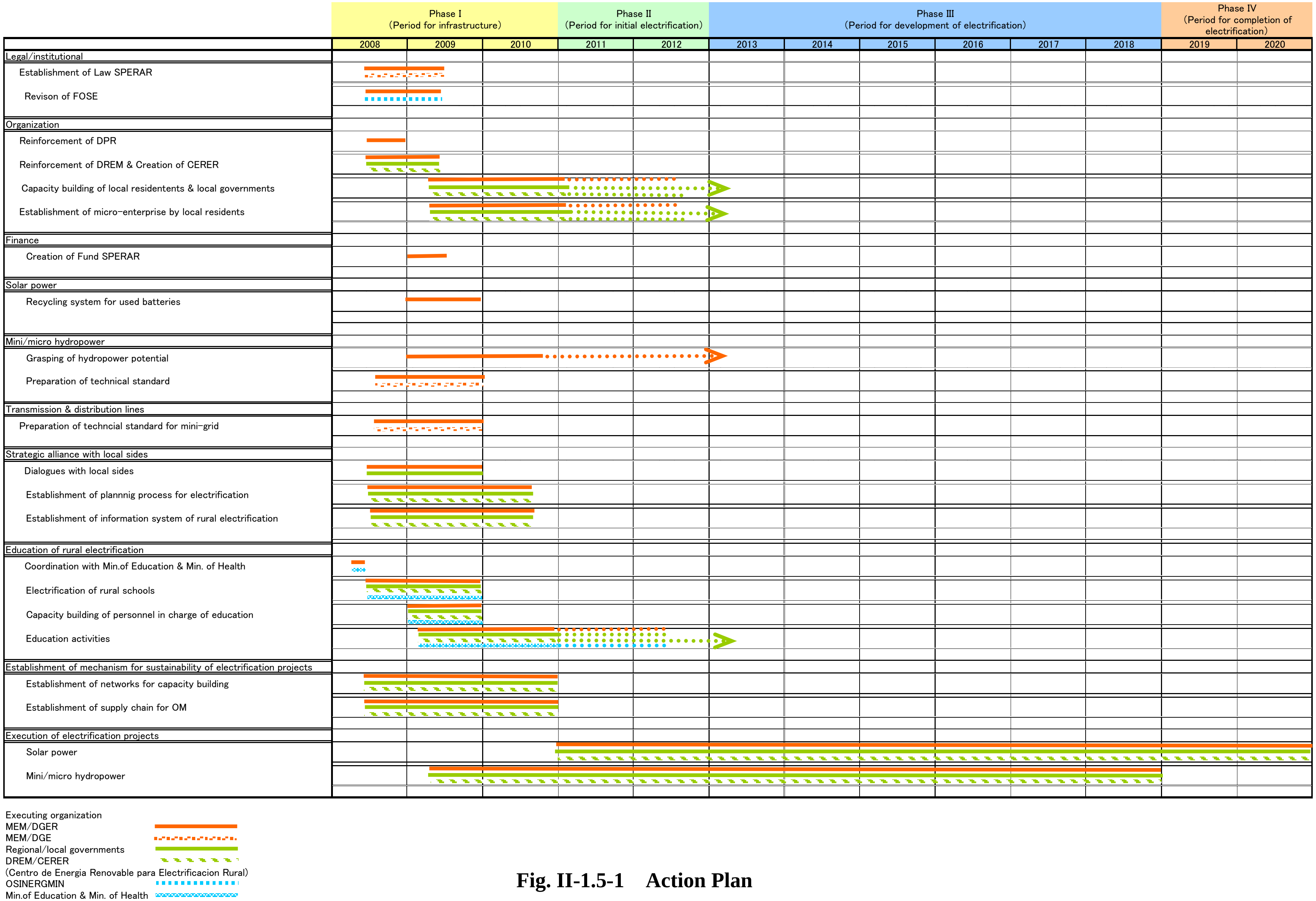


Fig. II-1.5-1 Action Plan

The table below categorizes the Action Plan shown in Fig. II-1.5-1 by action and organization.

Table II-1.5-1 Action Plan by Organizations and Actions

	MEM/DGER	MEM/DGE	Regional/local governments	DREM/CERER	OSINERGMIN	Mins of Education & Health
Legal/institutional	- Law SPERAR - Revision of FOSE	- Law SPERAR			- Revision of FOSE	
Organization	- Networks with universities as center - Reinforcement of DPR - Reinforcement of DREM - Capacity building of local people & local governments - Creation of micro-enterprises by local people - Creation of CERER in regional government		- Networks with universities as center - Reinforcement of DREM - Capacity building of local people & local governments - Creation of micro-enterprises by local people - Creation of CERER in regional government	- Networks with universities as center - Reinforcement of DREM - Capacity building of local people & local governments - Creation of micro-enterprises by local people - Creation of CERER in regional government		
Finance	- Fund					
Solar power	- Recycling system of used batteries					
Mini/micro hydropower	- Hydropower potential (by questionnaire and GIS) - Technical standard	- Technical standard				
Transmission/ distribution lines	- Technical standard for mini-grid	- Technical standard for mini-grid				
Strategic alliance with local sides	- Dialogues with local sides - Planning process for electrification - Information system of rural electrification		- Dialogues with local sides - Planning process for electrification - Information system of rural electrification	- Dialogues with local sides - Planning process for electrification - Information system of rural electrification		
Education of electrification	- Education by electrification of rural schools		- Education by electrification of rural schools	- Education by electrification of rural schools		- Education by electrification of rural schools
Mechanism for Sustainability	- Networks for capacity building - Supply chain for OM		- Networks for capacity building - Supply chain for OM	- Networks for capacity building - Supply chain for OM		

As mentioned above, Phase I is an important period to consolidate the infrastructure necessary to effectively implement the long-term rural electrification plan, by making strategic alliance through dialogues with local sides and establishing networks for capacity building and supply chain for OM. Therefore, the following actions are necessary conditions to smoothly implement the long-term rural electrification plan.

- It is necessary to make legal/institutional preparation and technical standards, fund procurement, establish the information system of rural electrification and planning mechanism by participatory approach, and create CERER (Centro de Energías Renovables para Electrificación Rural) in each region.
- As for legal/institutional aspects, It is desirable to take legal measures such as a special law like Law SPERAR incorporating the suggestions made in this Master Plan. At the same time, the current FOSE, cross subsidy system for tariff, is not able to respond to very small power

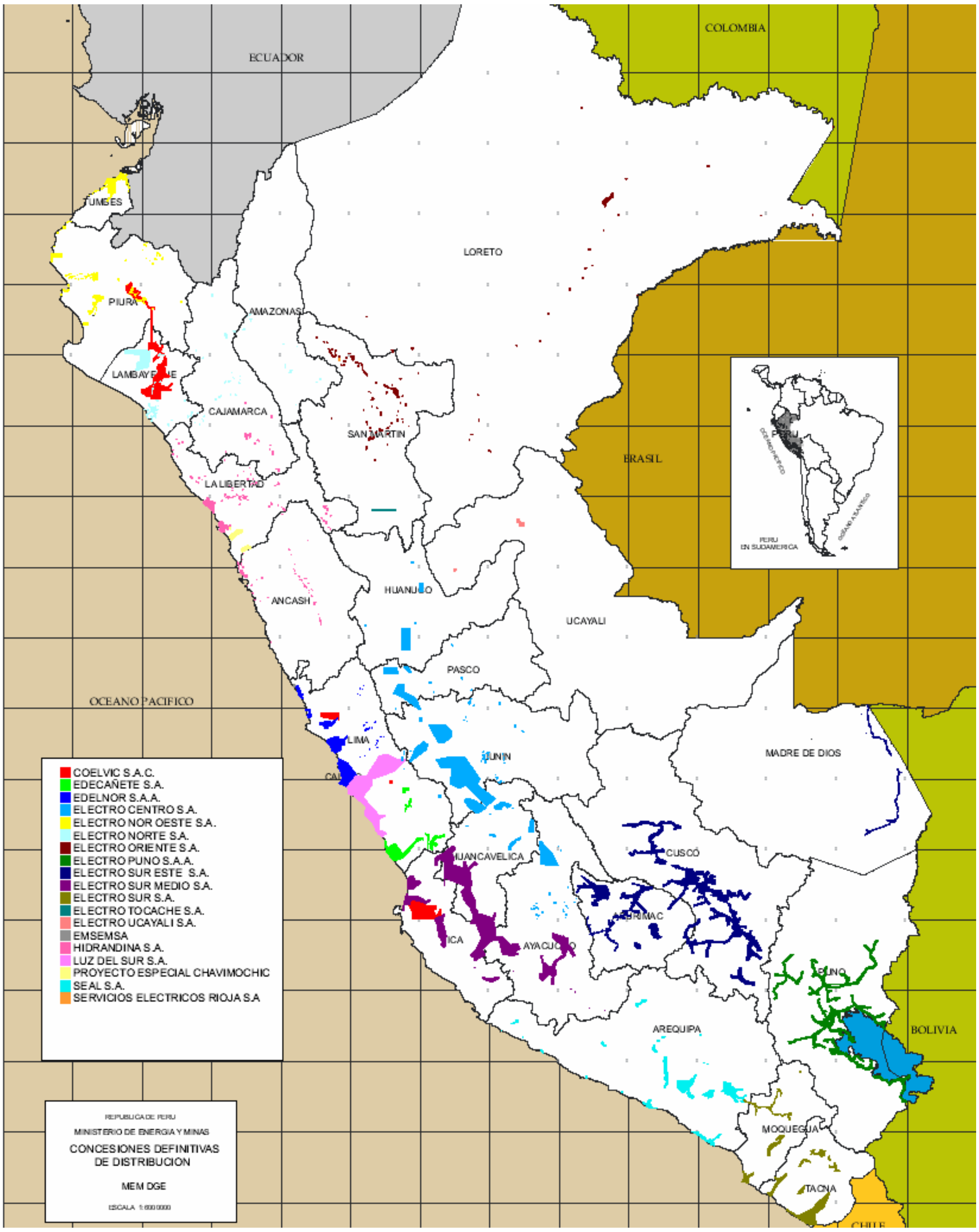
consumers in remote areas, so that it is necessary to review the system and desirable to establish a new FOSE in the same period.

- As for financing, it is proposed to create Fund SPERAR, which would require to obtain approval of the long-term rural electrification by renewable energies by SNIP as a program. In the case of introducing foreign aid, it would also be necessary to obtain approval as such.
- Under the decentralization of government, it is required to establish a system for promotion of rural electrification by local initiative. Therefore, it is important to establish strategic alliance through dialogues with local sides. It is also proposed to create CERER as implementing agency, making use of DREM. In this period, as suggested in II-1.4, it is necessary to establish the networks for capacity building and supply chain for OM with CERER as main agency, so that it is vital to create CERER in each region with assistance by MEM/DPR in the early part of the same period.
- Meanwhile, it is necessary to conduct education activities for local residents to educate them about electrification by renewable energies and enable electrification projects by initiative of local residents with participatory approach. It is desirable to continue those education in the later stages as well. It is suggested to electrify rural schools in non-electrified villages to use them as measures for education. In order to not hinder education activities, it is necessary to implement electrification of rural schools in the early part of this Phase.
- As for 4 sites where JICA Study Team conducted prefeasibility study, it is useful for smooth implementation of the long-term rural electrification to start the projects by conducting site investigations and capacity building for local residents in order to see if the proposed model plan would function.

II-1.6 Rural Electrification Plan

II-1.6.1 Demarcation between On-grid and Off-grid

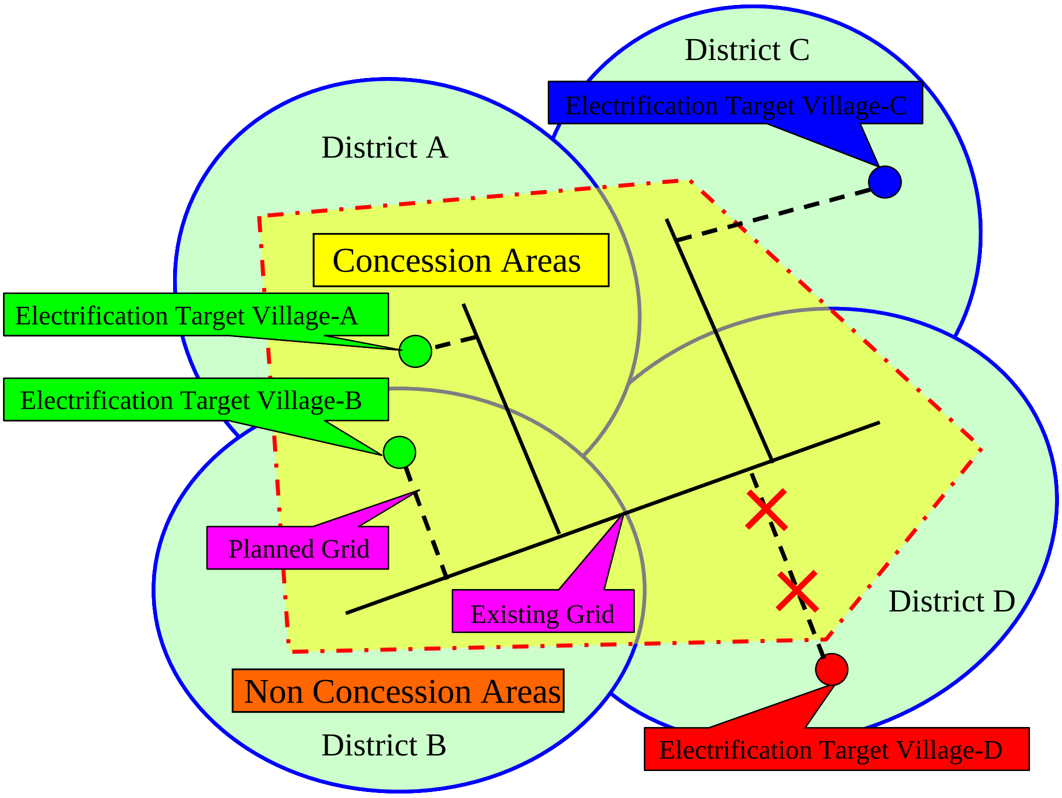
In progressing the rural electrification, MEM designated the target areas of the entire county, called Concession Area, on the map system of UTM (Universal Transverse Mercator [WGS84]) and has prioritized them to build infrastructures. Concession Areas are usually urban areas or ones where electricity is independently provided by mini hydropower, and they occupy just a small part of the entire land. (See Fig. II-1.6.1-1)



Source: MEM-DGE

Fig. II-1.6.1-1 Concession Area (2007)

In Concession area (within 100 m from concession area's border), the local distribution company is responsible for supplying electricity. At non-electrified village in Concession Area such as Village A or B in Fig. II-1.6.1-2 local distribution company has to make plan to supply the electricity. On the other hand, at non-electrified village outside of Concession area, MEM/DPR has to make plan to supply the electricity. Non-electrified village like Village C to which electricity line can be extended should be electrified by the grid extension and non-electrified village like Village D where grid extension is impossible will be done by renewable energy.



Drawing up by JICA study team

Fig. II-1.6.1-2 Image of Electric Power Supply

II-1.6.2 List of Non-Electrified Villages and Selection of Target Villages for Electrification by Renewable Energy

Regarding the target area of renewable energy electrification for the Master Plan, based on the data sent by MEM/DPR on 10th June 2008 is defined as “Mini Hydro Potential Villages” and on 27th February 2008, is defined as “Off-Grid.”

This Mini Hydro Potential Villages indicates that there are 519 villages, 18,498 households should be electrified by mini hydro and the rest of the villages, 33,182 non-electrified villages composed of 343,349 households, should be electrified by PV.

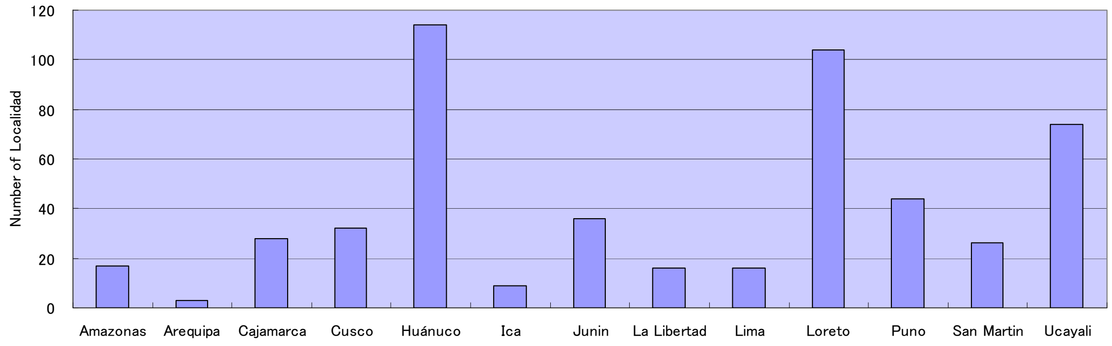


Fig. II-1.6.2-1 Number of Off-Grid Villages by Mini Hydro: 519 Villages

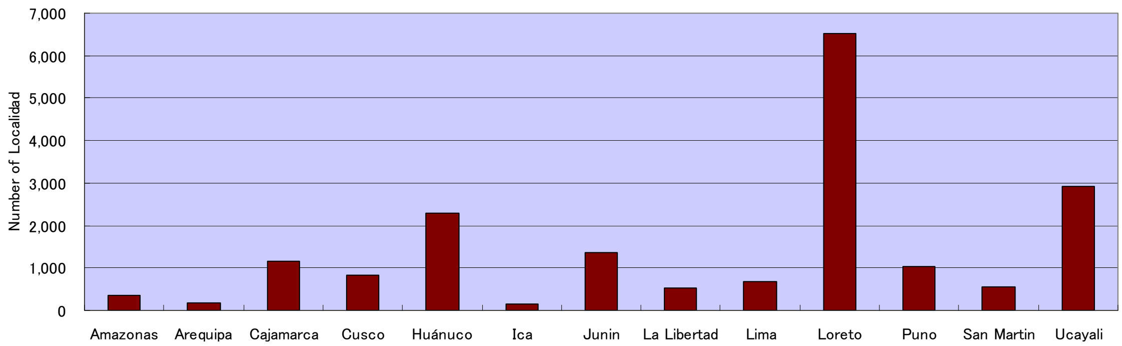


Fig. II-1.6.2-2 The Number of Off-Grid Households by Mini Hydro: 18,498 HHs

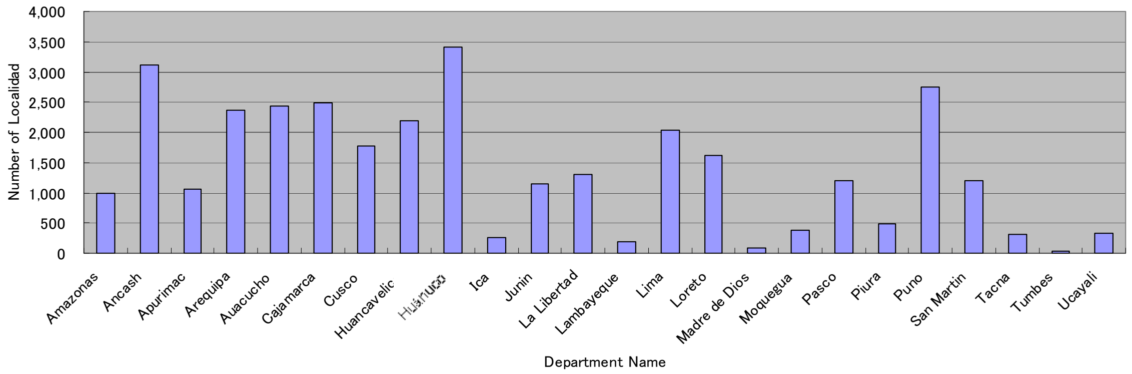


Fig. II-1.6.2-3 The Number of Off-Grid villages by PV: 33,182 Villages

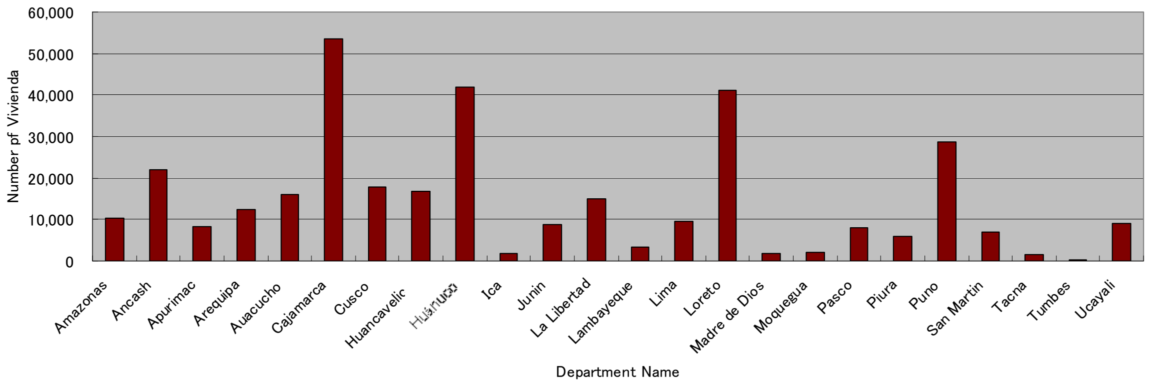


Fig. II-1.6.2-4 The Number of Off-Grid Households by PV: 343,349 HHs

1. Analysis for Electrification Target Villages by Mini-hydro

Table II-1.6.2-1 The Number of Households per Off-Grid Village <Mini Hydro>

Nº	DEPARTAMENTO	LOC.	VIVIENDAS
1	AMAZONAS	17	358
2	AREQUIPA	3	166
3	CAJAMARCA	28	1,149
4	CUSCO	32	830
5	HUANUCO	114	2,284
6	ICA	9	142
7	JUNIN	36	1,362
8	LA LIBERTAD	16	534
9	LIMA	16	676
10	LORETO	104	6,519
11	PUNO	44	1,023
12	SAN MARTIN	26	543
13	UCAYALI	74	2,912
		519	**18,498**

Regarding mini hydro, when the candidate power house location is decided, it is possible to electrify the villages around the power station, target villages for electrification should be defined all the non electrification villages independently of the scale of the villages.

2. Analysis for Electrification Target Villages by PV

Table II-1.6.2-2 The Number of Households per Off-Grid Village <PV>

No. of Households	> 50	10～ 49	< 10	Total	Electrification Target Exclude small village <10
Amazonas	30	329	630	**989**	**359**
Ancash	31	630	2,455	**3,116**	**661**
Apurimac	6	284	778	**1,068**	**290**
Arequipa	27	239	2,103	**2,369**	**266**
Auacucho	16	469	1,953	**2,438**	**485**
Cajamarca	226	1,414	850	**2,490**	**1,640**
Cusco	44	560	1,166	**1,770**	**604**
Huancavelica	33	515	1,646	**2,194**	**548**
Huánuco	150	1,127	2,132	**3,409**	**1,277**
Ica	2	55	202	**259**	**57**
Junin	18	253	873	**1,144**	**271**
La Libertad	44	476	788	**1,308**	**520**
Lambayeque	12	114	68	**194**	**126**
Lima	22	161	1,859	**2,042**	**183**
Loreto	154	1,232	223	**1,609**	**1,386**
Madre de Dios	3	68	20	**91**	**71**
Moquegua	0	65	324	**389**	**65**
Pasco	9	236	949	**1,194**	**245**
Piura	14	199	276	**489**	**213**
Puno	60	980	1,708	**2,748**	**1,040**
San Martin	11	193	997	**1,201**	**204**
Tacna	2	39	268	**309**	**41**
Tumbes	0	13	20	**33**	**13**
Ucayali	43	221	65	**329**	**264**
Localidad	957	9,872	22,353	**33,182**	**10,829**
Vivienda	(74,188)	(187,332)	(81,829)	**(343,349)**	**(261,520)**
	21.6%	54.6%	23.8%	**100%**	

Exclude small village <10

: Prioritized Regions

On the other hand, about Off-Grid villages by PV, large scale of the villages has a lot of advantages such as certain level of demand and tariff, investment effect and operation and maintenance system, therefore, target villages for electrification by PV should be defined as non electrified villages having more than 10 households (10,829 Villages, 261,520 households).

II-1.6.3 Process for Selection of Electrification Method

According to PNER by MEM/DPR, the basic policy for electrification is to promote electrification by grid extension. This is justified from the viewpoint of stable and consecutive power supply in the long term.

The basic electrification method is grid extension as above mentioned, but it is no other choice to select renewable energy in remote areas where it is economically and technically difficult to expand the distribution line.

To select which energy source are the most reasonable is very important and such conditions should be well considered as natural conditions, amount of sources and social condition Additionally, renewable energy has such characteristics that the quantity and quality of power supply fluctuates and depends on natural conditions to compare with that of grid expansion. Therefore, its users should utilize these energy sources understanding well its advantage and disadvantage and should conduct various measures for its long term operation. Concrete methods of process for selection of electrification and economic cost comparison are shown in Volume 3 Educational Material.

II-1.6.4 Standard Design and Costs for Long-term Rural Electrification Plan by Renewable Energies

1. PV System

(1) Design Condition

1) The design is based on minimum monthly irradiation in minimum annual average irradiation area of the country.
2) Set the tilting angle of PV module in smallest irradiation month to make larger irradiation value. Minimum tilting angle should be 10 degree. The appropriate angles calculated by celestial globe model at typical cities are shown in Table II-1.6.4-1. Solar irradiations on tilting surface are calculated after the correction of irradiation data at site by the globe model.

Table II-1.6.4-1 Appropriate Titling Angle by Celestial Globe Model

Latitude (south)	Tilting angle	Example city
up to 7°	10°	Iquitos, Chachapoyas, Chiclayo
from 7° to 10°	15°	Cajamaca, Pucallpa, Huanuco
from 10° to 13°	20°	Lima, Puerto Maldonado, Huancayo
from 13° to 16°	25°	Puno, Cusco, Ayacucho, ICA
from 16°	30°	Arequipa, Tacna, Moquegua

Source: JICA study team

3) On the basis of the minimum monthly irradiation at minimum annual average irradiation area in the country, the Master Plan is designed. Therefore, solar irradiation at Iquitos in January is selected as basic data for the Master Plan.
4) System voltage: SHS DC 12 V
   BCS DC 12 V
   Public facility AC 220 V (DC side 48 V)
5) LED is included for the purpose of night light and support light in SHS.
6) DC/DC converter is included for the use of existing DC equipment.
7) For BCS user, wiring and installation of lighting will be considered.
8) SHS will be designed under technical criteria of the Peru as shown below.
   NTP 399.403 "SISTEMAS FOTOVOLTAICOS HASTA 500 Wp", 2006-02-16
9) Deep cycle battery made in Bolivia selected under UNDP/GEF project is considered for SHS.

(2) Solar Irradiation Potential

Solar irradiation atlas shows the unevenly distributed irradiation by geographical and seasons. In the Master Plan, the same standard of the system is designed for all over the Peru considering easy operation and maintenance. Therefore, the Master Plan was designed on the basis of the site with minimum solar irradiation potential. The solar irradiation atlas shows most of the area with minimum solar irradiation area is located in regions of Loreto and Ucayali. For the Master Plan, solar irradiation data of Iquitos in Loreto region were selected for design. Table II-1.6.4-2 shows monthly horizontal irradiation and irradiation with tilting angle 10 degrees. The month with minimum monthly average of irradiation in a year is selected for the design because SHS is isolated power generation system. In study, the Master Plan was designed with the data of solar irradiation at tilting surface in January.

Table II-1.6.4-2 Monthly Solar Irradiation (horizontal, titling angle 10 deg.)

Month	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Irradiation Horizontal (kWh/m^2)	3.4	3.7	3.5	3.7	3.0	3.1	3.7	4.2	4.7	3.8	4.2	3.8	3.7
Irradiation 10 deg. (kWh/m^2)	3.1	3.5	3.5	3.8	3.2	3.4	4.0	4.4	4.7	3.7	3.9	3.4	3.7

Source: Generacion de Electricidad a pequena escala con Energia Solar Fotovoltaica, CENERGIA and ECOFYS

As an input energy, different from power generation system by fossil fuel such as diesel generator, solar irradiation cannot be controlled by human. On the other hand, output energy can be controlled by human by adjustment of power consumption. Therefore, power demand at the period of lowest irradiation season is used for the design of isolated power generation system by solar irradiation.

(3) Design: SHS

In this study, power demand estimation is carried out based on the result of field study at pre-feasibility level in Iquitos where solar irradiation potential is smallest. Table II-1.6.4-3 shows estimated power demand in January when monthly irradiation is smallest. Except January, power output from the system is enough for three fluorescent lights.

Table II-1.6.4-3 Power Demand

Demand	Rated power (W)	Hours (hours/day)	Power consumption (Wh/day)
Room: Fluorescent Light	12	3	36
Kitchen: Fluorescent Light	12	2	24
LED	2	8	16
Radio	10	3	30
Total			**106**

System voltage	12	V	
Total demand	8.8	Ah/day	

The capacity of SHS is decided by the balance between power demand and estimated power output on the basis of solar irradiation on tilting surface at minimum monthly average of solar irradiation.

Design loss: $K = K1 \times K2 \times K3 \times K4 \times K5 \times K6$

PV capacity (W) = Power demand (kWh/day) / (Design loss × Solar irradiation (kWh/m^2-day))

= 49.4 ≒ 50 W

K1:	Temperature correction coefficient	(25°C)	1.0
K2:	Module derating factor	normally 0.9~0.95	0.9
K3:	Power loss (PV module to battery)	normally 0.95	0.95
K4:	Controller		0.95
K5:	Battery Charge/discharge		0.9
K6:	Power loss (Battery to demand)		0.95

In this Master Plan, the capacity of SHS was decided as 50 Wp from the above calculation. Table II-1.6.4-4 shows the relation between irradiation and estimated monthly power output.

Table II-1.6.4-4 Estimated Power Output (50 Wp)

Month	Irradiation[*1] (kWh/m^2-day)	Power Output (Wh/day)	Power Output (Ah/day)	Monthly Output (kWh/Mo)
Jan	3.1	107.2	8.9	3.3
Feb	3.5	121.2	10.1	3.4
Mar	3.5	119.9	10.0	3.7
Apr	3.8	133.1	11.1	4.0
May	3.2	112.1	9.3	3.5
Jun	3.4	118.1	9.8	3.5
Jul	4.0	139.9	11.7	4.3
Aug	4.4	153.8	12.8	4.8
Sep	4.7	164.5	13.7	4.9
Oct	3.7	126.8	10.6	3.9
Nov	3.9	134.1	11.2	4.0
Dec	3.4	118.5	9.9	3.7
Average	**3.7**	**129.1**	**10.8**	**3.9**

Annual: 47.1 (kWh/year)

*1: tilting angle 10 deg. at Iquitos

Battery capacity is calculated based on the national standard of Peru.

Cu = (Autonomous day +1) (Daily consume) / PD max
= 88 ≒ 100 Ah

Autonomous day : 3 days
PDmax : 40%

Summary of SHS and the cost in the M/P study are shown below.

System Summary (SHS)

PV module : 50 Wp
Controller : 10 A
Battery : 100 Ah
Fluorescent Light : 12 W × 3
LED : 2 W × 1
DC/DC converter : input 12 V - output 1.5 V, 3 V, 4.5V, 6 V, 9 V

Table II-1.6.4-5 System Cost (SHS)

Item			No.	Unit	Price (US$)
PV panel	50	Wp	1	250	250
Controller	10	A	1	40	40
Battery*1	100	Ah	1	110	110
FC-light	12	W	3	20	60
LED	2	W	1	20	20
DC-DC converter	12	V	1	15	15
Accessories (wire, pole etc.)	1	set	1	125	125
Installation & Transportation	10	%	1	62	62
Total					**682**

*1: Deep-Cycle Battery, made in Bolivia

(4) Design: Rural School

The power demand is estimated at Iquitos where solar irradiation potential is smallest and field study at pre-feasibility level was carried out. The following table shows the power demand.

Table II-1.6.4-6 Power Demand

Demand	Rated power (W)	No.	Hours (hours/day)	Power consumption (Wh/day)
FC-light	12	15	4	720
PC	300	3	2	1,800
Printer	300	1	0.5	150
TV	60	1	2	120
DVD	40	1	1	40
Inverter (self consumption)	7.5	1	8	60
Total				**2,890**

The capacity of PV system for rural school is decided by the balance between power demand and estimated power output on the basis of solar irradiation on tilting surface at minimum monthly average of solar irradiation.

Design loss: K = K1 × K2 × K3 × K4 × K5 × K6 × K7

PV capacity (W) = Power demand (kWh/day) / (Design loss × Solar irradiation (kWh/m^2-day))

= 1,498 W ≒ 1.5 kW

K1:	Temperature correction coefficient		1.00
K2:	Module derating factor	normally 0.9~0.95	0.9
K3:	Power loss (PV module to battery)	normally 0.95	0.95
K4:	Controller		0.95
K5:	Battery Charge/discharge		0.9
K6:	Power loss (Battery to demand)		0.95
K7:	Inverter		0.9

System voltage 48 V

In this Master Plan, the capacity of PV system for rural school was decided as 1.5 kWp from above calculation. Table II-1.6.4-7 shows relation between monthly solar irradiation and estimated power output.

Table II-1.6.4-7 Estimated Power Output (1.5 kWp)

Month	Irradiation[*1] (kWh/m^2-day)	Power Output (kWh/day)	Power Output (Ah/day)	Monthly Output (kWh/Mo)
Jan	3.1	3.2	67.0	99.7
Feb	3.5	3.6	75.8	101.8
Mar	3.5	3.6	74.9	111.5
Apr	3.8	4.0	83.2	119.8
May	3.2	3.4	70.1	104.2
Jun	3.4	3.5	73.8	106.3
Jul	4.0	4.2	87.4	130.1
Aug	4.4	4.6	96.1	143.0
Sep	4.7	4.9	102.8	148.0
Oct	3.7	3.8	79.3	117.9
Nov	3.9	4.0	83.8	120.7
Dec	3.4	3.6	74.1	110.2
Average	**3.7**	**3.9**	**80.7**	**117.8**

Annual: 1,413.4 (kWh/year)

*1: tilting angle 10 deg. at Iquitos

Battery capacity is calculated based on the national standard of Peru.

Cu = (Autonomous day +1) (Daily consume) / PD max
= 669 ≒ 700 Ah

Autonomous day : 3 days

PDmax : 40%

System summary (Rural School)

PV module	:	1.5 kWp (130 Wp 3 × 4)
Controller	:	DC 48 V, 40 A
Battery	:	48 V, 700 Ah (700 Ah, 2 V × 24)
Inverter	:	2,500 W
Fluorescent Light	:	12 W × 15
Computer	:	300 W × 3
Printer	:	300 W × 1
TV	:	60 W × 1
DVD	:	40 W × 1

Table II-1.6.4-8 System Cost (Rural school)

Item			No.	Unit	Price (US$)
PV module: (130 Wp × 12)	1.5	kWp	12	600	7,200
Controller: (48 V)	60	A	1	500	500
Battery: (48 V)	700	Ah	24	320	7,680
Inverter:	2,500	W	1	2,000	2,000
Fluorescent Light: (AC)	12	W	15	7	105
Computer:	300	W	3	540	1,620
Printer:	300	W	1	100	100
TV:	60	W	1	180	180
DVD:	40	W	1	60	60
Grounding materials	100	Ω	1	600	600
Accessories Cost: (wire, etc.)	8	%			1,604
Installation & Transportation	10	%			2,005
Total					**23,653**

(5) Design: Rural Health Clinic

The power demand is estimated at Iquitos where solar irradiation potential is smallest and field study at pre-feasibility level was carried out. The following table shows the power demand. In the study, vaccine refrigerator for rural health clinic is selected from DC 12 V operation system. Also, communication radio is operated by direct current. The table below shows the power demand.

Table II-1.6.4-9 Power Demand (DC 12 V)

Demand	Rated power (W)	No.	Hours (hours/day)	Power consumption (Wh/day)
Vaccine refrigerator	60	1	10	600
Communication radio: stand-by	2	1	12	24
: transmitting	30	1	1	30
Total				**654**

Table II-1.6.4-10 Power Demand (AC 220 V)

Demand	Rated power (W)	No.	Hours (hours/day)	Power consumption (Wh/day)
FC-light	12	8	4	384
PC	300	1	2	600
Printer	300	1	0.5	150
TV	60	1	2	120
DVD	40	1	1	40
Inverter - operation	7.5	1	6	45
Total				**1,339**

The capacity of PV system for rural health clinic is decided by the balance between power demand and estimated power output on the basis of solar irradiation on tilting surface at minimum monthly average of solar irradiation.

Design loss (DC): K = K1 × K2 × K3 × K4 × K5 × K6

(AC): K = K1 × K2 × K3 × K4 × K5 × K6 × K7

K1:	Temperature correction coefficient		1.00
K2:	Module derating factor	normally 0.9~0.95	0.9
K3:	Power loss (PV module to battery)	normally 0.95	0.95
K4:	Controller		0.95
K5:	Battery Charge/discharge		0.9
K6:	Power loss (Battery to demand)		0.95
K7:	Inverter		0.9

System voltage 48 V

PV capacity (W) = {AC (Power demand (kWh/day) / Design loss)
+ DC (Power demand (kWh/day) / Design loss)}
/ Solar irradiation (kWh/m^2-day)
= 999 W ≒ 1.0 kW

Table II-1.6.4-11 Estimated Power Output (1.0 kWp)

Month	Irradiation (kWh/m^2-day)	Power Output (kWh/day)	Power Output (Ah/day)	Monthly Output (kWh/Mo)
Jan	3.1	2.1	44.7	66.5
Feb	3.5	2.4	50.5	67.9
Mar	3.5	2.4	50.0	74.3
Apr	3.8	2.7	55.4	79.8
May	3.2	2.2	46.7	69.5
Jun	3.4	2.4	49.2	70.9
Jul	4.0	2.8	58.3	86.7
Aug	4.4	3.1	64.1	95.3
Sep	4.7	3.3	68.5	98.7
Oct	3.7	2.5	52.8	78.6
Nov	3.9	2.7	55.9	80.5
Dec	3.4	2.4	49.4	73.5
Average	**3.7**	**2.6**	**53.8**	**78.5**

Annual: 942.4 (kWh/year)

*1: tilting angle 10 deg. at Iquitos

Battery capacity is calculated based on the national standard of Peru. The continuous autonomous days are estimated 4 days because the system supplies electricity to vaccine refrigerator.

Cu = (Autonomous day +1) (Daily consume) / PD max
= 558 Ah ≒ 600 Ah

Autonomous day : 4 days

PDmax : 40%

System summary (Rural Health Clinic)

PV module : 1.0 kWp (130 Wp 3 × 3)

Controller : DC 48 V, 40 A
Battery : 48 V, 600 Ah (600 Ah, 2 V × 24)
Inverter : 1,000 W
Fluorescent Light : 12 W × 8
Computer : 300 W × 1
Printer : 300 W × 1
TV : 60 W × 1
DVD : 40 W × 1
Vaccine refrigerator : 600 W × 1 (DC 12 V)
Communication radio : 30 W (DC 12 V)

Table II-1.6.4-12 System Cost (Rural Health Clinic)

Item			No.	Unit	Price (US$)
PV module:(130 Wp × 9)	1	kWp	9	600	5,400
Controller: (48 V)	60	A	1	500	500
Battery: (48 V)	600	Ah	24	300	7,200
Inverter:	1,000	W	1	1,000	1,000
Fluorescent Light:	12	W	8	7	56
Computer:	300	W	1	540	540
Printer:	300	W	1	100	100
TV:	60	W	1	180	180
DVD:	40	W	1	60	60
Vaccine refrigerator	600	W	1	2,500	2,500
Communication radio	30	W	1	2,000	2,000
Grounding materials	100	Ω	1	600	600
Accessories Cost: (wire, etc.)	8	%			1,611
Installation & Transportation	10	%			2,014
Total					**23,760**

(6) Design : PV System for Rural Industry

The power demand is estimated at Iquitos where solar irradiation potential is smallest and field study at pre-feasibility level was carried out. Power demands for industrial use are depending on the type of industry, capacity and required electrical tools. Power demand model of rural industry are estimated as Tool-A, Tool-B and Tool-C. The table below shows the power demand.

Table II-1.6.4-13 Power Demand (Rural Industry)

Demand	Rated power (W)	No.	Hours (hours/day)	Power consumption (Wh/day)
FC-light	12	10	3	360
Tool-A	200	2	2	800
Tool-B	250	2	2	1,000
Tool-C	400	2	2	1,600
Inverter - self consumption	7.5	1	10	75
				3,835

The capacity of PV system for rural industry is decided by the balance between power demand and estimated power output on the basis of solar irradiation on tilting surface at minimum monthly average of solar irradiation.

Design loss: K = K1 × K2 × K3 × K4 × K5 × K6 × K7

PV capacity (W) = Power demand (kWh/day) / (Design loss Solar irradiation (kWh/m^2-day))

= 1,987.8 W ≒ 2.0 kW

K1:	Temperature correction coefficient		1.00
K2:	Module derating factor	normally 0.9~0.95	0.9
K3:	Power loss (PV module to battery)	normally 0.95	0.95
K4:	Controller		0.95
K5:	Battery Charge/discharge		0.9
K6:	Power loss (Battery to demand)		0.95
K7:	Inverter		0.9

System voltage 48 V

Table II-1.6.4-14 Estimated Power Output (2.0 kWp)

Month	Irradiation (kWh/m^2-day)	Power Output (kWh/day)	Power Output (Ah/day)	Monthly Output (kWh/Mo)
Jan	3.1	4.3	89.3	132.9
Feb	3.5	4.8	101.0	135.8
Mar	3.5	4.8	99.9	148.7
Apr	3.8	5.3	110.9	159.7
May	3.2	4.5	93.4	139.0
Jun	3.4	4.7	98.4	141.8
Jul	4.0	5.6	116.6	173.4
Aug	4.4	6.2	128.1	190.7
Sep	4.7	6.6	137.1	197.4
Oct	3.7	5.1	105.7	157.2
Nov	3.9	5.4	111.7	160.9
Dec	3.4	4.7	98.8	147.0
Average	**3.7**	**5.2**	**107.6**	**157.0**

Annual: 1,884.5 (kWh/year)

*1: tilting angle 10 deg. at Iquitos

Battery capacity is calculated based on the national standard of Peru. The continuous autonomous days are estimated 3 days.

Cu = (Autonomous day +1) (Daily consume) / PD max

= 1,296 Ah ≒ 1,300 Ah

Autonomous day : 3 days

PD max : 40%

Outline of the System (industry)

PV module	:	2.0 kWp (130 Wp 3 × 5)
Controller	:	DC 48 V, 40 A
Battery	:	48 V, 1,300 Ah (1,300 Ah, 2 V × 24)
Inverter	:	3,000 W
Fluorescent Light	:	12 W × 10
Tool-A	:	200 W × 2
Tool-B	:	300 W × 2
Tool-C	:	400 W × 2

Table II-1.6.4-15 System Cost (Rural Industry)

Item			No.	Unit	Price (US$)
PV module:(130 Wp × 15)	3	kWp	15	600	9,000
Controller: (48 V)	60	A	1	500	500
Battery: (48 V)	700	Ah	24	320	7,680
Inverter:	2,000	W	1	2,500	2,500
Fluorescent Light:	12	W	10	7	70
Tool-A:	200	W	2	300	600
Tool-B:	250	W	2	400	800
Tool-C:	400	W	2	500	1,000
Grounding materials	100	Ω	1	600	600
Accessories Cost: (wire, etc.)	8	%			1,820
Installation & Transportation	10	%			2,275
Total					**26,845**

(7) Design: Battery Charging Station

BCS is the facility for battery users charges their battery. Compare to SHS, BCS is suitable for the household that require small power consumption and move to the other houses in season by season. The following table shows power demand of 70 Ah of battery.

Table II-1.6.4-16 Power Demand (70 Ah)

Demand	Rated power (W)	Hours (hours/day)	Power consumption (Wh/day)
Fluorescent Light (1)	12	3	36
Fluorescent Light (2)	12	1.5	18
LED	2	10	20
Radio	10	1	10
Total			**84**

System voltage	:	12 V
Demand (Ah)	:	84 Ah
Charging interval	:	4 days
Solar Insolation	:	3.1 h/day (January of Iquitos)

Necessary current for charging I_N (Ah) = Battery capacity (70 Ah) × K6 / (K1 × K2 × K3 × K4 × K5)
= 47.9 Ah/day

K1:	Temperature correction coefficient	1.0
K2:	Module derating factor	0.90
K3:	Power loss (PV module to battery)	0.95
K4:	Controller	0.9
K5:	Battery Charge/discharge	0.90
K6:	Depth of discharge	40%

Number of necessary PV module is calculated as follows.

Number of PV module: $N = I_N / (I_{pmax} \times \text{Solar insolation} \times K1 \times K2 \times K3 \times K4 \times K5)$

Table II-1.6.4-17 shows capacity of PV module and power current at maximum power point

Table II-1.6.4-17 Optimum Current

PV module (Wp)	I_{pmax} (A)
50	3.0
80	4.6
130	7.4

The table below shows the necessary number of PV module to charge each capacity of batteries. In the Master Plan, considering both aspects of price and installation, PV capacity of a set of battery charging system is decided as 2 modules of 130 Wp.

Table II-1.6.4-18 Number of PV Module vs. Batteries

PV module		Battery (50Ah)		Battery (70Ah)	
Capacity (Wp)	Unit price (US$)	Necessary number of PV module	Price of PV array	Necessary number of PV module	Price of PV array
50	320	5	1,600	6	1,920
80	480	3	1,440	4	1,920
130	600	2	1,200	3	1,800

System summary (BCS)

Number of household	:	4 households/system
PV module	:	130 Wp × 2 modules
Controller	:	20 A

Household

Battery	:	50 Ah, 70 Ah
Fluorescent Light	:	12 W×3
LED	:	2 W
DC/DC converter	:	input 12 V - output 1.5 V, 3 V, 4.5 V, 6 V, 9 V
Voltage meter	:	DC

Table II-1.6.4-19 System Cost (BCS: 20 households)

Item			No.	Unit	Price (US$)
PV module	130	Wp	10	600	6,000
Controller:	20	A	5	80	400
Accessories (wire etc.)	8	%			512
Installation & Transportation	10	%			640
Total					**7,552**

Table II-1.6.4-20 System Cost (wiring in a house)

Item			No.	Unit	Price (US$)
Battery:	70	Ah	1	100	100
Fluorescent Light:	12	W	2	20	40
LED:	2	W	1	20	20
DC/DC converter:	12	V	1	15	15
Voltage meter:	DC 12 V		1	10	10
Accessories (wire etc.)	8	%			15
Installation & Transportation	10	%			19
Total					**218**

(8) Operation and Maintenance

In component of PV system, some consumable parts such as battery and controller should be replaced every few years. On the other hand, life span of PV module and LED are longer as around 20 years and basically replacement are not necessary for every few years. The life span of controller is around 10 years. In this system, deep cycle battery made in Bolivia is chosen. Therefore, lifespan of battery in SHS becomes around 5 to 7 years. On the other hand, for BCS car battery is considered because users own the battery and easy to obtain. Life span of fluorescent light are estimated 2 to 3 years and that of inverter is estimated 10 years. The following table shows life span of component of SHS.

Table II-1.6.4-21 Life Span of PV System Component

Item	Lifetime (years)
PV module	20
Controller	10
Battery (deep cycle)	5 to 7
Battery (car)	2 to 3
Fluorescent Light	2 to 3
LED	20
Inverter	10

O&M cost: Annual O&M cost is estimated 2% of initial investment.

2. Mini/Micro Hydropower

(1) Trend of Mini/micro Hydropower Construction Cost in Peru

Unit cost for hydropower construction will be different by topographic conditions, output capacity and technical specifications. Table II-1.6.4-22 shows a cost comparison between ITDG and MEM/DPR project as a case example of construction cost for mini/micro hydropower in Peru. The cost of MEM/DPR is almost twice as much as ITDG.

Table II-1.6.4-22 Cost Comparison between ITDG and MEM/DPR Project

(per kW, household)

Description	ITDG	MEM/DPR
Investment cost ($/kW)	$2,448/kW	$5,184/kW
Investment cost ($/household)	$1,263/household	$2,000–3,000/household

From “Evaluation of the Strategic and Replicable Aspects of the IDB – ITDG Fund for the Promotion of Micro hydro Plants in Peru (MPF) – 2005”

(2) Technical Specification

Table II-1.6.4-24 shows a specification comparison regarding civil structures, cost (construction, transportation) between ITDG and MEM/DPR from the study reports of Llaucan Hydropower Project (ITDG-1996) and Omia Hydropower Project (MEM/DPR-2005). The different points can be grasped between ITDG and MEM/DPR project regarding construction cost (unit price) from this table. The construction cost of ITDG can be considered held down compared with MEM/DPR because the technical specifications are simpler than MEM/DPR, local labor forces are being utilized and a cost of road development are not included.

The construction cost for mini/micro hydropower is likely to be high compared with middle and large scale one. However, if technical specification is controlled at low level without careful consideration, it will cause to bring down durability and also increase the cost for operation and maintenance. For instance, technical specification to be adopted should be decided in consideration of features regarding weather, temperature, humidity, topography, geology and plant discharge, etc. For this reason, it is hoped that the technical standards/criteria is drawn up in order to select appropriate technical specification in consideration of durability and cost depending on technical specification.

(3) Standard Design and Cost

In the Master Plan, the construction cost (civil works and turbine/generators) shown in Table II-1.6.4-25 was estimated with standard specification of MEM/DPR in mind by the same method as Pre-FS based on the information regarding discharge, length of headrace and penstock, distance between lodgment city and site and so on shown in Table II-1.6.4-25. In addition, buried PVC pipe was adopted for headrace and penstock because of environment and landscape consideration. The location map and construction cost (civil works and turbine/generators) for each project is shown in Appendix. As well, the transmission and distribution cost is estimated by using the data of the length of the line, the number of households and its average unit cost as shown in Table II-1.6.4-25. From the above results, the relation between the cost for mini/micro hydropower and its installed capacity is sorted out as shown Fig. II-1.6.4-1. However, cost of transportation for materials and access road construction are not considered in this figure. For this reason, if the cost for mini/micro hydropower is rough estimated using this figure, appropriate cost should be allocated taking necessity of transportation cost from lodgment city to site and access road into consideration.

Table II-1.6.4-23 Distribution Unit Cost

	Linea Primaria (23kVGrid)	Redes Primaria (23kV Network)	Redes Secundaria (400V Grid)
Distribution Unit Cost	US$8,000/km	US$200/household	US$500/Household

Table II-1.6.4-24 Technical Specification Comparison between ITDG and MEM/DPR Project

Item	Description	ITDG	MEM/DPR
1	Location / year construction	Cajamarca – 1996 (Potency = 50 kw)	Amazonas – 2005 (Potency = 2×50 kw)
2	Civil works structures		
2-1	Concrete structures	Medium-quality (f'c=140 and 175 kg/cm^2)	Standard quality (f'c=210 kg/cm^2)
2-2	Reinforcement bars	Installed in few structures.	Installed in more places (concrete reinforcement)
2-3	Materials considered in Powerhouse	Cement-sand bricks (walls) Wood Beam (roof) Corrugated plastic plate (roof)	Concrete bricks (walls) Reinforcement concrete (Columns and beams) Wood Beam (roof) Corrugated plastic plate (roof)
2-4	Sanitary and Electrical Service	Have considered basic facilities.	Have considered full facilities (septic tank, etc).
2-5	Security system	Have not considered	Have considered
2-6	Metal works	Have considered in spotted location.	Have considered in many location (handrail, floor grating, etc)
3	Unit Price		
3-1	Equipment	Have not considered. Only 3% - 5% in the unit price analysis.	Have considered in PU (wheel loader, excavator, etc)
3-2	Labor	Have considered a percentage of the cost. Market study has been made to obtain the labor cost. Semiskilled and unskilled were considered in the unit price analysis. Foreman only in few items.	Have considered all Foreman, skilled, semiskilled and unskilled were considered in the unit price analysis.
3-3	Efficiency	Lower efficiency, because unit price do not include equipment and ITDG has hired local people.	Standard efficiency, because unit price include equipment and skilled labor.
4	Mobilization	Amount of cost lower. Not equipment to mobilize. Villagers help to transport materials.	Amount of cost higher. Many equipment and materials to mobilize.

Source: JICA study team (from Project Study Report)

Table II-1.6.4-25 Cost for Each Mini/micro Hydropower Project in Master Plan

No.	Project Name	Region	Installed Capacity (kW)	Discharge (m^3/s)	Catchment Area (km^2)	Weir (B x H) (m)	Diameter of Intake & Outlet (m)	Headrace Total Length (m)	Headrace PVC Diameter (mm)	Penstock Total (m)	Penstock Diamter (mm)	Penstock Steel (m)	Penstock PVC (m)	Altitude of Intake (m.a.s.l.)	Altitude of Powerhouse	Gross Head (m)	Loss (m)	Design Head (m)	Nearest City to project site	Distance from Lima to the nearest city (Km)	Distance from the nearest city to the nearest town of the project site	Distance and accessibility from the road or river to the project site		Civil Cost (US$)	Beneficiary Number of Villages	Beneficiary Number of Households	Length of Primary Lines (km)	Network Primary No. of Households x 0.8	Distribution Cost Linea Primaria (US$/km)	Distribution Cost Redes Primaria (US$/Households)	Distribution Cost Redes Secundaria (US$/Households)	Distribution Cost Sub Total (US$)	Total Cost (US$)
1	P.C.H. Cachiyacu	Amazonas	50	0.064	313.21	20 x 0.3	0.50	1,040	400	360	200	33	327	550	440	110	3.5	106.5	Chachapoyas	1,717 km by car	320 km from Chachapoyas by road and then by Cachiyacu River	1 km from Cachiyacu River, Nieva and Marañón	by river	**238,000**	17	358	77.78	287	8,000	200	500	**823,140**	**1,061,140**
2	P.C.H. Palcapampa	Arequipa	25	0.035	33.00	20 x 0.3	0.50	1,270	400	240	200	22	218	4,250	4,140	110	3.1	106.9	Arequipa	1,049 km by car	185 km from Arequipa road	12 km from the road	by car	**201,110**	3	166	42.81	133	8,000	200	500	**435,580**	**636,690**
3	P.C.H. La Majada		60	0.085	20.70	20 x 0.3	0.50	1,900	500	560	200	0	560	2,849	2,749	100	5.4	94.6	Cajamarca	875 km by car	88 km from Cajamarca by road	3 km from the road	by car	**386,750**	11	420	29.76	336	8,000	200	500	**473,280**	**860,030**
4	P.C.H. Quebrada Honda	Cajamarca	30	0.050	18.10	20 x 0.2	0.50	1,560	400	175	150	0	175	4,000	3,900	100	3.1	96.9	Cajamarca	876 km by car	75 km from Cajamarca by road	by road 2km from this	by car	**186,830**	5	194	11.5	156	8,000	200	500	**201,200**	**388,030**
5	P.C.H. Yerba Buena		80	0.112	22.85	11 x 0.3	1.00	1,300	600	210	315	20	190	3,530	3,430	100	3.0	97.0	Cajamarca	875 km by car	57 km from Cajamarca by road	0.3 km from the road	by car	**337,960**	12	557	23.75	557	5,800	290	490	**572,210**	**910,170**
6	P.C.H. Quellouno		30	0.020	83.60	20 x 0.2	0.50	610	300	320	150	192	128	1,850	1,600	250	2.9	247.1	Cusco	1,566 km by car	156 km from Cusco by road	3.5 km from Yavero River	by river	**184,450**	11	198	26	159	8,000	200	500	**319,300**	**503,750**
7	P.C.H. Sarapampa	Cusco	60	0.090	208.70	20 x 0.3	1.00	1,100	500	150	200	0	150	1,350	1,250	100	2.5	97.5	Cusco	1,566 km by car	221 km from Cusco by road	N/A	by car	**239,190**	13	426	28.1	341	8,000	200	500	**463,500**	**702,690**
8	P.C.H. Yanama		30	0.050	218.90	20 x 0.2	0.50	700	400	110	200	0	110	2,100	2,000	100	1.9	98.1	Cusco	1,567 km by car	N/A	N/A	by car	**128,520**	8	206	32.6	165	8,000	200	500	**376,300**	**504,820**
9	P.C.H. Cayay		60	0.120	95.20	20 x 0.3	1.00	630	600	120	315	0	120	1,650	1,580	70	1.9	68.1	Huaraz	529 km by car	172 km from Huaraz by road	N/A	by car	**226,100**	18	405	35.3	324	8,000	200	500	**509,200**	**735,300**
10	P.C.H. Chontabamba	Huanuco	65	0.090	349.83	20 x 0.3	0.50	460	500	180	200	16	164	2,400	2,290	110	2.0	108.0	Huánuco	546 km by car	54 km from Huánuco by road	11 km from the road	by car	**208,250**	13	447	53	358	8,000	200	500	**674,600**	**882,850**
11	P.C.H. Quechuarpata		200	0.260	127.72	20 x 0.4	1.00	600	700	180	350	16	164	3,100	2,990	110	2.2	107.8	Huánuco	546 km by car	97 km from Huánuco by road	7 km from the road	by car	**421,260**	83	1,432	68.73	1,146	8,000	200	500	**1,352,040**	**1,773,300**
12	P.C.H. Lomo Largo	Ica	20	0.030	27.50	20 x 0.2	0.50	870	300	210	150	0	210	1,350	1,250	100	2.6	97.4	Ica	303 km by car	24 km from Ica by road	N/A	by car	**117,810**	9	142	22.5	114	8,000	200	500	**259,800**	**377,610**
13	P.C.H. Poyeni		50	0.070	26.50	20 x 0.3	0.50	1,350	400	440	200	21	419	400	295	105	4.2	100.8	Huancayo	395 km by car	479 km from Huancayo by road and 100 km by Tambo River	by river 1.3 km from Tambo River	by river	**361,760**	8	375	43.63	300	8,000	200	500	**559,040**	**920,800**
14	P.C.H. Saureni	Junín	60	0.090	90.60	20 x 0.3	0.50	890	500	340	200	0	340	500	400	100	3.2	96.8	Huancayo	395 km by car	479 km from Huancayo by road and 100 km by Tambo River	N/A		**334,390**	11	426	61.6	341	8,000	200	500	**731,500**	**1,065,890**
15	P.H.C. Shima		75	0.130	137.00	20 x 0.3	1.00	2,210	600	380	315	0	380	400	310	90	4.8	85.2	Huancayo	395 km by car	479 km from Huancayo by road and 100 km by Tambo River	by river 1 km from Tambo River	by river	**592,620**	17	561	105.2	449	8,000	200	500	**1,155,900**	**1,748,520**
16	P.C.H. Huaraday	La Libertad	75	0.070	223.02	20 x 0.3	0.50	850	400	270	200	106	164	1,750	1,585	165	2.9	162.1	Trujillo	557 km by car	99 km from Trujillo by road	7.5 km from the road	by car	**234,430**	16	534	57.46	428	8,000	200	500	**759,280**	**993,710**
17	P.C.H. Marachanca	Lima	15	0.045	30.70	20 x 0.2	0.50	240	400	100	150	0	100	2,650	2,600	50	1.4	48.6	Lima	0 km by car	95 km from Lima by road	1.8 km from the road	by car	**83,300**	10	107	10.8	86	8,000	200	500	**146,600**	**229,900**
18	P.C.H. Quiula		100	0.201	44.90	20 x 0.3	1.00	450	600	170	315	0	170	4,300	4,220	80	2.0	78.0	Lima	0 km by car	94 km from Lima by road	6 km from the road	by car	**272,510**	6	569	10.8	456	8,000	200	500	**405,600**	**678,110**
19	P.C.H. Aichiyacu		30	0.085	820.40	20 x 0.3	0.50	840	500	330	200	0	330	350	300	50	3.1	46.9	Chachapoyas	1,717 km by car	367 km from Chachapoyas by road and 117 Km by Marañón River	N/A	by river	**290,360**	10	190	68.8	152	8,000	200	500	**656,800**	**947,160**
20	P.C.H. Balsa Puerto	Loreto	50 (80)	0.056 (0.090)	26.50	11 x 0.3	1.00	1,900	600	177	315	20	157	425	300	125	3.4	121.6	Yurimaguas	1,872 km by car	136 km from Yurimaguas by Cachiyacu River	by river 11 km from Cachiyacu River	by river	**593,810**	14	534	37.28	534	8,100	140	260	**515,568**	**1,109,378**
21	P.C.H. San Antonio		200	0.200	77.80	20 x 0.3	1.00	1,450	600	660	315	220	440	700	550	150	5.4	144.6	Yurimaguas	1,872 km by car	75 km by Paranapura River	by river 15 km from Paranapura River	by river	**904,400**	37	1,420	137.7	1,136	8,000	200	500	**1,896,800**	**2,801,200**
22	P.C.H. Santa Catalina		620	1.300	43.94	20 x 1.0	1.50	2,070	1,500 (open channel)	170	700	170	0	350	270	80	3.6	76.4	Iquitos	N/A	745 km from Iquitos by Ucayali Rive	30 km from Orellana town	by river	**3,760,400**	43	4,422	225.7	3,538	8,000	200	500	**4,282,200**	**8,042,600**
23	P.C.H. Challapampa	Puno	45	0.060	50.00	20 x 0.3	0.50	700	400	250	200	23	227	4,650	4,540	110	2.6	107.4	Juliaca	2,721 km by car	232 km from Juliaca by road	10 km from the road	by car	**198,730**	22	308	68.31	246	8,000	200	500	**718,680**	**917,410**
24	P.C.H. Huari Huari		100	0.093	9.50	20 x 0.3	0.50	900	500	190	200	17	173	1,200	1,090	110	2.5	107.5	Juliaca	2,721 km by car	237 km from Juliaca by road	3.5 km from Huari Huari River	by river	**283,220**	22	715	86.44	572	8,000	200	500	**1,091,920**	**1,375,140**
25	P.C.H. Porotongo	San Martín	50	0.133	21.10	20 x 0.3	1.00	1,100	600	180	315	0	180	2,450	2,398	52	2.7	49.3	Chachapoyas	1,717 km by car	84 km from Chachapoyas by road	12 km from the road	by car	**305,830**	12	329	32.47	264	8,000	200	500	**444,560**	**750,390**
26	P.C.H. Selecachi		30	0.045	24.60	20 x 0.2	0.50	1,520	400	390	150	0	390	450	350	100	4.1	95.9	Tarapoto	1,665 km by car	140 km from Tarapoto by road	N/A		**223,720**	14	214	16.4	172	8,000	200	500	**251,600**	**475,320**
27	P.C.H. Quebrada Tahuanía		55	0.070	13.72	20 x 0.3	0.50	2,200	400	600	200	55	545	400	290	110	5.9	104.1	Pucallpa	1,041 km by car	261 km from Pucallpa by Ucayali Ri	by river 11 km from Ucayali River	by river	**547,400**	14	386	62	309	8,000	200	500	**712,300**	**1,259,700**
28	P.C.H. Río Iparia	Ucayali	280	0.770	134.05	20 x 0.5	1.50	560	1,000 (open channel)	590	630	0	590	200	147	53	4.2	48.8	Pucallpa	1,041 km by car	97 km from Pucallpa by Ucayali Riv	by river 8 km from Ucayali River	by river	**2,499,000**	40	1,948	217.73	1,559	8,000	200	500	**2,833,140**	**5,332,140**
29	P.C.H. Shinipo		80	0.220	27.00	20 x 0.3	1.00	1,000	600	160	315	0	160	450	398	52	2.5	49.5	Pucallpa	1,041 km by car	272 km from Pucallpa by Ucayali Ri	by river 11 km from Ucayali River	by river	**484,330**	20	578	50.8	463	8,000	200	500	**730,500**	**1,214,830**

Pre-FS site

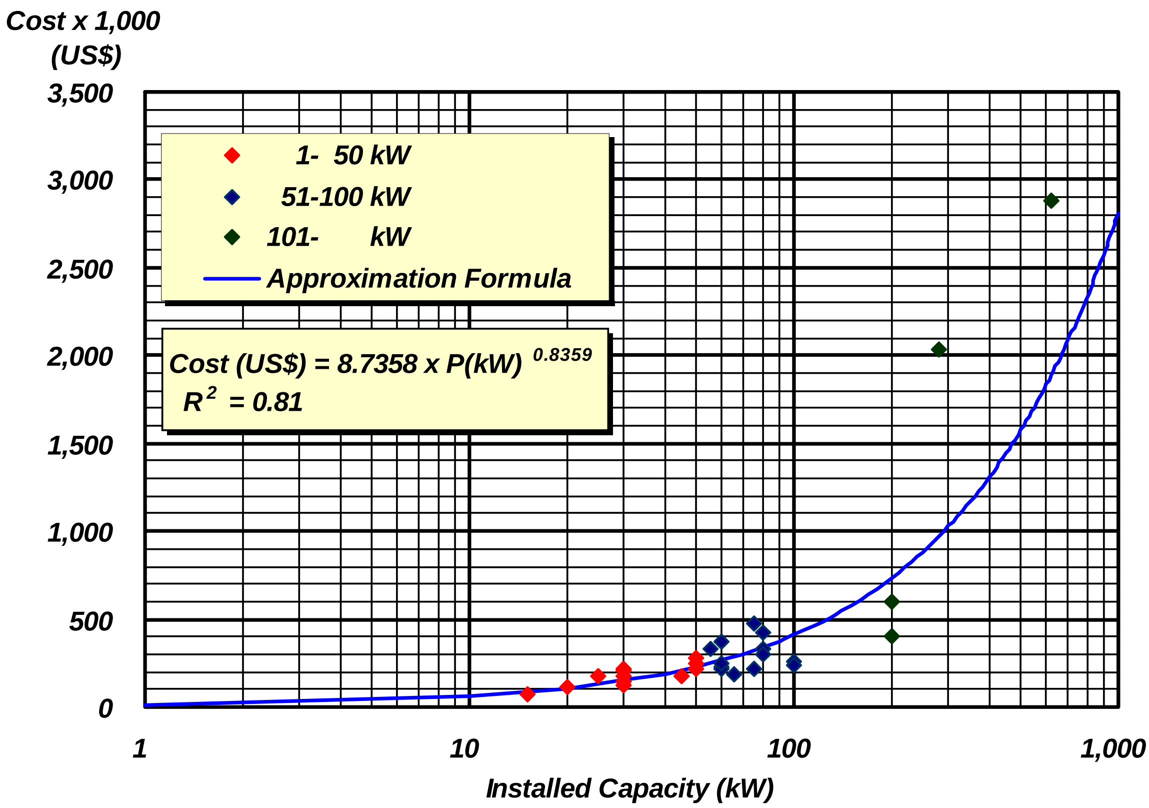


Fig. II-1.6.4-1 Standard Cost for Mini/Micro Hydropower Project (Except Transportation and Access Road Construction Cost)

II-1.6.5 Model Plan for Electrification

1. Organization

There are several types of organization: municipality, public corporation and private company. In this study a micro enterprise is selected and examined[6].

The purpose of creation of micro enterprise is to have a proper operation and management of renewable energy system on site. As the places where renewable energy is needed tend to be in remote and isolated areas, in such places unless villagers stand up by themselves to take care daily operation and become autonomous, sustainability of the system cannot be obtained. In addition, it has to aim the ownership and management separated, and to make clear the responsibility of the enterprise.

(1) Organization Form

It will be created as private enterprise and will be registered legally. However, if it is created as legal body (personal juridica), then under Peruvian law, monthly tax report is necessary. It is then extremely difficult or almost impossible to undertake such obligation for an enterprise which is

[6] As of February 2008, ITDG created 13 Microenterprises, 5 of them are standard type and 8 are operated with single staff.

created in remote villages. On the other hand, if it is created as an individually-owned company (personal natural), then the enterprise will be free from such obligation and simply pay a kind of withholding tax. Therefore, for the moment, the enterprise shall be registered as human owned enterprise for the time being.

(2) Personnel

The personnel of the enterprise will be selected from those who express interests in undertaking the business. As the revenue size of the enterprise is small, the basic structure of the enterprise will be with two people; one manager -commercial staff and one technical staff in principle. However, before selection, around 10 candidates will be selected from the village who expresses interests in undertaking the operation and management and all of them will be trained equally. By doing such, back up staff can be secured and if the final selected members will not continue, the remaining people can substitute.

(3) Training[7]

The training in principle will be done on site and this training will be provided initially to the villagers for awareness raising, then to the candidates.

Training includes following;

1) Significance of electrification
2) Conditions for electrification
3) Cooperation of villagers, responsibility and rights
4) Electrification plan and power supply service
5) Role of Micro enterprise, responsibility and rights
6) Establishment procedure of micro enterprise
7) Binding contracts (Micro enterprise with Residents and Municipalities)
8) Accounting records with revenues and costs, etc
9) Creation of users organization (Junta de Usuarios)
10) Open information with reporting to users on the activities and financial results of micro enterprise

Then training will be done to the candidates of managing personnel. In the case of mini/micro hydropower system, the following steps will be taken

1st Civil Work Training
1st Machine and Equipment Training
2nd Civil Work Training
2nd Machine and Equipment Training

[7] The contents of this part is based on ITDG training system.

1st Distribution line Training
2nd Distribution line Training
1st Operation and Management Training
2nd Operation and Management Training
3rd Operation and Management Training

During the training, also expected is the participation of villagers in installation of equipment and civil work, so that not only the candidates but also villagers can understand the electrification system as reality

In the case of solar PV system, civil work and distribution line training is excluded. The rest of training is the same.

In both mini/micro hydropower and PV systems, back-stop training will be held for those who undertake the business within 6 months after start operation. Monitoring activities by trainers will be done at least 3 times after starting operation in order to secure the sustainability.

(4) Corporate Governance

In order to secure corporate governance, the enterprise must record accounts with revenues and expenditures. User organization (junta de usuarios) will be created and the enterprise shall be responsible for periodical reporting to the organization of their operation based on the records. With this, the enterprise will be defined as opened company to users and at the same time, users will be able to monitor each other, as the enterprise can only be sustained with users' equal participation and assuming responsibility.

(5) Contract

Micro enterprise will make contract with owner of facility including government institutions in order to undertake the public service. In addition, the enterprise will make contracts with users in order to provide service. By binding contracts, the rights and obligations of the enterprise will be secured together with those of users.

(6) External Assistance

External assistance will be indispensable for the following activities; explanation to villagers, training to the corporate operation candidates in terms of technology, operation and management, supervision for erection and installation of equipment, assistance for setting up the enterprise, assistance for start up of the operation, and monitoring and back stop of the activities

Table II-1.6.5-1 Cost of Operation and Management

Cost Items	Annual Cost	Remarks
Network management cost	US$ 24,000	To be reduced after 4th year
Operation of assistance center	US$ 260,000	Cost in one group of regions. 4 centers is assumed in one group
Initial training cost	US$ 196,000	In each center 4 times is assumed to be held. It is a cost for training municipal staff and trainers
Micro enterprise operation cost: Mini/micro hydropower		
Assistance and monitoring	US$ 30,000	Cost per one enterprise
Initial investment	US$ 500	Office cost
Annual operation	N.Soles 12,000	Cost for operation including personnel cost (2 people)
Micro enterprise operation cost: PV System		
Assistance and monitoring	US$ 25,000	Cost per one enterprise
Initial investment	US$ 500	Office cost
Annual operation	N.Soles 12,000	Cost for operation including personnel cost (2 people)

Remarks:
1. The cost of center and initial training are the cost in one group.
   Therefore for nationwide implementation, it will be required 4 folds.
2. Assistance and Monitoring includes cost of travel to a certain extent.
   However, it may vary depending on distance.
3. Operation cost is a cost for one enterprise.
   The cost necessary for power generation including spare parts are excluded.
4. In the case of Hydropower, if the capacity is above 100 kw, it will increase.

2. Variation of Financing Mechanism

(1) Solar Power Projects

Solar power projects have the following major characteristics:

- Power generation can be made for a long time range with the system purchase at the beginning of the project, and replacement of battery after every few years;
- Investment cost per system is relatively low.

1) Introduction of Models

Financing models for solar power project can be divided into two: one is the Sales Model and the other is the Service Model. From a viewpoint of ownership, in the case of the Sales Model, it is transferred to the consumer through purchase of the PV equipment, and the self generation is made with his own equipment. On the other hand, in the case of the Service Model, the customer receives power supply from the equipment owned by the service company. Therefore, the ownership of the PV equipment does not pertain to the customer, but to the service company.

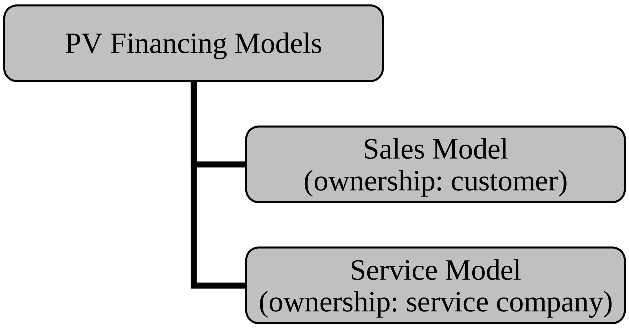


Fig. II-1.6.5-1 Finance Models for PV

Variation of the model is examined below: For the examination, Rural Energy Supply Models by International Solar Energy Society was referred.

<Sales Model>

Sales Model has two types: Cash sales and Credit sales.

- Cash Sales

  Cash sales may be divided into "Cash Sales" and "Cash and Carry". The difference between the two is that who will be installing the PV equipment. In the case of Cash Sales, the equipment will be installed by the seller, while it will be installed by the purchaser in the case of Cash and Carry.

  Another variation of Cash Sales is a Modular Cash Sales. In this case, component is sold separately (battery, PV panel, controller, in the case of PV), and after completing purchase of all equipment, it will begin to function as a system. Form a viewpoint of the customer, even if he is in short of a certain amount of fund, he can purchase little by little at a smaller amount, and he can access to electricity according to his purchase schedule. Anyway Cash Sales can be available to the limited target who have cash earning and who can afford to spend money. Generally speaking, the main target should be those who live within the urban area.

- Credit Sales

  Credit Sales is used for cases where there is temporal shortage of required cash at the moment of purchasing equipment. Credit Sales may be divided into the following: (1) Dealer's (Supplier's) Credit, where equipment dealer (supplier) extends credit to the customer; (2) Installment Credit, where financial institution like a bank intermediates the extension of credit (or installment payment); and (3) Hire-purchase, where the equipment is leased out. As the name indicates, credit is extended to the user upon evaluating their payment capacity. In many cases, the party who extends credit would like to minimize the cost required for debt collection, therefore, the credit period is usually limited to a short term around one year, thus each repayment amount becomes relatively high. From this viewpoint, generally speaking, the main target is also limited to those who live within the urban area.

  Characteristics of Credit Sales is that, in many cases, PV equipment is used as collateral during the credit period. And it is usual practice that the seller of the equipment would implement basic maintenance service during the credit period in order for the PV equipment to function normally, so that the purchaser would constantly pay for the credit amount.

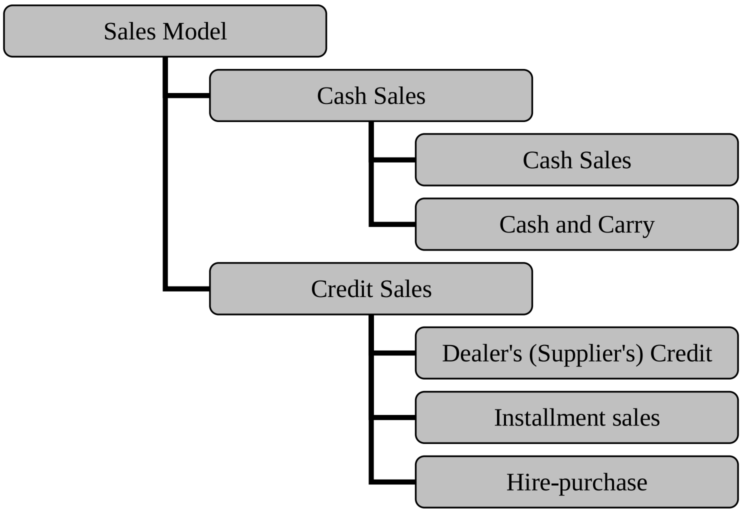


Fig. II-1.6.5-2 Variation of Sales Model

Characteristics of each variation of the Sales Model are shown below. Amount of total payment of Cash Sales is smaller as compared to the Credit Sales, but quite a large amount of money for local people is necessary at the moment of purchase. On the other hand, much less money is required for each repayment in Credit Sales, however, addition of interest and collection cost would lead to larger amount in total payment. Thus application of this model is also limited to those who live around the urban area, having relatively higher and periodical cash revenue.

Table II-1.6.5-2 Characteristics of Variation of Sales Model

Item	Advantage	Disadvantage	Main target
CASH SALES			
Cash Sales	- No charge	- Sizable sum of money is required	Urban dwellers
Cash & Carry	- No charge - No installation fee	- Sizable sum of money is required - Skill for installation is required	Urban dwellers
Modular Cash Purchase	- No charge	- Take time until obtaining all the equipment - Sizable sum of money is required, though less amount	Urban dwellers
CREIDT SALES			
Dealer's Credit	- Each repayment is less expensive	- High interest rate - Total cost becomes expensive - Short repayment period	Urban dwellers
Installment Credit	- Each repayment is less expensive	- High interest rate - Total cost becomes expensive - Short repayment period	Urban dwellers
Hire-purchase	- Each repayment is less expensive - Ownership is transferred after the contract	- High interest rate - Total cost becomes expensive	Urban dwellers

<Service Model>

In a Service Model, an energy service company, which owns generation equipment, provides customers with electricity supply service. In the case of “Energy Service”, the service company installs the electrical appliances and the service fee including the use of appliance will be collected. On the other hand, in the case of “Fee for Service” their service is limited to the supply of electricity to the customers, and the electrical appliances are owned by customers. Typical example of the latter is the electric utility in charge of services from generation to distribution.

Service Model has the very similar system with the Hire-purchase (Lease), however, definitive difference is that in the case of Lease, the ownership is transferred to the customer; while in the case of Service Model, no transfer of ownership is expected.

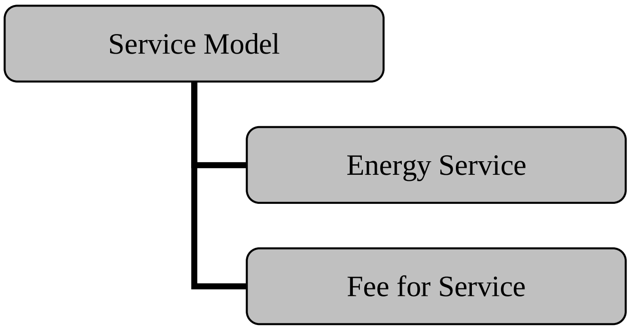


Fig. II-1.6.5-3 Variation of Services Model

Characteristics of each variation of the Service Model is shown below. In this mode, the service is provided with a relatively low price, it is possible to apply it in the area where the revenue is relatively small.

Table II-1.6.5-3 Characteristics of Variation of Services Model

Item	Advantage	Disadvantage	Main target
Energy Service	- Fee is relatively low	- Fee is higher than Fee for Service, having electrical appliances - Customer cannot add electrical appliance with his choice	Rural area
Fee for Service	- Fee is relatively low - Fee is lower than Energy Service, having no electrical appliances		Rural area

2) Model Plan to Be Applied

Fee for Service is applied to the rural electrification project with PV among the several service models. The reason is as follows:

In the case of application of the Sales Model, there is a pre-condition that a sizable sum of money is available for payment, and thus, very limited number of household is affordable in rural areas. If initial investment cost is subsidized totally, the problem of moral may emerge: the customers tend to think that they have received a present, so they do not care much about the future situation that the equipment does not function well for whatever reason.

On the other hand, in the case of application of the Service Model, energy service company has the ownership of the equipment. If the initial investment cost is subsidized totally, there is a merit that the company can offer less expensive fee to the customers, which leads to extend service to more households. In addition, there is a merit that inhabitants can enhance the sense of the owner by making monthly (or periodical) payment. Another merit is that due to the equipment being the property of the energy service company, the company implements maintenance, thus the customer can enjoy the benefit of electrification for longer time.

It is recommended that the initial investment cost shall be provided from the SPERAR Fund, as a subsidy to implement the Fee for Service. Introduction of subsidy for the initial investment from the SPERAR Fund leads to the decrease of the level of operation and maintenance cost. This will also lead to decrease the level of electricity tariff to be established based on the O&M cost. Therefore, it is expected that the sustainability will be enhanced due to increased affordability to pay for the tariff by the beneficiary = customers.

(2) Mini/Micro Hydropower Projects

Mini/micro hydropower projects require a lot of fund for initial investment at the beginning of the project. On the other hand, different from thermal power project such as diesel generation, it does not require fuel for generation, therefore, it can be operated economically from a viewpoint of the O&M cost. And it has a characteristic that proper maintenance will enable it to operate steadily for a long period.

1) Introduction of the Models

Required amount for investment in mini/micro hydropower projects depends greatly on installed capacity and site feature. In the case of the plant to satisfy the demand for a few houses, the required amount should be small and it is possible to apply the similar financing model to the solar power project, such as cash-sales or credit-sales. Generally speaking, in the case of the installed capacity being more than tens of kilowatt, the related facilities should be large, and this would make it difficult to secure financing on a personal basis. In this study, relatively large scale project is assumed from a viewpoint of village electrification. Here, there is no argument as to the model to be selected, i.e. Fee for Service, which would be only one option considering its efficiency. Therefore, an examination was made as to the method of financing the initial investment to construct the mini/micro hydropower plant.

There are several financial models generally applicable to the mini/micro hydropower project as follows:

1) Equity finance (Financing through issuance of equity)

2) Debt finance (Borrowing money from financing institutions or limited term borrowing by issuing a long term bond)
3) Project finance (Attracting investment by way of cash flow to be generated by the asset of the project)
4) Corporate finance (Borrowing money from banks by way of equity or asset)
5) Lease finance (Payment of leasing fee to the asset owner for use of the generating asset)
6) Government finance (grant aid and subsidy)

An examination was made to each financing scheme from a viewpoint of financing for mini/micro hydropower project, as follows:

Table II-1.6.5-4 Comparison of Finance Models for Small Hydropower

Item	Comment
Equity finance	• In order to draw attention of the investors, it is necessary to have a certain level of project scale.
Debt finance	• Credibility of the enterprise is reflected in the interest for borrowing. Due to lack of past record in case of a newly incorporated enterprise, it is usual to assess the personal asset of its partner. • There are cases where a fund specifically designed for small hydropower development projects under cooperation of international institutions.
Project finance	• Smaller the project scale, less attention is paid by the investors. Investors usually expect higher return.
Corporate finance	• It is usual that the newly incorporated enterprise does not have any asset.
Lease finance	• Actually there exists no enterprise to lease asset for small hydropower generating plant.
Government finance (grant/subsidy)	• Construction cost is covered by financial assistance from international agencies or tax. Such finance will be implemented based on the rural electrification policy, and this is quite effective for promoting electrification in the area with less income. • It is important to encourage local people to have a sense of participation in their own project.

From the above, it is considered that the existing financial models based on the credibility of the borrower are not easily applicable to the small hydropower projects to be implemented by newly incorporated micro enterprises. Therefore, available scheme is realistically limited to the Debt Financing with an involvement of international institutions and the Government finance.

2) Model Plan to Be Applied

Fee for Service is applied to the rural electrification project by mini/micro hydropower.

It is recommended that the initial investment cost shall be provided from the SPERAR Fund, as a subsidy to implement the Fee for Service. Introduction of subsidy for the initial investment from the SPERAR Fund leads to the decrease of the level of Operation and Maintenance cost. This will also lead to decrease the level of electricity tariff to be established based on the O&M cost. Therefore, it is expected that the sustainability will be enhanced due to increased affordability to pay for the tariff by the beneficiary = customers.

Additionally, in order to avoid a sense of receiving a present from the government
It is preferable to incorporate the element of the community participation as much as possible, such as the labor contribution in the construction work, in order for the residents not to have a sense of just receiving a present.

II-1.6.6 Long-term Rural Electrification by Renewable Energies

As of February 2008, the number of the target households (villages) for electrification by renewable energies is 361,847 (33,701). As mentioned in II-1.6.2, out of the above number, the target household for electrification by mini/micro hydropower is 18,498 (519). The remaining 343,349 (33,182) should be electrified by solar power, out of which villages with 10 or more households are taken as target villages for electrification by solar power, considering the efficiency of electrification. Therefore, the number of the target households (villages) by PV is 261,520 (10,829).

The long-term rural electrification by renewable energies shown in Table II-1.6.6-1 is prepared with 30,000 households as yearly upper limit of installation of solar panels, considering the limits of organizational capacity and physical installation. Priority of electrification as mentioned in II-1.6.8 is not made, so that the number of households to be electrified in each year only is shown. In the meantime, as for mini/micro hydropower, the number appearing in the said table follows the number of the households electrified in the corresponding year as shown in Table II-1.6.6-1.

Table II-1.6.6-1 Long-term Rural Electrification Plan by Renewable Energies

No. of households to be electrified

	Phase I			Phase II		Phase III						Phase IV		Total
	Period for infrastructure			Period for initial electrification		Period for development of electrification						Period for completion of electrification		
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Solar				10,000	20,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	21,520	**261,520**
Hydro						1,930	2,006	1,840	1,085	3,551	8,086			**18,498**
Total				10,000	20,000	31,930	32,006	31,840	31,085	33,551	38,086	30,000	21,520	**280,018**

*Figures shown in each year are the number fo households which have been electrified in the respective years.

The long-term plan is divided in 4 phases considering the following. As for mini/micro hydropower, different from solar power in implementing method, yearly development of mini/micro hydropower follows the way explained in Fig. II-1.6.7-1.

- Phase I: Period for Infrastructure (2008-2010)

  Phase I is an important period, as mentioned in II-1.5 Action Plan, when legal/institutional preparation should be made, CERER created, strategic alliance made and the networks for capacity building and supply chain for OM established, all essential for implementation of the long-term rural electrification.

  Some of the mini/micro hydropower projects should be started in this Phase with capacity building and site survey for prefeasibility study, considering hydropower projects take 5-6 years for implementation.

- Phase II: Period for Initial Electrification (2011-2012)
  Phase II is a period when installation of solar panels will start, so that it is necessary for central and local organizations involved to acquire proficiency in implementation of electrification projects. Therefore, 10,000 to 20,000 households are taken for electrification by solar power. In this Phase, it is desirable to improve the system of the organizations and institutions where necessary.
- Phase III: Period for Development of Electrification (2013-2018)
  Phase III is a period when electrification will be in full swing with 30,000 households to be electrified by solar power yearly. If the organizations involved would rise in capacity in such that more than 30,000 households can be electrified, it is desirable to consider increase of the yearly number of the households to be electrified.
- Phase IV: Period for Completion of Electrification (2019-2020)
  Phase IV is a period to conclude the electrification by renewable energies and, however, the target villages by solar power have 10 or more households, so that the villages with less than 10 households, 81,820 households (22,353 villages) would not be electrified by the end of Phase IV. It is desirable to consider whether those villages with less than 10 households should be electrified and how to electrify them based on the experience so far acquired.

The long-term rural electrification plan by renewable energies is developed with physically possible number of installation of solar panels in particular. Meanwhile, in order to make sure the sustainability of electrification projects, as suggested in II-1.4, it is desirable to group certain number of villages for creation of local organizations and capacity building for managerial and technical aspects. It is considered to take a considerable time to conduct such capacity building, different from massive installation of solar panels at a time.

In the solar projects so far implemented, capacity building has been basically conducted with vendors of solar panels providing capacity building for 2 years. If such a method for capacity building would not cause any problem of sustainability, it would be applied to the long-term rural electrification plan. However, JICA Study Team considers that sustainability can be assured in that micro-enterprise or other management organization should be established with initiative by local residents and such an organization should be in charge of electrification project. At the same time such activities may lead to other organizing activities for infrastructure such as water and sewerage and telecommunications and economic activities of production and sales.

Regarding the method of capacity building, it is desirable to consider whether the conventional method will be continued or the suggested method of JICA Study Team will be taken even partly, at the time of incorporating the long-term rural electrification plan by renewable energies into PNER by MEM/DPR.

II-1.6.7 Fund Requirements for the Long-term Electrification Plan

Fund requirements by year for implementing rural electrification is estimated based on the following conditions:

1. Solar Power Projects

Amount of fund requirement for each year has been obtained based on a unit construction cost of US$682 /household, multiplied by number of target household to be electrified proposed in Table II-1.6.6-1.

Table II-1.6.7-1 Yearly Target Number of Households for PV Electrification

Year	Target number	Remarks
2011	10,000	Phase II
2012	20,000	Phase II
2013-2019	30,000 × 7 years	Phase III and IV
2020	21,520	Phase IV

2. Mini/Micro Hydropower Project

(1) Development Schedule for Mini/Micro Hydropower Projects

In the Master Plan, a model plan of development schedule regarding each project was studied as shown in Table II-1.6.7-3.

1) Technical Viewpoint

- Survey and Design Matter

  In general, the appropriate consultation period is necessary for grasping topography and geology in a project site in the case of developing mini/micro hydropower. If these surveys are not sufficient, such a situation may happen that plant operation stop due to overestimate/ underestimate design. Therefore, this matter should be sufficiently considered in order to maintain project sustainability.

  - Fundamental Survey (Collection of fundamental data and Pre-feasibility study)

    The purpose of this survey is to collect the fundamental data by grasping river discharge and confirming topography, geology and simplified estimate of electricity demand. Especially, the survey of river discharge is important factor for success or failure of its project. If there is no data of river discharge, consecutive surveys should be carried out for several years.

  - Feasibility Study

    Topographic survey, hydrological analysis, structure design and electricity demand survey should be carried out based on the data from the fundamental survey. In addition, generally speaking, although small scale project regarding its installed capacity is not required to carry out environment impact assessment (EIA), it will be necessary for Santa Catalina project because its installed capacity is more than 500 kW as mentioned above.

Evaluation periods should be more than 2 years in general. In this case, reduction of evaluation periods should be considered from the aspect of efficient project execution by carrying out Pre-EIA in the fundamental survey and Pre-FS.

- Detailed Design

  Final design and planning of construction schedule should be drawn up based on the result of feasibility study, and then the total cost should be finalized by cost estimation based on those design and planning.

➢ Construction Period

Although necessary construction periods usually fluctuate depending on its project scale, it is expected that most construction works are implemented during dry season in this study. For instance, it is assumed that the construction period for the hydropower plants with installed capacity of less than 200 kW is necessary for 1 season and for those with installed capacity of more than 200 kW the construction period is necessary for 2 seasons as shown in Table II-1.6.7-2. (1 season means the dry season among 1 year.)

Table II-1.6.7-2 Relation between Necessary Construction Periods and Rainy/Dry Seasons

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Remarks
Term of Construction			**Preparatory Works**		**Construction Works**					**Examination**			Projects that installed capacity is beyond 200kW will be needed 2 seasons
Term of Rainiy and Dry Season	**Rainy Season**				**Dry Season**					**Rainy Season**			

➢ Others (Development priority depends on the project scale)

If a responsible organization of project has no technical experience, each project development should take a step-by-step approach from small to large scale project.

2) Viewpoint of Implementation System for Project

It is important for a capacity building for persons who will be in charge of projects and establishment of its lodgment, as well as the aspect of securement of project sustainability. For this reason, CERER as a training/maintenance center where capacity building for personnel who is in charge of projects is carried out should be established and then training should be implemented there for 6 months to 1 year. In addition, training contents will be mainly survey, planning, maintenance and operation as shown below, and it is assumed that professional consultants should be actively used regarding design and construction, etc.

- Survey, Planning (Use of CERER)
- Design, Construction (Use of professional consultants and general contractors)
- Maintenance and Operation (Use of CERER)
- Project management (Micro enterprise, etc.: Use of CERER)

In addition, CERER will be introduced to the following priority regions at first.

- Cajamarca
- Madre De Dios
- Loreto
- Puno
- San Martin
- Ucayali

(2) Draft Development Schedule for Mini/Micro Hydropower Project

From the above, a concept of development schedule for mini/micro hydropower is shown in Fig. II-1.6.7-1 and also a concrete draft schedule is shown in Table II-1.6.7-3 based on the above concept.

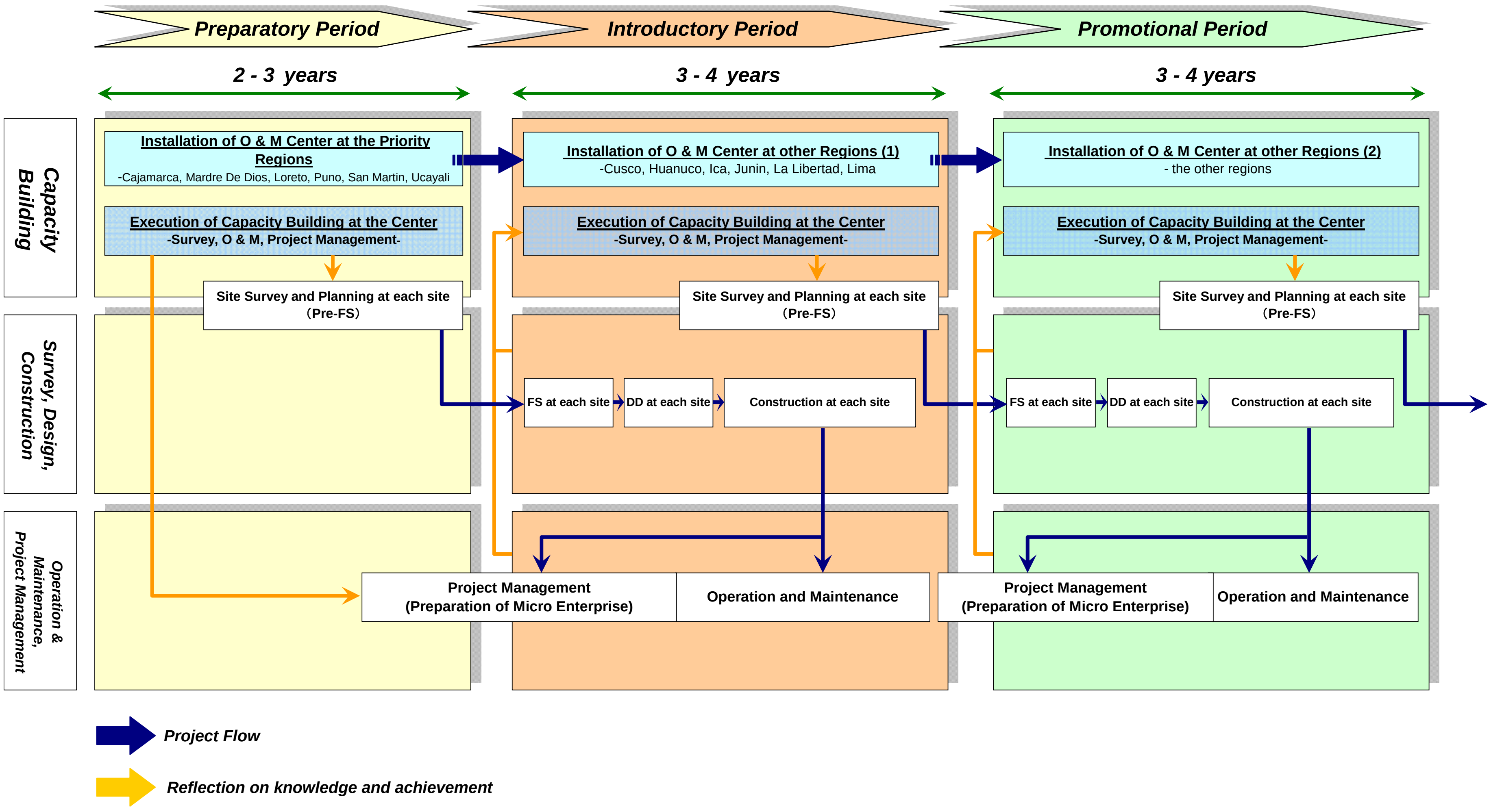
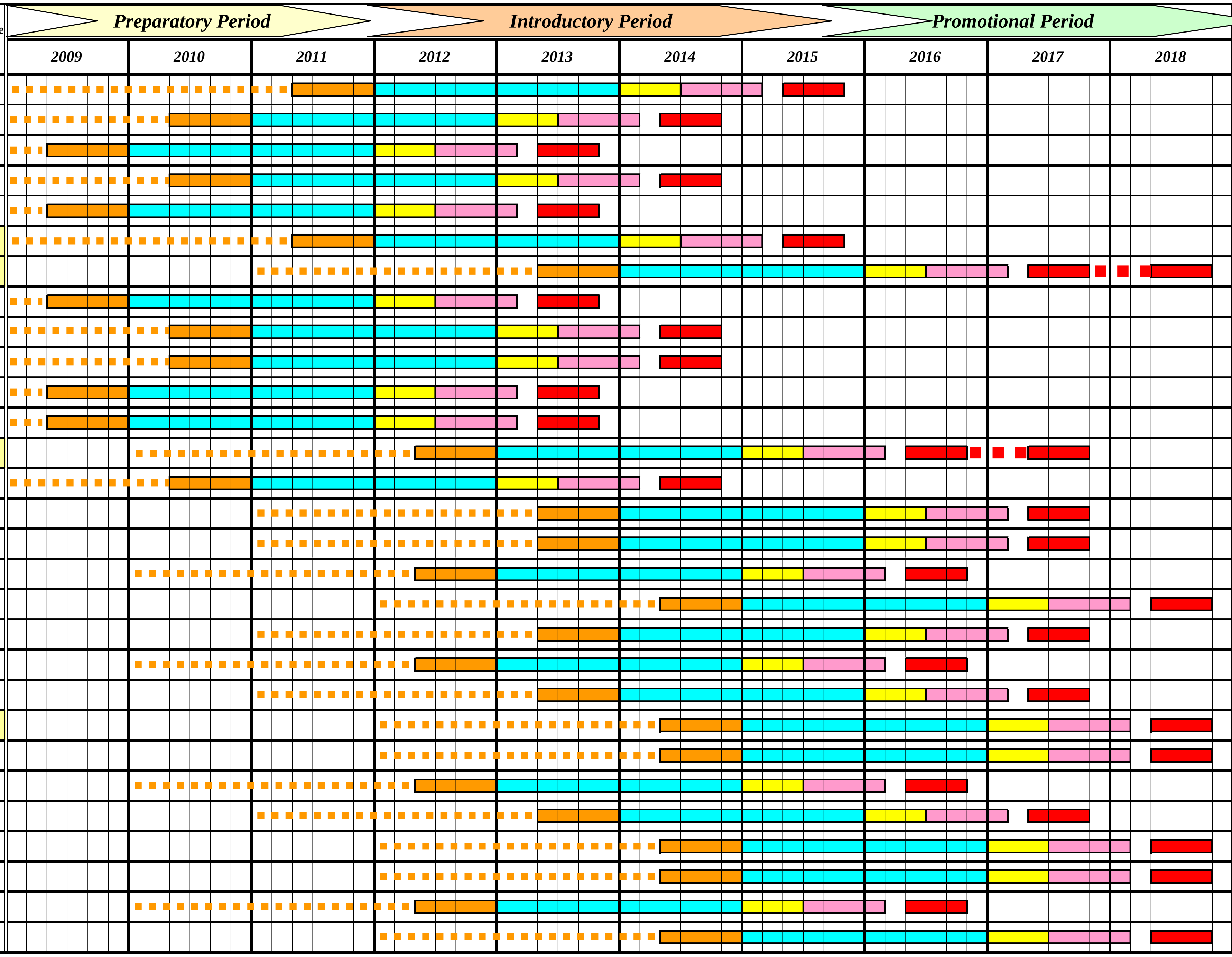


Fig. II-1.6.7-1 Concept of Development Schedule for Mini/Micro Hydropower

Table II-1.6.7-3 Draft Development Schedule for Mini/micro Hydropower Projects

No.	Project No.	Project Name	Region	Beneficiary: Number of Villages	Beneficiary: Number of Households	Installed Capacity (kW)	Discharge (m^3/s)	Remarks
1	3	P.C.H La Majada	Cajamarca	11	420	60	0.085	
2	4	P.C.H Quebrada Honda	Cajamarca	5	194	30	0.050	
3	5	P.C.H Yerba Buena	Cajamarca	12	535	80	0.112	
4	19	P.C.H Aichiyacu	Loreto	10	190	30	0.085	
5	20	P.C.H Balsapuerto	Loreto	14	487	80	0.090	
6	21	P.C.H San Antonio	Loreto	37	1,420	200	0.200	
7	22	P.C.H Santa Catalina	Loreto	43	4,422	620	1.300	
8	23	P.C.H Challapampa	Puno	22	308	45	0.060	
9	24	P.C.H Huari Huari	Puno	22	715	100	0.093	
10	25	P.C.H Porotongo	San Martin	12	329	50	0.133	
11	26	P.C.H Selecachi	San Martin	14	214	30	0.045	
12	27	P.C.H Quebrada	Ucayali	14	386	55	0.070	
13	28	P.C.H Rio Iparia	Ucayali	40	1,948	280	0.770	
14	29	P.C.H Shinipo	Ucayali	20	578	80	0.220	
15	1	P.C.H Cachiyacu	Amazonas	17	358	50	0.064	
16	2	P.C.H Palcapampa	Arequipa	3	166	25	0.035	
17	6	P.C.H Quellouno	Cusco	11	198	30	0.020	
18	7	P.C.H Sarapampa	Cusco	13	426	60	0.090	
19	8	P.C.H Yanama	Cusco	8	206	30	0.050	
20	9	P.C.H Cayay	Huanuco	18	405	60	0.120	
21	10	P.C.H Chontabamba	Huanuco	13	447	65	0.090	
22	11	P.C.H Quechuarpata	Huanuco	83	1,432	200	0.260	
23	12	P.C.H Lomo Largo	Ica	9	142	20	0.030	
24	13	P.C.H Poyeni	Junin	8	375	50	0.070	
25	14	P.C.H Saureni	Junin	11	426	60	0.090	
26	15	P.C.H Shima	Junin	17	561	75	0.130	
27	16	P.C.H Huaraday	La Libertad	16	534	75	0.060	
28	17	P.C.H Marachanca	Lima	10	107	15	0.045	
29	18	P.C.H Quiula	Lima	6	569	100	0.201	



Legend

- Execution Period for Capacity Building
- Execution Period for Site Survey and Pre-FS
- Execution Period for Feasibility Study
- Execution Period for Detailed Design
- Construction Period
- Possible Execution Period for Capacity Building, Site Survey/Pre-FS ahead of

(3) Construction Period

Estimation of construction cost (including hydropower plant and mini-grid) is made for each 29 sites to be developed. The amount is allocated according to the estimated construction period as shown in Table II-1.6.7-4.

Table II-1.6.7-4 Construction Periods of Small Hydropower

Year	Number of sites	Remarks
2013	5	Phase III
2014	5	Phase III
2015	2	Phase III
2016	4	Phase III
2017	6	Phase III
2018	7	Phase III
Total	**29**	

3. Yearly Fund Requirements (Solar Power + Mini/micro Hydro)

As a result, total fund requirement for rural electrification project is estimated to be US$217,555,640, which is allocated to each year, as follows:

Table II-1.6.7-5 Yearly Fund Requirements for Long-term Rural Electrification by Renewable Energies

(unit: US Dollar)

Year	Solar Power	Mini/micro Hydro	Total
2011	6,820,000	0	6,820,000
2012	13,640,000	0	13,640,000
2013	20,460,000	4,671,000	25,131,000
2014	20,460,000	4,675,000	25,135,000
2015	20,460,000	3,661,000	24,121,000
2016	20,460,000	5,056,000	25,516,000
2017	20,460,000	12,612,500	33,072,500
2018	20,460,000	8,523,500	28,983,500
2019	20,460,000	0	20,460,000
2020	14,676,640	0	14,676,640
Total	**178,356,640**	**39,199,008**	**217,555,640**

This fund requirement by year has been prepared from a viewpoint of physically feasibility of project implementation, and this is not necessarily compatible with the assumptions made for capacity building, which is proposed from organizational point of view. On the other hand, capacity building is quite important for sustainable rural electrification, therefore, it is expected that MEM shall incorporate it by securing the required budget by MEM's judgement.

4. Fund Requirements by Region

The table below shows the fund requirements by region for the long-term electrification plan.

It has been revealed that Region Loreto (some 40M$) and Region Cajamarca (some 36M$) require a lot, while Tumbes (0.2M$) or Tacna (0.45M$), where there are very few target households, require much less fund for electrification.

Table II-1.6.7-6 Fund Requirements by Region

Region	PV		Mini/micro Hydro		Total US$
	Households	US$	Projects	US$	
AMAZONAS	8,134	5,547,388	1	1,061,000	6,608,388
ANCASH	12,544	8,555,008	0	0	8,555,008
APURIMAC	4,918	3,354,076	0	0	3,354,076
AREQUIPA	6,230	4,248,860	1	637,060	4,885,860
AYACUCHO	8,715	5,943,630	0	0	5,943,630
CAJAMARCA	49,505	33,762,410	3	2,158,000	35,920,410
CUSCO	13,284	9,059,688	3	1,712,000	10,717,688
HUANCAVELICA	10,773	7,347,186	0	0	7,347,186
HUANUCO	33,270	22,690,140	3	3,391,000	26,081,140
ICA	1,072	731,104	1	378,000	1,109,104
JUNIN	6,177	4,212,714	3	3,736,000	7,948,714
LA LIBERTAD	11,646	7,942,572	1	994,000	8,936,572
LAMBAYEQUE	3,087	2,105,334	0	0	2,105,334
LIMA	4,620	3,150,840	2	908,000	4,058,840
LORETO	39,931	27,232,942	4	12,900,000	40,132,942
MADRE DE DIOS	1,651	1,125,982	0	0	1,125,982
MOQUEGUA	992	676,544	0	0	676,544
PASCO	4,774	3,255,868	0	0	3,255,868
PIURA	4,564	3,112,648	0	0	3,112,648
PUNO	21,660	14,772,120	2	2,292,000	17,064,120
SAN MARTIN	4,497	3,066,954	2	1,225,000	4,291,954
TACNA	665	453,530	0	0	453,530
TUMBES	289	197,098	0	0	197,098
UCAYALI	8,522	5,812,004	3	7,807,000	13,619,004
Total	**261,520**	**178,356,640**	**29**	**39,199,000**	**217,555,640**

II-1.6.8 Priority Criteria for Electrification

Rural electrification, under decentralization of government, basically corresponds to regional/local governments and those regions relatively rich in funds have been carrying out electrification on their own. Therefore, even if the central government unilaterally indicates the nationwide order of electrification as to the priority of electrification of non-electrified villages, regional/local governments do not have to obey such order and may make objections to it.

On the other hand, it is not realistic to realize electrification for all villages wishing for it at one time. Hence, there must be some criteria for priority or project adoption. Those projects meeting such criteria will be able to enjoy the benefits of technical/financial assistance from central government as well as capacity building and supply chain.

Electrification projects planned by village inhabitants will be examined by district municipalities according to the above criteria. Only those projects that have passed such examination will be realized through the process described in Chapter II-1.2.

The criteria for priority or project adoption should, in the first place, consider that management of electrification systems will be conducted by initiative of village inhabitants as participatory approach recommended in this Master Plan. Hence, it is proposed to establish criteria attaching much importance to sustainability of electrification projects, with the following guidelines for reference.

1) Village inhabitants should have strong desire for electrification and have plans by their own initiative properly reflecting electrification needs.
2) Village inhabitants should have taken education or capacity building of electrification.
3) Village inhabitants should have already management organization of electrification system such as micro-enterprise or be prepared to create such an organization at their own will.
4) Village inhabitants should have adequate ability to pay to cover costs of management and operation and maintenance.
5) In the case of low ability to pay, the amount of subsidy from FOSE should be small.
6) The number of households to be electrified should be large – hopefully 50 or more and not fewer than 10)
7) The economics of electrification projects should be good.

In the meantime, MEM/DPR should establish some criteria to decide whether to make financial contribution from SPERAR Funds as to electrification projects applied from local levels, with the following guidelines for reference.

1) Regional/local governments should have concluded agreement for strategic alliance with MEM/DPR and should have an intention to play roles in promotion of electrification.
2) Regional/local governments should have funds to cover costs of construction and capacity building and supply chain to be borne by them and should have an intention to take budgetary measures.
3) The degree of establishment of the mechanism for sustainability such as capacity building and supply chain.
4) Those applying projects should not be included in grid extension plans by MEM/DPR or regional/local governments.
5) Those applying projects should be included in PLER/PRER from regional/local governments.

<Prioritized Regions>

As to prioritized regions, those should be treated not as prioritized regions for electrification but as for establishment of the proposed mechanism for sustainability. MEM/DPR should select such prioritized regions through dialogues with local sides. The mechanism for sustainability is necessary to establish with initiative by MEM/DPR and in collaboration with local sides, which will not allow such establishment for all regions of the country at one time. This is another reason for selection of the prioritized regions.

It is therefore important make selection of the prioritized regions only after confirming the will of collaboration of regional/local governments and available organizations for the mechanism of sustainability through dialogues between MEM/DPR and local sides. Those regions that have established the mechanism for sustainability may be an example for other regions, so that in selecting the prioritized regions it is necessary to consider their geographical locations in view of convenience for visits from other regions. Another point to be considered is that the prioritized regions should have a larger number of non-electrified villages and households according to the latest list of non-electrified villages.

It is to be noted that the selection of prioritized regions should not hinder rural electrification with renewable energies by initiative of other regions

The following regions have tentatively been selected as prioritized regions; and, however, it is necessary to reconsider this selection by satisfactory dialogues with each region and taking into account the above-mentioned points.

- Cajamarca (2,518 villages 54,730 households)
- Loreto (1,669 villages 43,020 households)
- San Martín (1,218 villages 7,395 households)
- Ucayali (406 villages 11,916 households)
- Madre de Dios (91 villages 1,761 households)
- Puno (2,795 villages 29,847 households)

* Figures in parenthesis are the numbers of non-electrified villages and households from the list of the non-electrified villages provided by MEM/DPR on February 2008 (the number of all the non-electrified villages is 33,701 villages with 361,847 households)

The long-term electrification plan shown in II-1.6.6 was prepared based on the tentative selection of prioritized regions, so that it will be necessary to modify the plan according to the eventual selection of the prioritized regions.

II-2 Use of Master Plan

II-2.1 Planning of Individual Projects and Updating of Master Plan

Updating should be done to the following parts of Chapter II-1.6 ‘Electrification plan of non-electrified villages’ of the Master Plan: ‘List of non-electrified villages’ shown in II-1.6.2, ‘Renewable energy potential of hydropower’ in II-1.6.7, ‘Standard design and cost for electrification’ in II-1.6.4, ‘Model plan of electrification’ in II-1.6.5, and ‘Electrification plan of non-electrified villages and fund requirements’ in II-1.6.6 and II-1.6.7.

Updating of the abovementioned parts is proposed below.

1. List of Non-electrified Villages

As described in Chapter II-1.2, it is important for village inhabitants to make plans of individual electrification projects by their own initiative. This starting point will make work the mechanisms for implementation of electrification projects, while such plans, at the same time, will be input to Information System of Rural Electrification (SIER) to be built and updated by MEM/DPR. By use of such information, the list of non-electrified villages mentioned in II-1.6.2 should be updated based on the project lists of electrification by renewable energies shown in PRER/PLER and the project lists of grid extension to be implemented by regional/local governments. Here is a point to be cautious: determine whether grid extension projects by regional/local governments are planned by economic criteria or not.

Under decentralization of government, some local resistance may occur to central intervention in electrification by local initiative. Nevertheless, it is important to persuade local sides to change to electrification by renewable energies proposed in this Master Plan by talks of the economics of electrification project in dialogues with local sides if appropriate to do so. The list of non-electrified villages should be updated in consideration of this factor.

2. Renewable Energy Potential by Hydropower

As for potential of mini/micro hydropower, it is difficult to grasp beforehand. This makes it necessary for village inhabitants to identify such potential in making plans of electrification. This is the only source of information on hydropower potential. MEM/DPR is currently trying to identify hydropower potential by GIS; and, however, such hydropower potential of mini/micro scale will not be certain until a site is visited to make geographical judgment and measurement of waterflow. Another important point for hydropower is an analysis of characteristics of demand side: power demand, distance between powerhouse and demand center, required magnitude of mini-grid and so forth. Identification of hydropower potential should consider those factors, which should be included in plans made by local initiative.

3. Standard Design and Cost

Standard design and cost for electrification of non-electrified villages are established based on the results of the 4 field studies at the level of prefeasibility in this Master Plan. Individual projects should make reference to such standard design and cost, and in the meantime it is wise to review the standard design and cost according to actual local conditions. It is also desirable to update the standard design and cost because development of individual projects may require more appropriate standard design and cost to reality.

4. Model Plan for Electrification

Model plan of management and financial mechanism is also based on the results of the 4 field studies at the level of prefeasibility. Individual projects should be based on such model plan. It is however necessary to make management plans tailored to actual situation of villages. Likewise, development of individual projects may require more appropriate model plan, so that it is desirable to update it opportunely.

5. Electrification Plan of Non-electrified Villages and Fund Requirements

The long-term rural electrification plan by renewable energies and its fund requirements should be updated according to the progress of individual projects. Updating should be done periodically reflecting the change of the overall scale of the whole of the electrification projects due to development of grid extension plans, updated standard design and cost, development of hydropower of mini/micro scale and other factors.

II-2.2 Project Approval and Financing Procedure

There are usually three stages for project implementation: pre-investment, investment and post-investment. These stages are closely related to form a project cycle for better investment.

Pre-Investment Stage	Implementation of various studies (Profile, PreF/S, F/S) to confirm the feasibility of the project
⇩	
Investment Stage	Implementation of design, works, training.
⇩	
Post-Investment Stage	Operation and maintenance, training, post-evaluation.

There is no difference from project cycle generally used from a viewpoint of implementation of a project through each step. It should be pointed out that the characteristics of the system in Peru is that various studies in the Pre-investment Stage are incorporated as a procedure to judge if the project is worth enough for public investment.

This procedure is called National System of Public Investment (SNIP: Sistema Nacional de Inversión Pública) and the Ministry of Economy and Finance is in charge of its operation. In the SNIP, it is required to implement studies at different levels (Profile, Pre-feasibility, Feasibility) according to the requirement of the study detail, from viewpoints of project purpose, demand and supply forecast, cost, benefit, impact on environment, sustainability, etc. in order to confirm if the project is worth enough to implement using a public budget. In other words, the purpose of the study is to obtain declaration of the viability. Required final level of a study depends on the project amount. In order to implement the final level of the study, it is required to have completed previous level of the study.

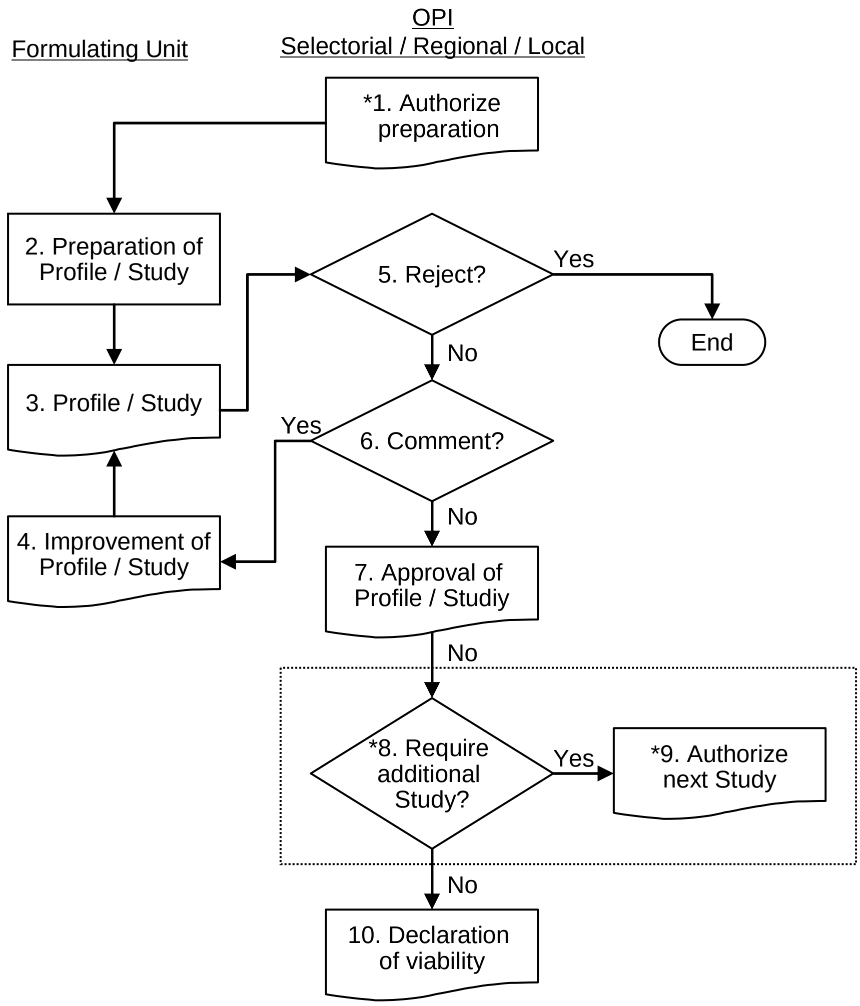
Study Level	Project Amount
Profile	3~6M Soles
Pre-Feasibility Study	6~10M Soles
Feasibility Study	10M Soles or more

Flowchart of the SNIP procedure to confirm the viability is shown in Fig. II-2.2-1. This figure shows the procedure which does not require foreign credit.

As a first step, the Formulating Unit prepares the study report at a profile level, and register it to the Project List. Upon this registration of the project, an automatic decision is made as to which Programming and Investment Office (OPI: Oficina de Programación e Inversión), among the OPIs established at Ministry of Energy and Mines or Regional/Local Government, will be in charge of its evaluation. After this decision, the Formulating Unit will submit its document to the OPI in charge. Then OPI evaluate the contents and decide their actions from the following:

1) to approve the Profile, and authorize the preparation of the study at next level (Pre-FS)
2) to declare the viability
3) to return the study report with comments for improvement
4) to reject the study report

In the case of the item 3), the Formulating Unit shall improve the study incorporating the comments, and resubmit the documents for evaluation. The evaluation period at OPI is established as 20 to 30 working days. The same procedure will be applied for the studies at Pre-feasibility and Feasibility level.



Nota: *1 : Not applicable in case of Profile.
*8 and *9 : Not applicable in case of Feasibility Study.
Source: Directiva General del SNIP

Fig. II-2.2-1 Flowchart of Project Approval by SNIP

From a viewpoint of promotion of decentralization, OPI of local government has been authorized to declare viability of the project since January 2007, without going through evaluation at the Ministry of Economy and Finance. It should be noted that the project which requires foreign credit or a credit with the governmental guarantee shall continue to be evaluated at the Ministry.

In the case that there is uniformity for investment contents such as of solar power projects, for which the same technology is applied and there is little difference in project cost by project except transportation, it is possible to combine plural projects into as an aggregate of each project, and consider it as a Program (Programa de Inversión). SNIP procedure can be proceeded for Program as a whole, and the viability of the Program is obtained through implementation of studies from the level of Profile to Feasibility Study. Thereafter approval of each project should be obtained as a sub-project. The point is that standard criteria to identify and approve each project is proposed in the document for the Program and obtain approval of OPI, therefore, approval procedure for each sub-project is simplified and expected to be proceeded without problem.

On the other hand, there is much difference in project cost and design for each hydropower project, therefore, procedure for the Program is not appropriate. Thus the SNIP procedure shall be made for each Project from the beginning.

SNIP system attains a certain positive result in that it incorporates "bottom up" system, and intends to select more effective selection of public investment projects, avoiding the duplication of projects. On the other hand, it is often complained that there are delays in project evaluation and the bidding procedures afterwards. Therefore, it is strongly recommended that the preliminary arrangement be made among the persons concerned to accelerate the procedure.

II-2.3 Financing for Executing Master Plan

In order to accelerate the electrification by renewable energy, it is proposed to establish a fund for rural electrification called "SPERAR Fund".

<Outline of the SPERAR Fund>

1. Financing Source

(1) General

Financing source for SPERAR Fund shall basically be the fiscal resources mentioned at the Article 7 of the General Law of Rural Electrification – Law No.28749. (Refer to I-4.3 for details.)

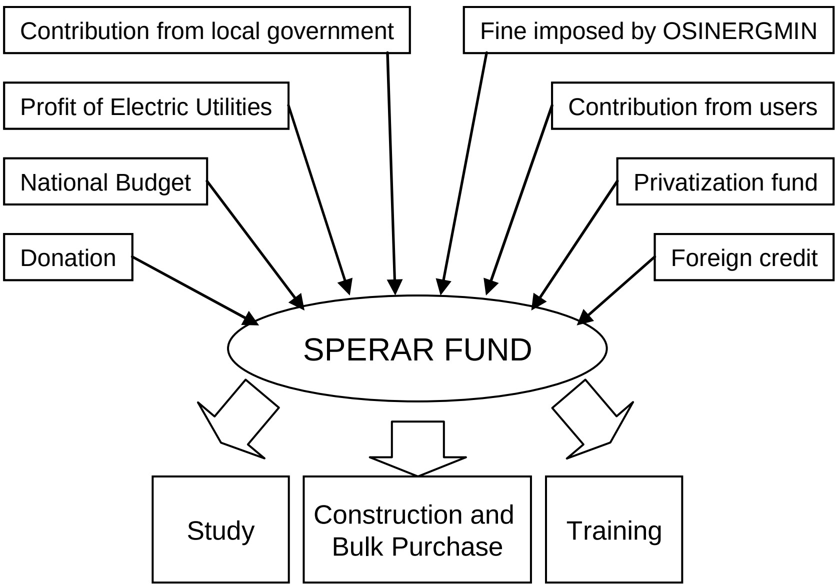


Fig. II-2.3-1 Financial Sources for SPERAR Fund

(2) Current Budget

The following table shows the budget and execution amount of rural electrification managed by MEM/DGER during the past five years.

Table II-2.3-1 Budget Planned and Used of MEM/DGER in the past 5 years for Rural Electrification

(Unit: 1,000 Nuevos Soles)

Year	Budget	Execution	Remaining Amount	
			Total	Excl. Foreign Credit portion
2003	290,570	151,734	138,836	46,791
2004	206,652	130,912	75,741	19,665
2005	184,498	155,186	29,312	8,273
2006	232,402	116,460	115,942	103,422
2007	396,980	262,809	134,171	120,003
Total	1,311,103	817,101	494,002	298,155
Average	262,221	163,420	98,800	59,631

This table shows the fact that there is a lot of unused budget every year with annual average amount being 59,630 thousand Soles (= US$20,562 thousand), excluding the foreign credit portion which is destined to specific projects. And that the remaining amount is almost twice than the annual average amount during the recent two years. In spite of such situation, the similar budget is still assigned for 2008. The reason for such large balance is due mainly to the delay in implementation of the construction works, which can only be made after the bidding procedure with transparency required for the public investment.

As a result, if the required amount for rural electrification is around US$20M/year, it is possible to cover the cost with the recent level of budget. Anyway, it is important to contribute certain amount of budget specifically to the SPERAR Fund destined for rural electrification by renewable energy.

2. Financing

(1) Required Amount and Financial Resources

Chapter II-1.6.7 has revealed that the amount required for rural electrification by renewable energy is calculated as US$217,556 thousand. Annual fund requirement gradually increases from US$6,820 thousand in 2011 which corresponds to the beginning year of the work implementation, and reaches to the maximum amount of US$33,073 thousand in 2017.

Required amount is compared with the remaining budget amount as examined above. As a result, it was found that the “budget” is enough to cover the required amount at the beginning, and it is possible to effectively use the budget surplus for capacity building. But there would be a deficit corresponding to the required amount for hydropower projects after commencement of its construction works in 2013.

Table II-2.3-2 Comparison of Fund Requirement for Rural Electrification with the Outstanding Budgetary Amount

1000 US Dollar

	Solar Power (a)	HydroPower (b)	Total (c=a+b)	Budget (d)	Difference (e=d-c)
2011	6,820	0	6,820	20,562	13,742
2012	13,640	0	13,640	20,562	6,922
2013	20,460	4,761	25,131	20,562	-4,569
2014	20,460	4,675	25,135	20,562	-4,573
2015	20,460	3,661	24,121	20,562	-3,559
2016	20,460	5,056	25,516	20,562	-4,954
2017	20,460	12,613	33,073	20,562	-12,510
2018	20,460	8,524	28,984	20,562	-8,421
2019	20,460	0	20,460	20,562	102
2020	14,677	0	14,677	20,562	5,886
Total	**178,357**	**39,199**	**217,556**	**205,624**	**-11,932**

(2) Financing

From the above table it is considered that the rural electrification with solar power can be implemented with the actual level of the national budget amount. If permitted by the budgetary system, it is desirable that the remaining amount be carried forward to the next fiscal year for steady implementation of the rural electrification. On the other hand, it is necessary to secure budget for the required cost corresponding to hydropower projects. For this purpose, the following options are contemplated:

1) National budget (including distribution of CANON)

Considering the fact that the further increase of electrification rate by grid extension is limited and it is necessary to promote more costly electrification, it is important to show the attitude of the government to put priority in electrification by renewable energy as a national policy. And this would be realized in increasing contribution of national budget. This should include the distribution of CANON. Assuming that the required amount for electrification by hydropower is US$5M, it corresponds to only 0.3% of the total distributed amount of CANON Minero in 2007 (US$1,778M); and the amount required for hydropower development in the eight biggest beneficiaries of CANON (Cajamarca, Cusco, Moquegua, Tacna, Loreto, Piura, Puno, Ucayali) occupy 69% of total hydropower cost. Therefore, it is important to establish a cooperation scheme with the regional/local government to implement rural electrification by renewable energy, in order to secure the necessary budget.

2) Contribution by customers

If it still requires further financing,, another option is to increase the contribution rate of the customers. In 2006, there was an income of 151,572,000 Soles (US$52,266,207) for this category. If it is increased by 1%, it would bring about more than US$500,000/year, and it will cover the one tenth of the required amount for hydropower development for four years from 2013.

3) Foreign credit

Economy of Peru has been steadily expanding during recent years, and it is no more necessary to rely on the foreign credit for development. But for the cases of decrease of tax amount due to possible shrinkage of economy in short/mid term, or availability of soft loan from international financing institutions, it would be better to consider the possibility of utilizing such fund. In order to introduce foreign credit, the requisite is to have a project cost over US$10M, therefore, it is necessary to formulate an overall project with several sub projects. From this viewpoint, it is better to incorporate all the mini/micro hydropower projects into one package to form a project.

If permitted by the budgetary system, it is desirable that the remaining amount be carried forward to the next fiscal year for steady implementation of the rural electrification.

3. Use of the Fund

The fund required to implement the Master Plan can be broadly divided into four categories: study, construction, operation and maintenance, and training. Budget from SPERAR Fund shall be spent for implementation of the required study, construction of electrification facilities and the training.

(1) Study Cost

Pre-investment study as a part of SNIP procedure mentioned in II-2.2 is indispensable because the public budget is used for project implementation. And that construction of mini/micro hydropower requires design and construction supervision. In many cases, local consultants are employed for carrying out such studies. Such cost shall be provided from the SPERAR Fund.

(2) Construction Cost

In line with the policy of the Peruvian Government to implement the rural electrification project with public investment, and transfer it to the local entity or people once completed, budget for rural electrification is spent for construction. Especially the procurement of equipment and construction materials should be made by integrated purchase with SPERAR Fund, in order to enjoy economic benefit thereof. The cost of construction works shall be borne by local government through previous agreement. The contribution rate shall be determined according to the budgetary amount of the local government considering the distribution of CANON.

(3) Operation and Maintenance

Operation and Maintenance shall be borne by the beneficiary with its contribution as electricity tariff. In order to avoid a situation that electricity tariff becomes expensive and only a part of the local people can afford it, active application of the current system of FOSE or Compensation Mechanism shall be considered. With such provision, it is possible to lower the burden of the local people and to permit more people to have an access to the electricity service.

- Electric Social Compensation Fund (FOSE: Fondo de Compensación Social Eléctrica)
  FOSE is a cross subsidy system among customers. The fund is contributed from the customers with more electricity consumption by a surcharge, and it is distributed to lower the electricity tariff for the customers with less consumption. Irrespective of its scale, any entity registered in MEM can be benefited from FOSE. Therefore, in establishing a micro enterprise for operation and maintenance of the electricity service, registration in MEM as an electric service company is indispensable. For the calculation of amount for cross subsidy, micro enterprise shall be prepared to submit periodical submission of such data as generation volume and number of customers to OSINERGMIN.

- Compensation Mechanism
  While FOSE is a cross subsidy system among customers, this Mechanism targets to adjust the tariff among electric companies. This compensates a part of the difference existing between the Bar Prices (i.e. the average cost of generation and transmission) of the Isolated Systems and the interconnected system. However, regulation for application of this Mechanism to micro enterprise of solar power system has not been prepared. Rural electrification by renewable energy has a characteristic of higher generation cost due to its small scale, therefore, earlier application of this Mechanism is strongly expected.

(4) Training

In order to maintain the sustainability of rural electrification by renewable energy, implementation of a proper training is indispensable. Therefore, fund required for training should also be provided from the SPERAR Fund as a part of the project cost.

4. Administration of the Fund

SPERAR Fund is administrated by MEM/DPR. It will be in charge of preparation of annual budget, contracting, and provision of budget for pre-investment study, integrated purchase of equipment/materials, construction works and training.

II-3 Environmental and Social Consideration

II-3.1 Plan of Environmental and Social Consideration for the Master Plan

This study aims at formulating a master plan for rural electrification by renewable energy in Peru. Electrification by renewable energy is generally said to have little impact upon environment. But environmental and social consideration is necessary at the pre feasibility level because mini/micro hydropower system is supposed to give impact on land use and water resource use to a certain extent. Therefore, this study was categorized into Category B that requires IEE level survey according to the JICA Guideline for Social and Environmental Considerations. The study team examined environmental impacts and measures of environmental items that are mentioned in the guideline and supposed to occur when the project is implemented.

It is the goal of the project implementation to maximize the effect of electrification in all target communities according to the master plan. To achieve this goal, the electrification project must reduce negative impacts and increase positive effects on physical and social conditions of the area in concern as much as possible. In this section, not only the measures to mitigate negative impacts on environment but also measures using participatory method were examined so that the electricity can be used with sustainability.

Environmental and social consideration of the master plan is described in the following section and that of field study sites at pre-feasibility level is described in the Volume III.

II-3.2 Impacts and Measures of Rural Electrification by Renewable Energy upon Environment and Community

Electrification by PV system is generally understood to have little impact on environment and is used for facilities inside the natural protected area. However, the study team judged that inappropriate treatment of used battery has impact on environment and examined in the item ‘solid waste’.

As for mini/micro hydropower, on the other hand, Law 25844 prescribes that power generation equivalent 500 kW and less does not need to execute IEE and EIA. Among 29 sites that GIS survey of MEM found potential of hydropower generation (see Table II-1.6.4-25), implementer is obligated to apply the permission of development to the Department Government only for Santa Catalina in Loreto Department whose generation capacity MEM is estimated at 620 kW. Generation capacity of other 28 sites is estimated less than 300 kW (among 28 sites, 25 sites are 100 kW or less) and their generation facilities planned is too small; however, the study team anticipates that environmental and social impact may occur relating to several environmental items.

The following Table II-3.2-1 shows result of the survey of anticipated impacts and measures concerning the plans and activities proposed in the master plan.

Table II-3.2-1 Result of the Survey on Anticipated Impacts and Measures

Item	Land use and utilization of local resources (Mini/micro hydropower)
Anticipated impact	Construction of facilities for mini/micro hydropower generation needs certain area of land. As the detail condition of the communities being object of the master plan, except the pre feasibility study sites, is not known and the scale of impact is not clear at present. However, construction of facilities has possibility to give impact on actual land use and utilization of resources in general.
Measures	Implementer shall execute field survey to understand the actual use and interest of the planned place at the beginning of the project. It is necessary to make a design to minimize the impact on the actual use and to build consensus about the project implementation through opinion exchange with land right claimants.
Score	D: Low level impact may happen. More minute investigation and evaluation are required at each community.
Item	**The poor, indigenous and ethnic people (PV system and Mini/micro hydropower)**
Anticipated impact	At the time of the drawing up the master plan, information of each community being object of the electrification by renewable energy is not obtained. However, a number of native communities are supposed to exist in them because approximately eleven thousand target communities are mainly located in the remote area far from cities and trunk lines. It is reported that land rights of indigenous people in the native community in general is abused by outsider and live with the condition of vulnerable economy and very weak political assistance (See I-8.5). In consideration of this situation, it is anticipated that outsiders like local governments will take initiative of the project and that inhabitant’s intention will be ignored. Also, the area of indigenous people inside the project area may sustain disadvantage by the project.
Measures	Implementer needs to understand the real condition by checking the list of the native community prepared by RENIEC (Registro Nacional de Identificación y Estado Civil or National Registration of identification and Civil Status) and ONPE (Oficina Nacional de Procesos Electorales or National Office of Electoral Process) at the profile study. In the communities where indigenous people live, implementer is advised to carry out the survey on social organization, social relation and customs in the community at the pre feasibility study, in order to understand the social capital and actual living condition of the people in concern. Based on this information, it is advisable to make implementation plan in consideration of the land use of the project site for avoiding disadvantage of the indigenous people. Adding to this, it is indispensable that the inhabitants understand the content of the project clearly. Communication and explanation by enlightening material in ethnic language as well as problem analysis and planning by inhabitants themselves using participatory method will produce effect.
Score	C: Not strong impact is expected but impact sometimes occurs.
Item	**Gender (PV system, Mini/micro hydropower)**
Anticipated impact	As the communities being object of the master plan are dispersed in all regions of the country, condition of women’s human development and degree of participation in social activity are diversified. But the social survey in the electrified communities shows that women hardly participate in the training of utilization of electric facilities as well as maintenance of battery. It also shows that degree of women’s participation in community activity is low. Thus, it is presumed that women will have difficulty in participating in enlightenment and training planned by the master plan before the project implementation and management organization after the commencement of the electric service; and there is a possibility that electrification will fix inequity between both genders relating to social development.
Measures	It is important that MEM and local government give advice and support inhabitants in involving women in enlightenment, training and management organization. As the gender condition is diversified region by region, supports must be taken with concreteness corresponding to the area-specific condition based on the understanding of it. In this, measures need to be examined through gender analysis using participatory method.
Score	C: Not strong impact is expected but impact sometimes occurs.

Item	Uneven distribution of benefit and damage & Local conflict of interest (PV system, mini/micro hydropower)
Anticipated impact	Community survey in the pre feasibility study sites found that affordable amount of electricity for more than half of the respondent households is less than the necessary amount estimated in the master plan. The survey also shows that there is a considerable difference within a community and that there are households who can receive electric service and who cannot. Therefore, it is anticipated that electrification will bring uneven distribution of benefit of electricity between affordable and unaffordable households.
Measures	The master plan proposes that MEM/DPR establishes the system of financial support so that the poor people can use electricity.
Score	C: Not strong impact is expected but impact sometimes occurs.
Item	**Cultural heritage & Flora, fauna and biodiversity (Mini/micro hydropower)**
Anticipated impact	MEM database shows that 519 communities exist in 29 sites being object of the mini/micro hydropower projects. Among them, three communities in Rio Iparia site and one community in Shinipo site (all are in Ucayali Department) are designated as reserva comunal or communal reserve (but it is not clear whether the reserved area covers entire community or not). Also, a part or entire community of seven sites is designated as buffer zone of the protected area. It is anticipated that the project may give impact on environment if the project area is included in the protected area.
Measures	Law of the Nature Protected Areas of Peru prescribes that implementer must execute studies for IEE and EIA to examine the possible environmental problems and mitigation measures, if the concerned project will be done inside the communal reserve and buffer zone. Implementer must send the result of the survey to INRENA and receive permission (see I-9.4). Therefore, it is advised to take following process to deal with the implementation in above mentioned sites: First, confirm the boundary, topography and community location in INRENA; then, execute field survey; third, confirm the boundary of protected area and buffer zone on the spot; fourth, find the alternative plan (that is, installation of generation facilities outside the protected area). If the intake or beneficiary communities are inside the protected area or buffer zone, it is advisable that implementer considers change of the plan of hydropower system to PV system. In case that only a few communities of entire project site are found inside the protected area or buffer zone, different type of electrification (PV and hydropower) may cause uneven distribution of benefit. Discussion and information exchange is needed deeply at the public hearing.
Score	D: Low level impact may happen. More minute investigation and evaluation are required at each community.
Item	**Water usage and water rights (Mini/micro hydropower)**
Anticipated impact	As water is taken from the river and returned into it after a certain distance downstream for power generation, water level of the river falls between intake and discharging point. As accurate water volume, position of appropriate intake and discharging point, water use and water right are not surveyed at present except the case of pre feasibility study sites. Adding to this, In mini/micro hydropower system, water used for power generation is basically returned into the river inside the project area and does not give impact on the communities located downstream.
Measures	Implementer must understand water use and water right at the beginning of the project implementation. If the water rights problem is found, implementer has to make a plan for stabilizing water level, meeting with water users and building consensus of the project. If there is irrigation system, implementer needs to apply water right to the Ministry of Agriculture. Water discharge varies year by year. Thus, it is strongly advisable that the implementer collects hydrological data of different years and analyses them more minutely.
Score	D: Low level impact may happen. More minute investigation and evaluation are required at each community.

Item	Topography and geological features (Mini/micro hydropower)
Anticipated impact	Generally in hydropower project, construction of power house, headrace, or transmission line changes geographical features. However, it is expected that the impact on topography and geological features is slight because the capacity of generation is less than 300 kW and the scale of generation facilities is small except the case of Santa Catalina. On the other hand, the distance between road or river and generation facilities is more than 1 km in 20 sites among 22 sites whose distance is mentioned in the MEM database. Access road must be constructed in these sites; but, as a result, there is possibility of transformation of geographical features there.
Measures	Even though the generation capacity is small, implementer must make a plan for avoiding erosion and other impacts, and supervise construction work properly. In the sites where the construction of access road is needed, implementer must design road of the smallest scale that can be used for material transport to minimize the change of topography. In case that the scale of change of topography is large, it is advisable that implementer consider the change of generation type to PV system with taking account of the result of economic evaluation.
Score	C: Not strong impact is expected but impact sometimes occurs.
Item	**Water pollution (Mini/micro hydropower)**
Anticipated impact	Materials like concrete used for construction of hydropower plants contain chemical ingredients. If they are disposed in the river water, it may cause water pollution.
Measures	The implementer makes a construction plan that minimizes water pollution. At construction stage, the implementer should be obliged to supervise contractor's engineering work from environmental point of view.
Score	D: Low level impact may happen. More minute investigation and evaluation are required at each community.
Item	**Solid waste (PV system)**
Anticipated impact	The number of households being object of electrification by PV system in the master plan reaches approximately 260 thousands. At national level, quality and capacity of treatment and recycle of used battery is limited. As the number of project sites increases, recycling is supposed to become difficult. As result, it is anticipated that water pollution and air pollution will occur by acid and lead due to inappropriate treatment in the small scale factories.
Measures	The master plan proposes to establish the battery recycling system: the batteries used for the PV system will be collected, treated by private companies and re-used by PV users (refer to II-1.1.4). Also, it suggests that MEM/DPR should take initiative of giving administrative directives, in collaboration with Ministry of Production who are in charge of solid waste treatment and Ministry of Health in charge of industrial health, to the factories that discharge pollution through batter treatment and recycling.
Score	C: Not strong impact is expected but impact sometimes occurs.
Item	**Solid waste (Mini/micro hydropower)**
Anticipated impact	As there is no legal framework for control, it is anticipated that water pollution and dust pollution might occur during the construction if construction materials are dumped into river or remained on site.
Measures	Implementer must supervise construction contractor properly at the construction stage. And, as the need arises, MEM/DPR is recommended to give administrative directives to violators.
Score	D: Low level impact may happen. More minute investigation and evaluation are required at each community.

Item	Noise and vibration (Mini/micro hydropower))
Anticipated impact	Though the generation capacity is mini/micro level, noise and vibration are anticipated to a certain extent.
Measures	Implementer needs manage construction and operation avoiding noise and vibration exceeding forecast. If it is possible, it is advised to construct facilities at the place where impact on communities is low. It is also advised that implementer should inform construction schedule to the neighbouring people beforehand.
Score	D: Low level impact may happen. More minute investigation and evaluation are required at each community.

Note: Evaluation classification
A: Serious impact is expected.
B: Impact is expected to a certain extent.
C: Not strong impact is expected but impact sometimes occurs.
D: Low level impact may happen. More minute investigation and evaluation are required.

Source: JICA study team, 2008