Ministry of Energy and Mines

Republic of Peru

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

Final Report

<Executive Summary>

August 2008

Japan International Cooperation Agency

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

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Map of Peru

Map No. 3838 Rev. 1 UNITED NATIONS
September 2000

Department of Public Information
Cartographic Section

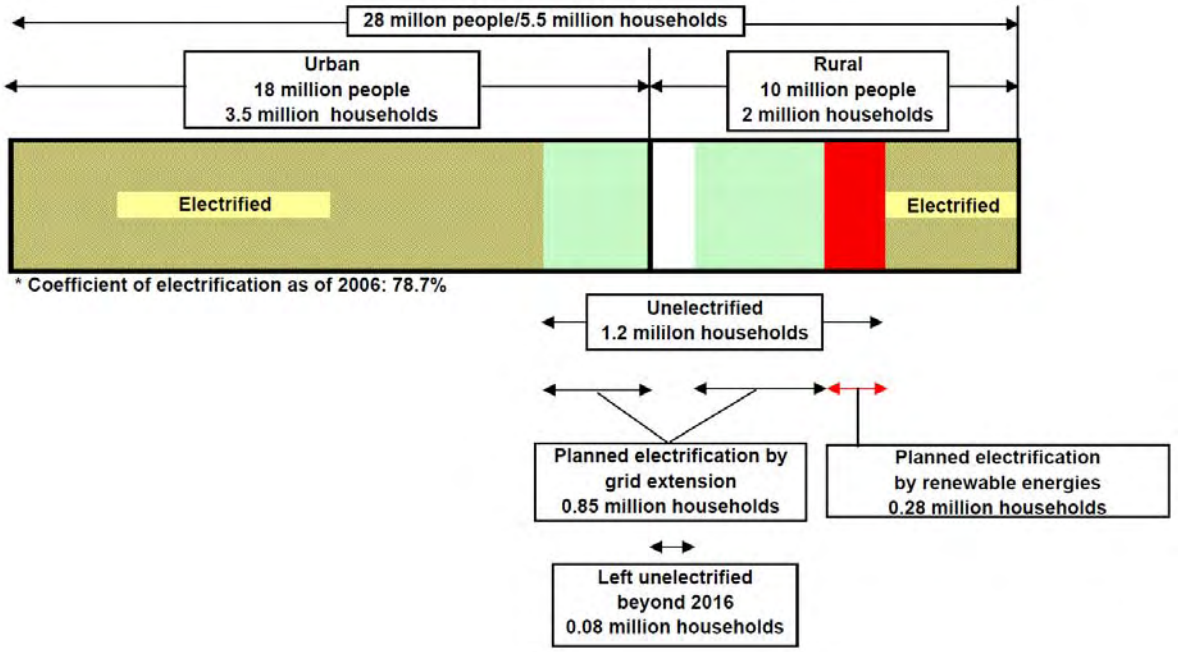
Acronyms/Acrónimos	
ADINELSA	Administration Company of Electrical Infrastructure (Empresa de Administración de Infraestructura Eléctrica)
BCS	Battery Charging Station (Estación de Recargo de Batería)
CERER	Renewable Energy Center for Rural Electrification (Centro de Energías Renovales para Electrificación 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)

Conclusions and Recommendations

(1) Objective of Rural Electrification with Renewable Energies

As shown in the figure below, the target of rural electrification by renewable energies of this Master Plan is some 280 thousand households.



(2) Issues on Rural Electrification by Renewable Energies

The study of this Master Plan has identified the following as main issues on rural electrification by renewable energies.

i) Inadequate knowledge of electrification of rural inhabitants
ii) Inadequate capability of local governments
iii) Gap between central and local levels on information and decision-making
iv) Absence of sustainable management organization of electrification system
v) Absence of supply chain for operation and maintenance
vi) Regional disparity due to uneven distribution of financial resources

(3) Countermeasures for the Main Issues

The following countermeasures are proposed for the above issues regarding rural electrification by renewable energies.

- Electrification projects should be planned by initiative of local inhabitants and managed by micro-enterprises or other similar organizations established by local inhabitants.
- To that effect, central and local governments should extend the following institutional support.

Proposition 1: Countermeasure for Issues i) and iii)
Planning mechanism for electrification by initiative of inhabitants of remote villages and unified integration of information by MEM/DPR

Proposition 2: Countermeasure for Issues ii), iii) and vi)
Dialogues between central and local levels for strategic alliance to build concensus on roles and collaboration for electrification by renewable energies

Proposition 3: Countermeasure for Issues i) and ii)
Awareness raising of inhabitants of remote villages on rural electrification by renewable energies by way of electrification of rural schools

Proposition 4: Countermeasure for Issue vi)
Financial mechanism with SPERAR Fund and tariff subsidy mechanism by FOSE

Proposition 5: Countermeasure for Issues i), ii) and iv)
Network establishment for capacity building of inhabitants of remote villages and local governments

Proposition 6: Countermeasure for Issues iv) and v)
Establishment of supply chain for construction and operation and maintenance

(4) Long-term Plan on Rural Electrification by Renewable Energies

The number of the target villages for electrification by renewable energies is 33,701 villages with 361,847 households. Out of the above number, the target villages for electrification by mini/micro hydropower is 519 villages with 18,498 households. The remaining villages and households are to be electrified by PV (solar energy). In the case of solar energy, as the number of households of a village is greater, the more efficient the electrification by PV. This Master Plan has, therefore, selected 10,829 villages with 10 households or more (corresponding to 261,520 households) as target villages for electrification by PV. The remaining 80 thousand households will be left unelectrified.

The long-term electrification plan proposes to divide the period of the plan in 4 phases. Phase I is the period for infrastructure aimed to mainly establish institutional infrastructure. Phase II is the period for initial electrification, aimed for relevant organizations to become familiarized with electrification procedure for massive installation of PV panels for solar power in particular. During this phase, 10 thousand PV panels will be installed in 2011 and 20 thousand in 2012. Phase III is the period for development of electrification for massive installation of 30 thousand PV panels per year. The last Phase IV is the period for completion of electrification to consider possible electrification of the above-mentioned households expected to be left unelectrified if more than 30 thousand PV panels have been installed in Phase III.

		Phase I (Period for infrastructure)			Phase II (Period for initial electrification)		Phase III (Period for development of electrification)						Phase IV (Period for completion of electrification)		
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
No. of households to be electrified	Solar				10000	20000	30000	30000	30000	30000	30000	30000	30000	21520	Total 261520
	Hydro						1930	2006	1840	1085	3551	8086			18498
	Total				10000	20000	31930	32006	31840	31085	33551	38086	30000	21520	280018

*Fgures shown in each year are the number of households which have been electrified in the respective years

It is to be noted that the above long-term electrification plan was prepared with a maximum number of installation of PV panels of 30,000 per year, which is considered to be possible in view of organizational capability and physically possible installation. Meanwhile, a considerable time would be required for capacity building regarding planning and creation of managing organization by initiative of local inhabitants as suggested by JICA Study Team. So, it is considered that it may be difficult to attain the electrification of the yearly number of households above planned because of great numbers of the villages and households to be electrified. Therefore, it is desirable to explore tentative methods, by utilizing ADINELSA, for electrification, managing and capacity building as transitory measures toward the eventual creation of managing organization by local initiative as suggested by JICA Study Team, while endeavoring to attain the electrification goal as much as possible.

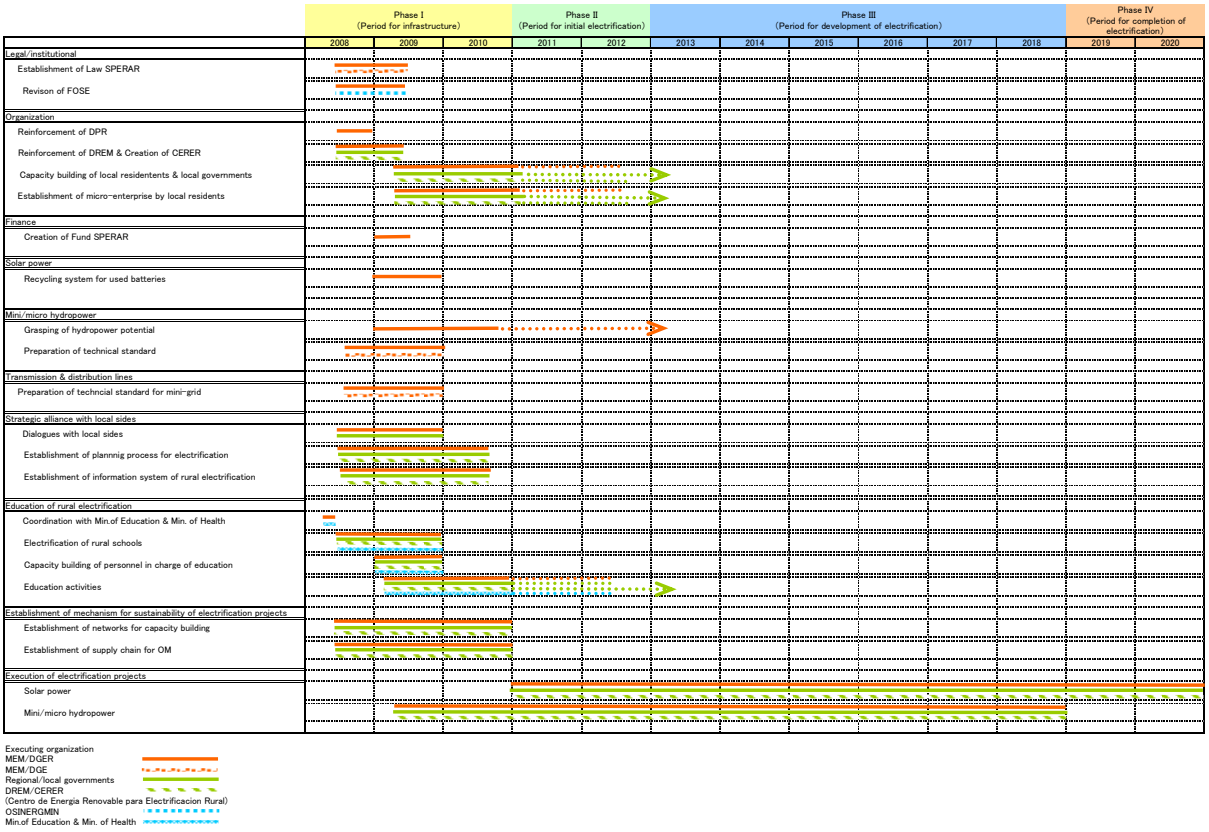
The financial requirement for the above electrification plan is about US$178 million for PV and about US$39 million, bringing the total to about US$218 million. The annual requirement is shown in the table below.

(Unit: US$)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Solar Power	6,820,000	13,640,000	20,460,000	20,460,000	20,460,000	20,460,000	20,460,000	20,460,000	20,460,000	14,676,640	178,356,640
Micro Hydro	0	0	4,671,000	4,675,000	3,661,000	5,056,000	12,612,500	8,523,500	0	0	39,199,000
Total	6,820,000	13,640,000	25,131,000	25,135,000	24,121,000	25,516,000	33,072,500	28,983,500	20,460,000	14,676,640	217,555,640

(5) Action Plan

The following figure shows the actions to be taken as countermeasures for the main issues on rural electrification by renewable energies by which organization and when.



1. JICA Master Plan Study

(1) Background

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 about one third of the population of the country live.

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.

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 of the Study

This study is aimed to make a master plan on rural electrification by renewable energies for unelectrified remote villages which are out of the plan of electrification by grid extension. Field investigations and desk studies were conducted from February 2007 through July 2008 to produce the following results:

i)	Master plan on rural electrification by renewable energies
ii)	Field studies at prefeasibility level on 4 project sites
iii)	Video and manuals for awareness raising and education

The following shows the basic composition of the Final Report containing the above results.

Basic Content of Final Report

Volume 1 Master Plan

I. Current Situation and Problems of Rural Electrification
- I-1 General Situation of Peru
- I-2 Situation of Rural Villages
- I-3 Situation of Power Sector
- I-4 Situation of Rural Electrification
- I-5 Situation of Rural Electrification by Renewable Energies
- I-6 Activities of Other Donors
- I-7 Problems in Execution and Diffusion of Rural Electrification by Renewable Energies

II. Master Plan
- II-1 Plan of Rural Electrification by Renewable Energies
- II-2 Use of Master Plan
- II-3 Impacts on Rural Socio-economic, Environmental and Gender Conditions by Rural Electrification by Renewable Energies

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

2. Situation of Rural Electrification and Countermeasures for Issues

2-1 Coefficient of Rural Electrification and Electrification Plan

(1) Coefficient of Electrification by Region

The table below shows the evolution of electrification coefficient by region (department). 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 in maintenance of electrification facilities and have not developed industries.

Coefficient of Electrification 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	

Regions with less than 78.1% of electrification coefficient

(2) Rural Electrification Plan

MEM/DGER has been implementing 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, the rural electrification plan is aimed to increase the electrification coefficient from 78.1% in 2005 (78.7% as of 2006) to 88.5% in 2011 (this target rate has been raised to 90.1%) and eventually to 93.1% by 2015.

Historical Electrification Coefficient transit 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

2-2 Legal/institutional, Organizational and Financial Aspects Related with Rural Electrification

(1) Legal/institutional Aspects

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.

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): aw 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 Eléctrico: 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.

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.

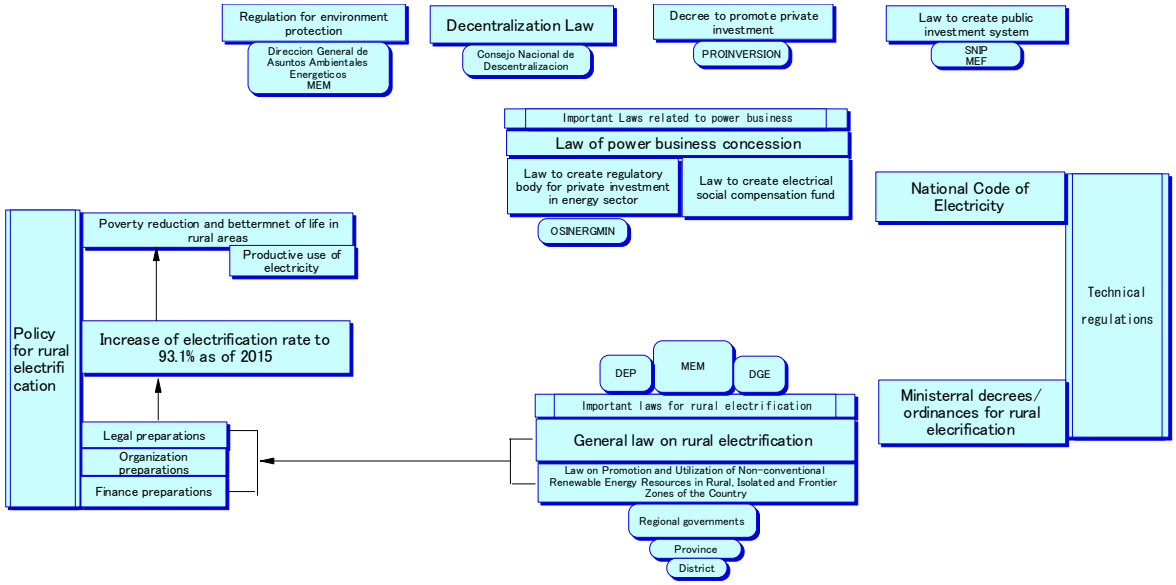


Diagram of Relevant Legal System and Organizations for Rural Electrification

(2) Organizational Aspects

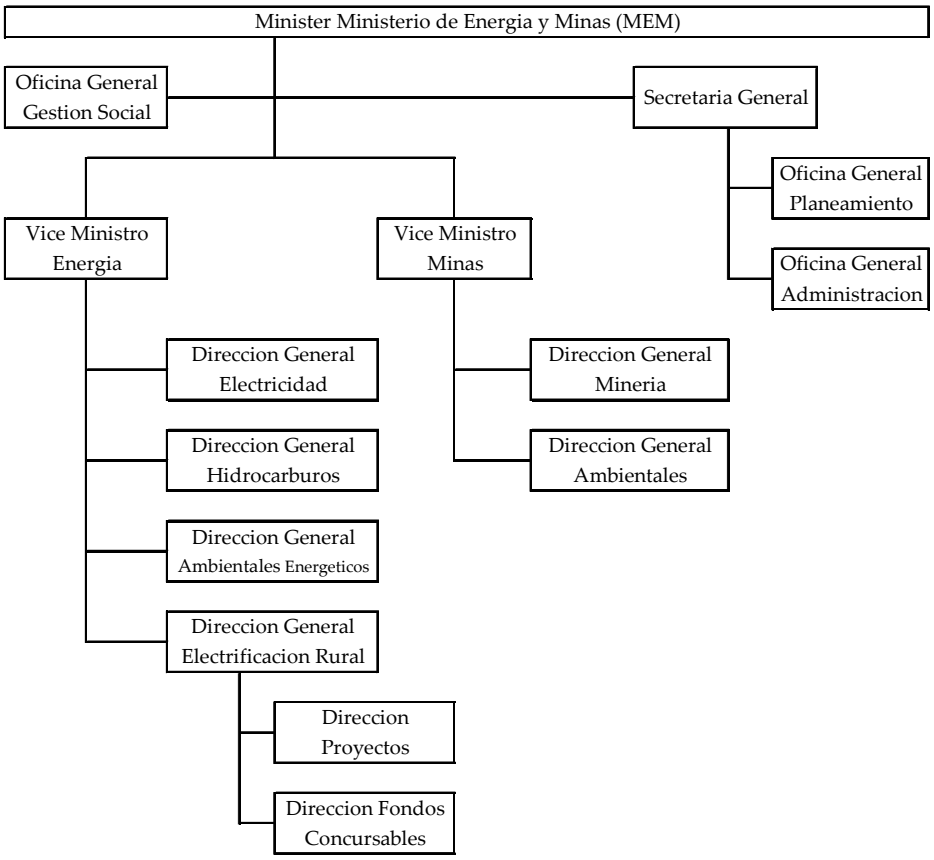
Various organizations have been engaged in rural electrification. Major organizations in the central government are: Ministry of Energy and Mines (MEM), Ministry of Education, Ministry of Public Health, ADINELSA, FONCODES, and PRONAMACHCS, while in the local administration, the regional governments have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

Among those organizations, the main organization is the Ministry of Energy and Mines (MEM), the policy making body. Electrification has been promoted according to MEM's electrification plans.

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.

The organization chart of MEM is shown in the next page.



Organization Chart of the Ministry of Energy and Mines (MEM)

The main responsible organization for rural electrification is the Dirección General de Electrificación Rural (DGER). Although this DGER is a new organization created on May 5, 2007, the two organizations which constitue DGER are the existing bureaus. One is Dirección de Proyectos (DPR) which was formerly Dirección Ejecutiva de Proyectos (DEP), and the other is Dirección de Fondos Concursables (DFC) which was formerly Fondo Nacional de Electrificación 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 Dirección 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.

(3) Financial Aspects

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 power subsector.
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 2/1000 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; and,
10) Others which will be assigned.

*) Note: UIT (Unidad Impositiva Tributaria): corresponding to 1UIT= S./3,450 (corresponding to some US$1000) as of January 2007.

It should be pointed out that these are funds 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.

Amounts of Financial Resources by the Law

(unit: 1000 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**

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

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/FONER	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

2-3 Situation of Renewable Energies

(1) Solar Power

i) Solar Potential

“Solar Atlas of Peru” was developed by MEM-DEP(currently DPR) 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). The atlas indicates high annual irradiation in the mountain ranges at around 5.5 to 6.5 kWh/m^2, and the irradiation of the 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.

Solar Irradiation Atlas

ii) Solar Power Projects in Peru

SHS (Solar Home System)

MEM/DPR has been working for UNDP project on rural electrification by PV system. In the project, 4,500 of SHS have been installed until the end of 2007. Power tariff will be collected by "pay for service" method and the monthly power tariff is determined at 18 soles.

As for the project by university, CER-UNI (Centro de Energías Renovables, Universidad Nacional de Ingeniería) 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 this project, loan repayment method was selected. The total amount of repayment is US$750. In divided repayment, 5 installments of US$150 are to be repaid within 3 years.

INADE, an organization under the Ministry of Agriculture, has been carrying out PV project near the border with Colombia from 2001. INADE has installed SHS for 329 households and 25 health posts. This project has been carried out by national donation, so that power tariff has not been collected in the project.

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 of US$ 0.80 for charging a battery. The payments are deposited in a bank account for spare parts and battery replacements in the future.

Rural Schools

Huascaran program is a program under the MOE (Ministry of Education) and the objective is to improve educational services of rural schools. The generated power is being supplied not only for lighting but also for communications radio, computer and audio-visual equipment for educational program. PV systems have been installed in 34 schools. This program is to replace the batteries every 6 years and has replaced batteries of 17 schools. 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. O&M including battery replacement are financed from budget of MOE. In MOE, around 15 members of staff are working for Huascaran program and more than 100 people are working at schools, including operators.

Rural Health Clinic

ISF (Ingenieria sin Fronteras) is a Spanish NGO which is working for 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 telecommunications system.

Telecommunications

FITEL program have implemented up to phase 4 and almost 7000 satellite phone systems using PV system have been installed. The beneficiaries from FITEL project is reported to be around 5.7 million people. In FITEL program, 400 systems supply electricity not only for telecommunications but also for computers for internet service. Tariff for telecommunications are charged mainly by pre-paid card. For some telecommunications system, the tariff is paid by coins instead of pre-paid card.

Industrial Use

PV system for industrial purposes was installed under UNDP project at Vilcallama village, Chuncuito prefecture of Puno region near the border with Bolivia in November 2007. The installed capacity of this PV system is 2kWp. This system supplies electricity to 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 weaving loom to sell in the market according to the plan.

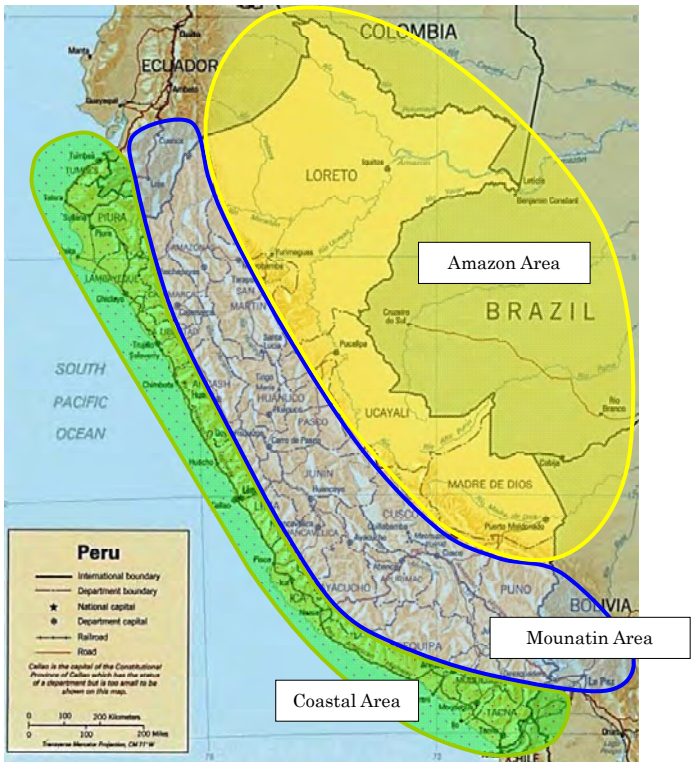
(2) Mini/micro Hydropower

i) Mini/micro Hydropower Potential

Major hydropower potential in Peru has been developed in mountainous regions to reach about 70% of the total generating capacity (5,700 MW) as of 2003.

Meanwhile, in the case of mini/micro hydropower, if its range of capacity is set from several dozen to 500 kW approximately, its potential area will not necessarily correspond to that of medium and large hydropower. That is because mini/micro hydropower potential is sometimes feasible with a head ranging from several to several dozen meters, and it will be necessary for the location of power stations to be near to demand sites (village) due to adoption of isolated mini-grid, considering reduction of the construction cost for distribution lines.

For this reason, in grasping the mini/micro hydropower potential, it is necessary to consider not only natural conditions such as topography and climate but also such social factors as distance between the construction site and the neighboring villages and exsisting infrastructure.



Hydropower Potential Distribution

ii) Mini/micro Hydropower Potentials in the Master Plan

Grasping mini/micro hydropower projects was carried out by investigation for existing projects 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. The micro hydropower sites with less than 100 kW are 25 sites among 29 projects. 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.

List of Mini/micro Projects

	Project Name	Location			Beneficiary		Installed Capacity (kW)	Discharge (m^3/s)	Head (m)	Length of Primary Lines (km)
		Region	Province	District	Number of Villages	Number of Households				
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**			

Pre-FS site

2-4 Issues and Countermeasures for Rural Electrification

(1) General

The government of Peru has a policy goal of achieving 93.1% of national electrification by 2015, 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.

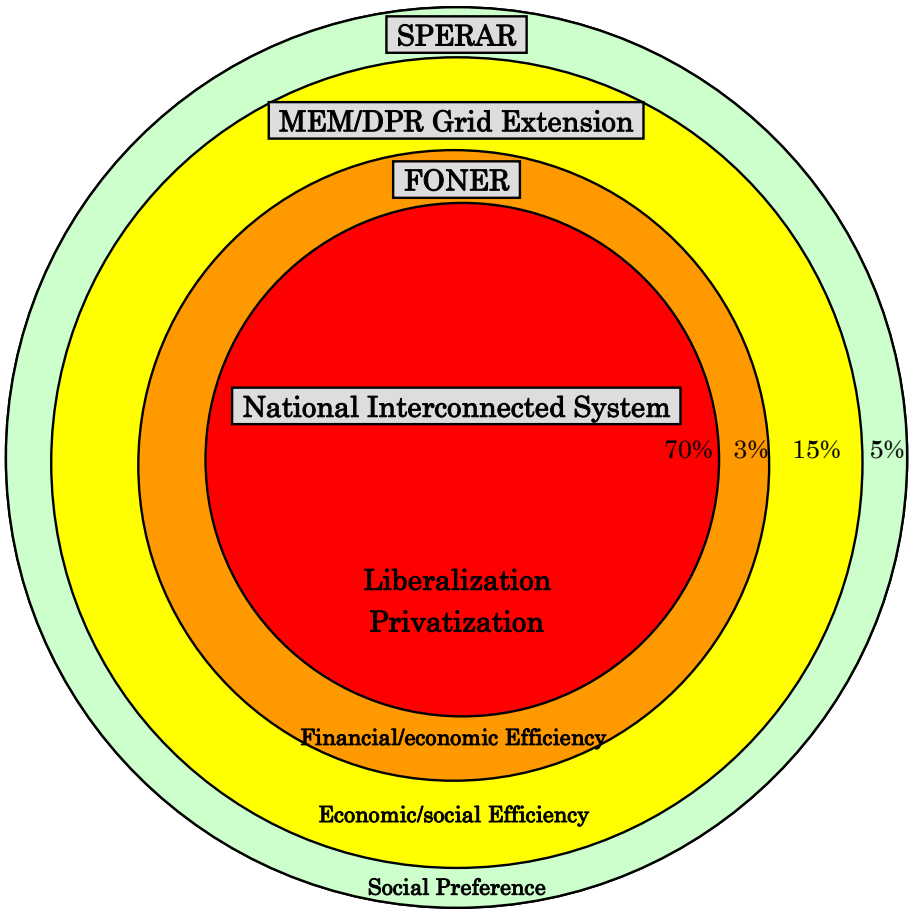
- Grid extension to outside of concession areas of concessionaire distribution companies by use of FONER fund
  - In order to promote electrification in areas difficult of grid extension in terms of business management, subsidize initial costs by means of FONER established with financial assistance from 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 central 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 3 electrification strategies is one of the issues to be dealt with in this Master Plan.

- SPERAR: electrification by renewable energies (SPERAR: **S**oluciones **P**eruanas a **E**lectrificación **R**ural en las **A**reas Aisladas y Alejadas con Energías **R**enovables)
  - SPERAR or 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.

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



Hierarchical Strategy for Universal Services of Power Supply

* The total of coefficients of electrification by each strategy is 93%, the target coefficient of electrification.

JICA Study Team identified the following major issues related with rural electrification by renewable energy.

- Given that rural electrification plan by renewable energy covers 24 regions of Peru and that target villages are located in remote places, the current number of staff of MEM/DPR (formerly DEP) is not enough, which has resulted in lack of information combined with the situation described below.

- Under decentralization, there seems to be gap between MEM/DPR and local governments and communities regarding information and decision-making process. This situation may hinder the elaboration of 10 year plan of rural electrification by MEM/DPR and the attainment of target coefficient of electrification.

- Endeavors have so far been made for electrification by renewable energy such as solar energy and mini-hydropower but only ad hoc, which has not allowed to replicate or share the systems and mechanisms for capacity building and maintenance or share experience. From the point of view of sustainability in particular, these points are essential: training for management ability in capacity building and supply of personnel and repair parts at the time of inspection and trouble-shooting, there has not been established national supply chain for such purposes.

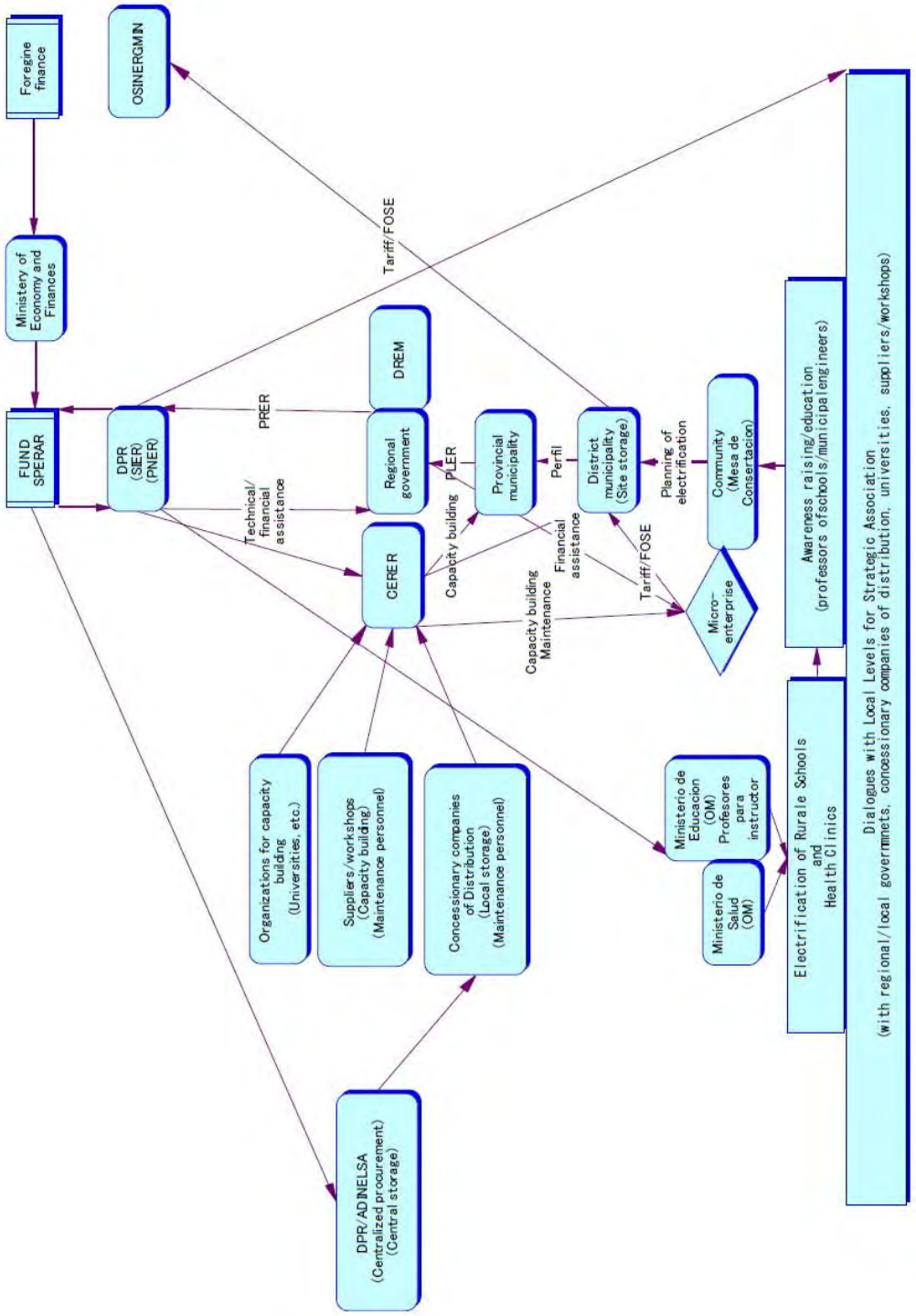
- There are regions with relatively ample funds from CANON and those short of funds, which has caused regional gaps in connection with promotion for rural electrification. If electrification is implemented on its own at local level, there may cause problems regarding the quality and safety of electrification systems, partially due to inadquate capability of local governments. And there is another concern over sustainability if power tariff is set arbitrarily. Local governments and communities have few or no personnel capable of investigation, planning and design, which allows them to have little choice but to outsource those works. In this regard as well, there may cause problems if they do not outsource them to appropriately capable engineering consultants and the like.

There have not been institutional measures to cope with the above issues, so that rural electrification, particularly in the areas difficult of grid extension has been hindered. Hence, it is one of the issues of this Master Plan to propose some institutional measures. The following propositions are made to cope with those issues:

- Electrification projects should be planned by initiative of local inhabitants and managed by micro-enterprises or other similar organizations established by local inhabitants.
- To that effect, central and local governments should extend the following institutional support.

Proposition 1:	Planning mechanism for electrification by initiative of inhabitants of remote villages and unified integration of information on rural electrification by MEM/DPR
Proposition 2:	Dialogues with local sides for strategic alliance to form agreements on roles and collaboration between central and local sides for electrification by renewable energies
Proposition 3:	Raising awareness of inhabitants of remote villages on electrification by renewable energies by way of electrification of rural schools
Proposition 4:	Financial mechanism with SPERAR and subsidy mechanism by FOSE
Proposition 5:	Capacity building for inhabitants of remote villages and local governments
Proposition 6:	Supply chain for construction and operation and maintenance

The next page shows a conceptual diagram of the proposed institutional mechanism.



Conceptual Diagram of Institutional Design

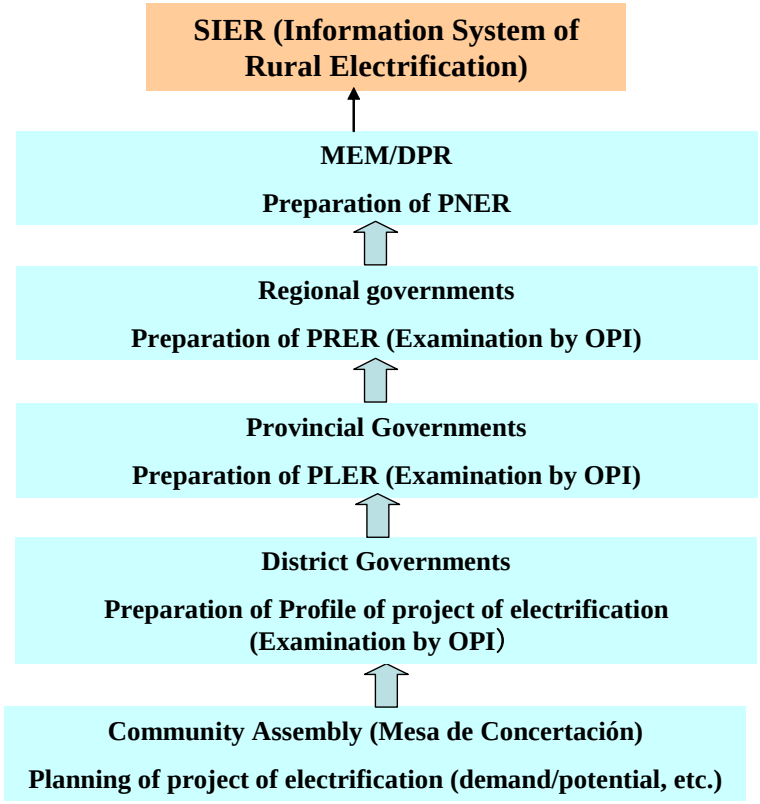
(2) Management Organization for Electrification Project

Several types of organization can be considered, including municipality, public corporation and private company. JICA Study Team proposes creation of micro enterprise to secure sustainable, proper operation and management of electrification project by renewable energy. 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 of daily operation and become autonomous, sustainability of the system cannot be obtained. Another aim is the separation of ownership and management, making clear the responsibility of the managing organization.

Form of organization	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 created in remote villages. On the other hand if it is created as an individually-owned company (Personal natural), then the company will be free from such obligation and simply pay a kind of withholding tax (deemed taxation). Therefore, for the moment, the enterprise shall be registered as individually-owned company for the time being.
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 enterprise will be basically composed of 2 people: 1 manager-cum-commercial staff and 1 technical staff. However, before selection, some 10 candidates will be selected from the village who express interests in undertaking the operation and management and all of them will be trained equally. By doing such, backup staff can be secured and if the finally-selected members will not continue, the remaining people can substitute.
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 periodically reporting to the organization of their operation based on the records. With this, the enterprise will be defined as opened body to users and at the same time, users will be able to monitor each other, since the enterprise can only be sustainable with users' equal participation and responsibility.
Contract	Micro enterprise will make contract with the owner of electrification facility, including government institutions in order to undertake the public service. In addition, the enterprise will make contracts with users in order to provide power supply service. Thus, the rights and obligations of the enterprise will be secured together with those of users.
External assistance	External assistance will be indispensable for the following activities: Explanation to villagers, training of candidates for the enterprise management, in terms of technology, operation and management, supervision for erection and installation of equipment, assistance for setting up the enterprise, assistance for startup of the operation, and monitoring.

(3) Outline of Institutional Mechanisms

i) Proposition 1: Planning Mechanism for Electrification by Initiative of Inhabitants of Remote Villages and Unified Integration of Information on Rural Electrification by MEM/DPR



Inhabitants of villages take initiative in planning of electrification, collecting information on power demand, ability to pay, energy potential, managing organization and other relevant factors and submit the electrification plan to district government. The district government examines the plan and make profile of the selected plans according to their criteria for priority and, then, submit them to the provincial government. The provincial government examines and compiles electrification plans from district governments and also gather information on actual conditions and plans of electrification by grid extension from district governments to eventually prepare PLER (Local Plan of Rural Electrification) for submission to regional governments. The regional government examines and compiles PLERs from provincial governments together with information on actual conditions and plans of electrification by grid extension to prepare PRER (Regional Plan of Rural Electrification) for submission to MEM/DPR.

MEM/DPR examines and compiles PRERs from regional governments to prepare PNER (National Plan of Rural Electrification) incorporating grid extension projects by MEM/DPR. PRERs from regional governmnets are to include information on actual conditions and plans of grid extension by

local initiative. In this way, MEM/DPR will be able to grasp the situation of grid extension and other electrification plans by local initiative and also will be able to provide financial resources for implementing electrification plans made by the initiative of local inhabitants.

The following guidelines are suggested for selection of electrification plan:

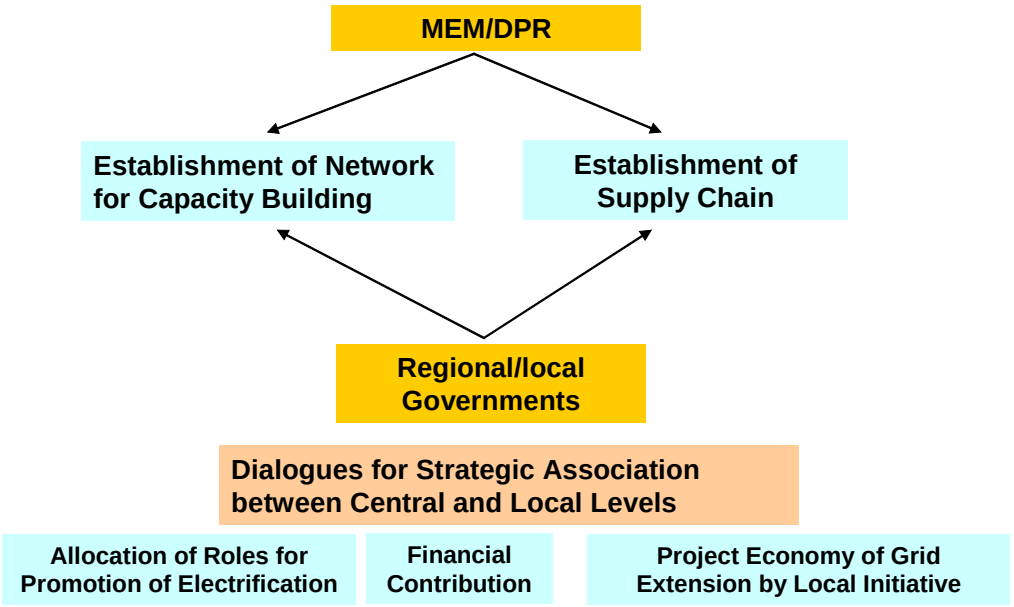
Criteria of Priority or Project Adoption by Local Governments

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.

Criteria of Priority or Project Adoption by MEM/DPR

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.

ii) Proposition 2: Dialogues with Local Sides for Strategic Alliance to Form Agreements on Roles and Collaboration between Central and Local Sides for Electrification by Renewable Energies



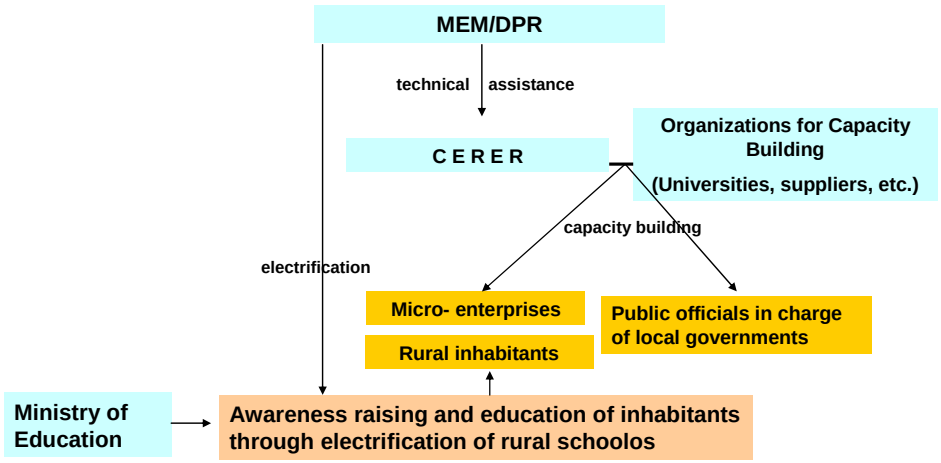
In implementing this Master Plan, the first thing to do for MEM/DPR is to have dialogues with local sides of each region for strategic alliance with regional/local governments on what to do to promote rural electrification such as the roles to be played by each side and financial burden.

It is also desirable to discuss project economy of grid extension plans promoted by local sides, and, if not feasible, such plans should be discarded to change to electrification by renewable energies.

The important thing in strategic alliance between central and local levels is to form concensus on the roles to be played by each party regarding the establishment of network for capacity building and supply chain for operation and maintenance, vital for electrification plans by renewable energies to become really sustainable.

iii) Proposition 3: Raising Awareness of Inhabitants of Remote Villages on Electrification by Renewable Energies by Way of Electrification of Rural Schools

Proposition 5: Capacity Building for Inhabitants of Remote Villages and Local Governments



Schools of unelectrified villages in remote areas are to be electrified for use of education center of electrification by renewable energies for local inhabitants. Education is provided by use of video and leaflets prepared by JICA Study Team to enable local inhabitants to take initiative in planning for electrification and motivate them toward organizing themselves for that purpose.

Each region is to create CERER (Renewable Energy Center for Rural Electrification), which is in charge of establishment of network for capacity building and supply chain for operation and maintenance. CERER is to be one-stop desk for electrification by renewable energies, through which capacity building is to be conducted by contracted organizations for capacity building including universities, suppliers and other appropriate entities.

Electrification of Rural Schools

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.

147 communities shown in the table below are selected by the above selection criteria.

Number of Communities for Rural School Electrification

Region	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**

Main Curricula of Capacity Building

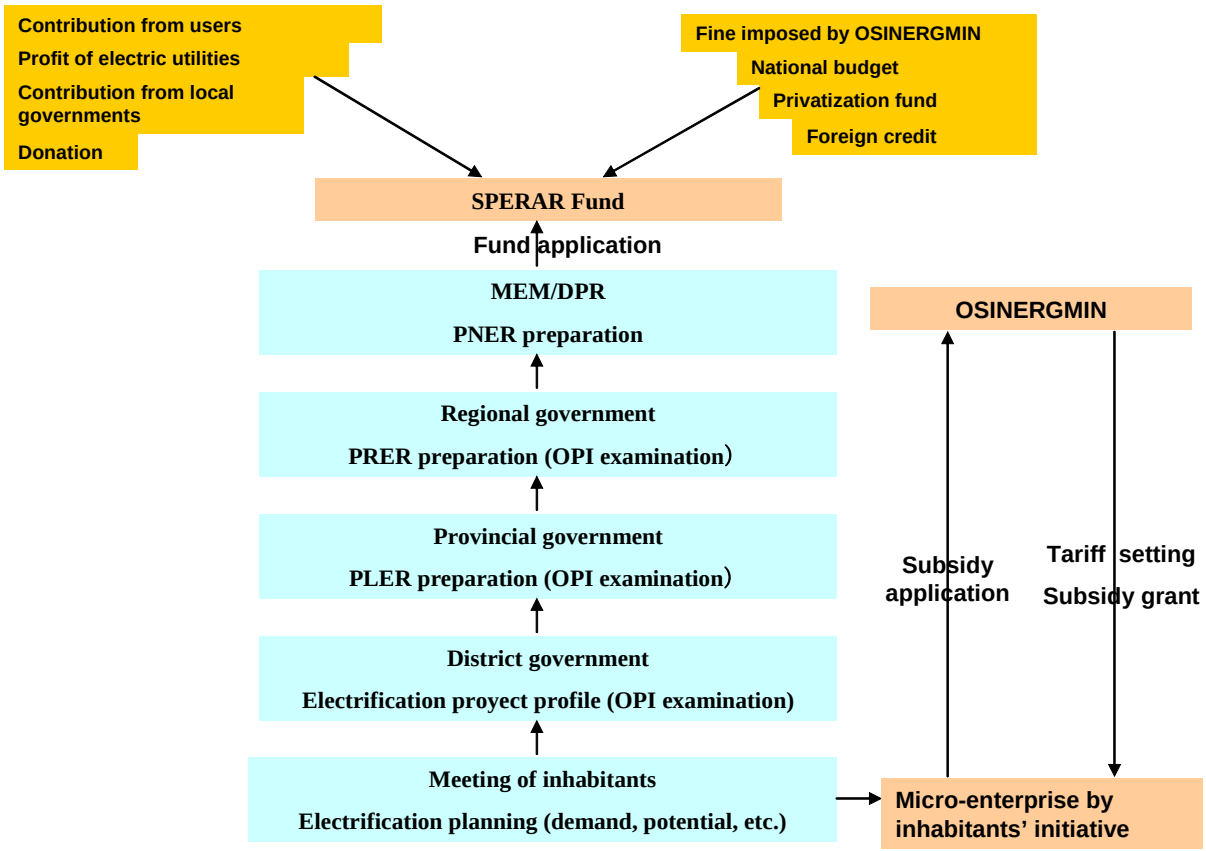
The suggested main curricula of capacity building are shown in each discipline below:

Main Curricula of Capacity Building

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
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

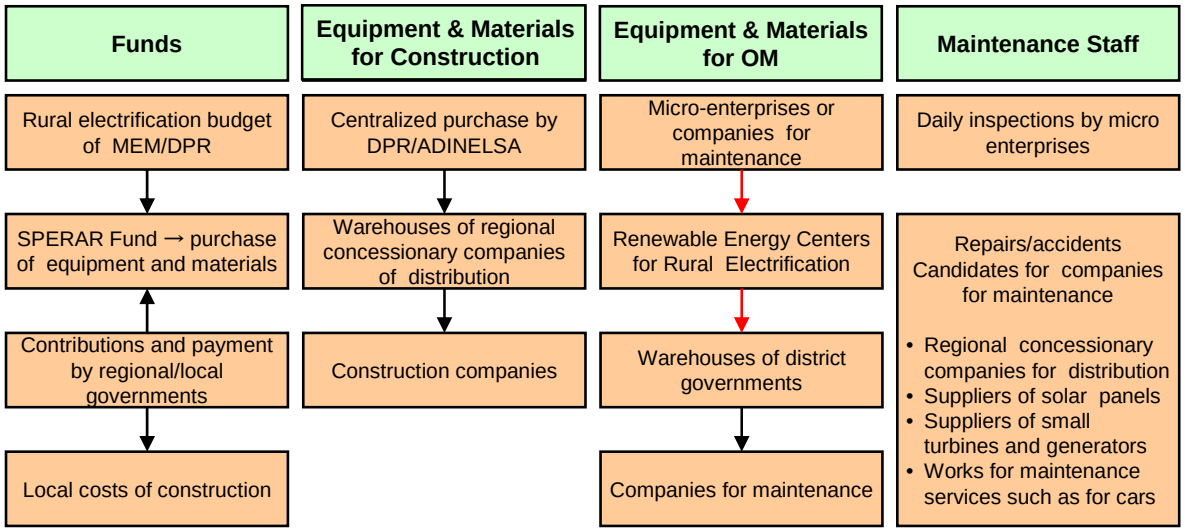
Subject	Trainee	Curriculum
Solar power	Expert on PV project planning	➢ Project plan and application ➢ Comparison of economic aspect on different types of rural electrification ➢ Procedure of site survey
	Engineer for PV project supervisor	➢ Estimation of power output and demand ➢ System design of PV 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
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
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
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

iv) Proposition 4: Financial Mechanism with SPERAR Fund and Tariff Subsidy Mechanism by FOSE



As for the projects adopted through the planning and selection process mentioned in i) Proposition 1, MEM/DPR is to request necessary funds from SPERAR Fund. In the meantime, as for operation and maintenance costs, application of tariff set by survey on demand and ability to pay and subsidy request to cover those costs is to be made before OSINERGMIN. OSINERGMIN is to notify the applying micro-enterprise of the approved tariff and the amount of subsidy after examination.

v) Proposition 6: Supply Chain for Construction and Operation and Maintenance



Supply chain comprises 4 elements: funds, equipment and materials for construction, equipment and materials for OM and maintenance staff.

As for funds, it is proposed to create a special fund for rural electrification by renewable energies, which is named "SPERAR Fund". The financial sources for this fund are budget for rural electrification of MEM and contributions and payments by regional/local governments.

In response to a financial request by MEM/DPR, the SPERAR Fund provides the required funds. On the other hand, the regional/local governments take the financial burden of local construction costs.

As for equipment and materials for construction, a central organization such as MEM/DPR o ADINELSA make centralized purchase in order to maintain purchasing power for negotiations and quality level of purchased goods.

Once purchased, the necessary equipment and materials are to be transported to warehouses of regional concessionary companies for power distribution and later to be delivered to construction companies.

As for equipment and materials for operation and maintenance, CERER is to instruct regional concessionary company for power distribution to transfer them to warehouses of district municipalities. At the request of micro-enterprises or maintenance companies, CERER instruct the district warehouses to deliver the necessary equipment and materials to maintenance companies.

With respect to maintenance staff, daily inspections must be conducted by micro-enterprises, while repairs and accidents necessitates employment of maintenance companies, for which candidates may include regional concessionary companies for power distribution, solar panel vendors and repair shops.

(4) Countermeasures in Different Sections

i) Organization

Countermeasures	
Creation of supporting network system based on existing universities	Network on the renewable energy will be established based on existing universities and others, aiming to be supporting system for information collection, training, and project implementation
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 villagers	Micro enterprise should be established by 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 an office at regional government level for renewable energy	CERER, 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 handle all issues

ii) Finance

Countermeasures	
Creation of SPERAR Fund	It is necessary to consider the necessity of creating a stable, permanent fund to promote rural electrification by renewable energies.
Use of FOSE to lower tariff level	OM cost should be borne by users in principle; however, the cost recovery level of tariff may not be affordable to a number of users in isolated areas. 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 electric companies. It is desirable to take measures to simplify the procedures of registration at MEM/DPR and the periodical report thereafter, so that the micro enterprises to be established for rural electrification may have easy access to such benefit.

iii) Technical Aspects of Solar Power

Countermeasures	
Used battery treatment	It is recommended to cooperate with existing battery recycle companies for used battery treatment. It is necessary for MEM/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 aspect.
Lower power tariff for users	Use of BCS is recommended because of its low cost for household. Electrification for public facilities such as school or health clinic is also recommended for such households that electricity is not affordable, so that they can receive some benefits through public services. By those and other means, it is desirable to lower financial costs to users.
Improvement of technical standards and others	It is necessary to develop technical standards for over 500Wp of installed capacity required for power supply system at public facility. Technical standards under 500 Wp is already developed in Peru. It is necessary to monitor solar irradiation where PV electrification is planned because there are no irradiation data for estimation of power output. Improvement of quality of PV components in the markets is important for general users. It is necessary to develop certification system on PV components, for example certification mark on certified PV components.

iv) Technical Aspects of Mini/micro Hydropower

Countermeasure	
Identification of mini/micro hydropower potential and continual use of questionnaire and interview survey to local sides and utilization of GIS	Grasping mini/micro hydro potentials and selection work of candidate sites is necessary to implement and promote rural electrification by mini/micro hydropower. In preparing a master plan, it is important for MEM/DPR to compile information on candidate sites and to consolidate fundamental data necessary for confirmation of project feasibility. In particular, project feasibility of small hydropower depends on river discharge; therefore, its feasibility should be studied first using isohyetal map or specific flow map. Identification of candidate sites should, for the time being, adopt the following methods in consideration of the above data still being prepared and advantage of bottom-up approach in Peru. • Continuing implementation of questionnaire and interview survey • Utilization of geographical information system (GIS)
Technical standards (design criteria)	Mini/micro hydropower stations of less than 500 kW have not been developed by unified technical criteria or standards. In the case that MEM/DPR checks the design of small hydropower that is studied by a local government (sub contracted by 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 design in order to solve those problems.

v) Technical Aspects of Mini-grid

It is proposed for cost reduction to introduce the following into the technical standards for rural electrification.

Countermeasures	
Standardization of poles	The most influential costing part of distribution facilities is poles, so that in rural electrification projects, it is important to reduce the costs of poles. Domestic eucalyptus wooden poles are the most reasonable, followed by wood from Canada and Chile. Another cost cutting measure is to simplify 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. Still another cost-cutting item is the minimum conductor height from the ground. National Electric Code rightly separates its regulations between urban and rural areas. For example, low voltage lines should be kept more than 5 meters distance from the ground in urban areas, but 4 meters in rural areas where there are no traffic of vehicles. Reduction of distance between the conductor and the ground is the most efficient measures for cost reduction of supports, so that there are still possibilities of such cost reduction in Peru.
Standardization and simplification of pole accessories	One of the most important purposes 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 pull poles, simplification of pole accessories are to 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 is adopted as a model with the cooperation with Brazil and Australia. By the said method it is possible to reduce cable and other materials
Reliability in rural areas	Quality Standards regulate supply reliability. In these standards there are a number of categories depending on the number of 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. Cost reduction can be expected by alleviating the grade of reliability in rural areas.

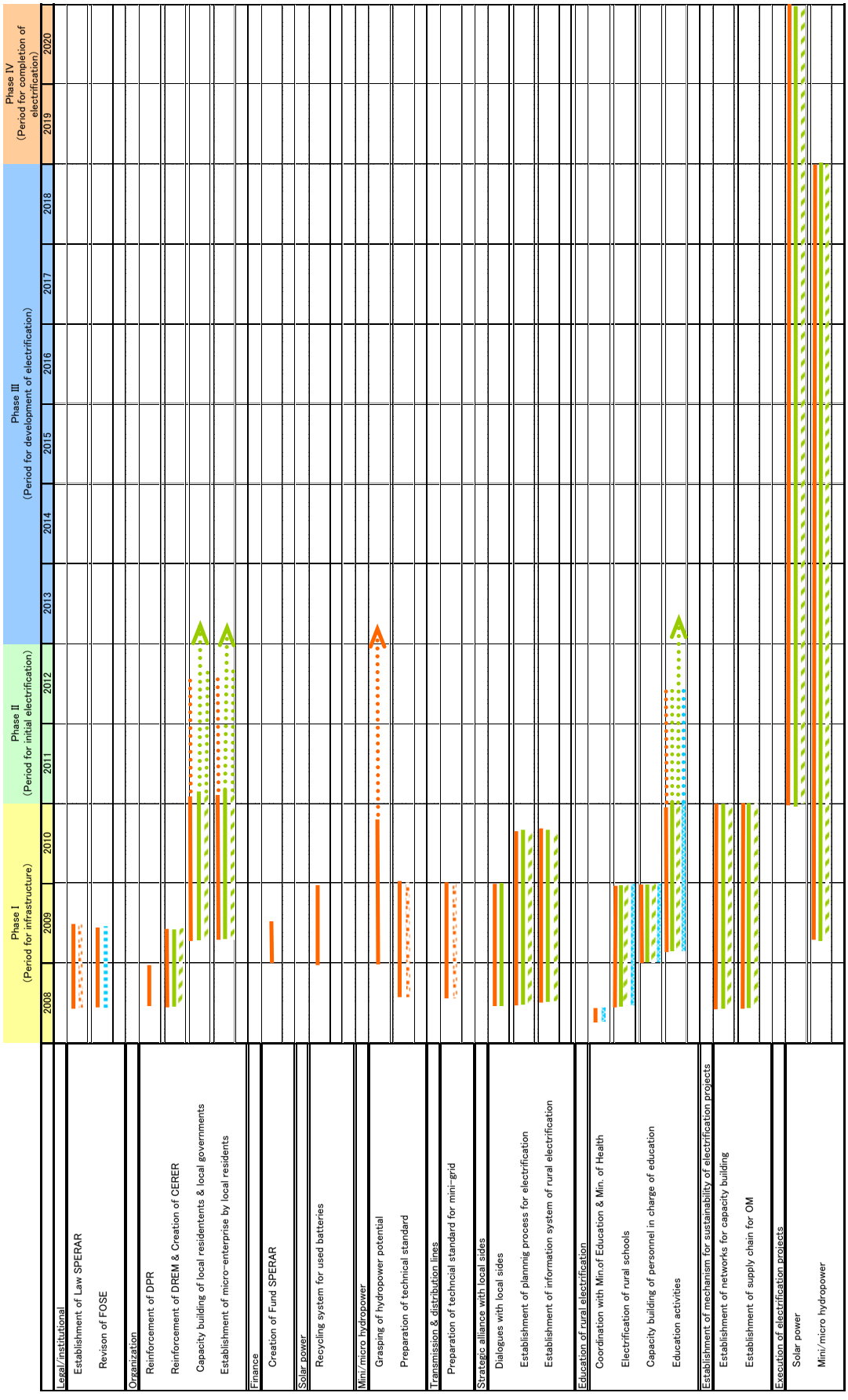
3. Action Plan for the Proposed Countermeasures

The Action Plan shown in the figure in the next page shows when and what actions to be conducted by which organization, so that those actions should be mainly implemented in Phase I, the period for institutional infrastructure, because they are necessary to implement the long-term rural electrification plan by renewable energies..

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 experts and senior volunteers. 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.


Phase I
(Period for infrastructure)
Phase II
(Period for initial electrification)
Phase III
(Period for development of electrification)
Phase IV
(Period for completion of electrification)
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Legal/institutional
Establishment of Law SPERAR
Revison of FOSE
Organization
Reinforcement of DPR
Reinforcement of DREM & Creation of CERER
Capacity building of local residentents & local governments
Establishment of micro-enterprise by local residents
Finance
Creation of Fund SPERAR
Solar power
Recycling system for used batteries
Mini/micro hydropower
Grasping of hydropower potential
Preparation of technical standard
Transmission & distribution lines
Preparation of technicial standard for mini-grid
Strategic alliance with local sides
Dialogues with local sides
Establishment of plannnig process for electrification
Establishment of information system of rural electrification
Education of rural electrification
Coordination with Min.of Education & Min. of Health
Electrification of rural schools
Capacity building of personnel in charge of education
Education activities
Establishment of mechanism for sustainability of electrification projects
Establishment of networks for capacity building
Establishment of supply chain for OM
Execution of electrification projects
Solar power
Mini/micro hydropower
Executing organization
MEM/DGER
MEM/DGE
Regional/local governments
DREM/CERER
(Centro de Energia Renovable para Electrificacion Rural)
OSINERGMIN
Min.of Education & Min. of Health

Action Plan

The table below categorizes the Action Plan by organizations and actions.

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		

Phase I is an important period to consolidate the infrastructure necessary to effectively implement the long-term rural electrification plan proposed in the next section, 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 (Renewable Energy Center for Rural Electrification) 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, 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/DGER in the early part of Phase I.

- 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 Phase I.

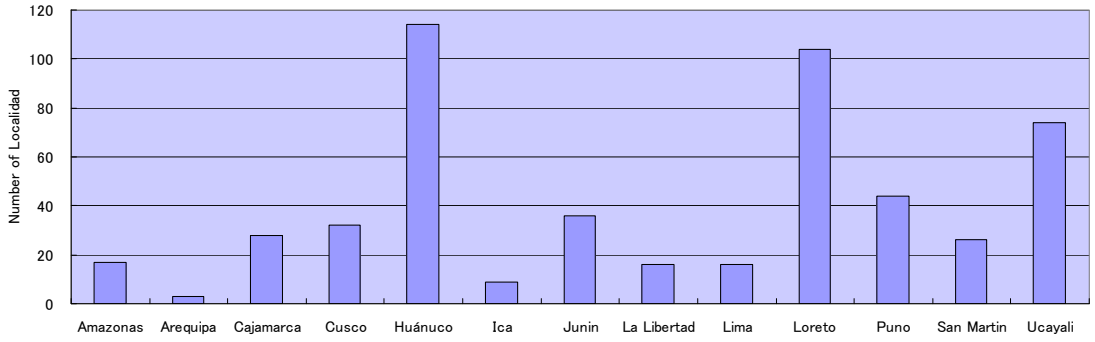
- As for 4 sites where JICA Study Team conducted prefeasibility study, it is useful for smooth implementation of the long-term rural electrification to start the projects by conducting site investigations and capacity building for local residents in Phase I in order to see if the proposed model plan would function.

4. Long-term Rural Electrification Plan by Renewable Energies

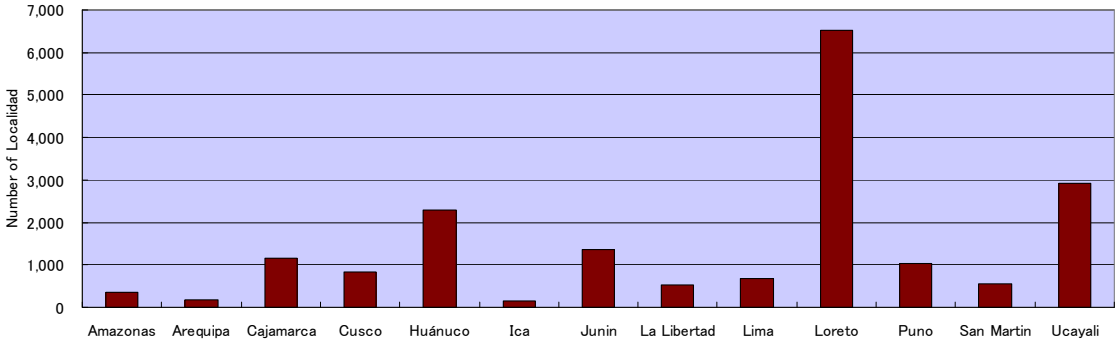
(1) List of Unelectrified Villages and Target Villages for Electrification by Renewable Energies

This Master Plan defines the target areas of renewable energy electrification based on the data given by MEM/DEP on 27th February 2008.

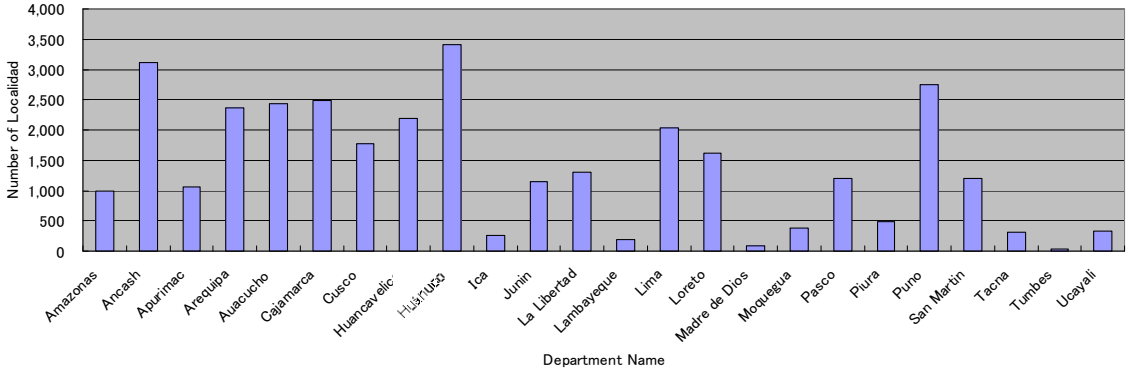
According to the above data, the total number of unelectrified villages is 33,701 villages with 361,847 households, out of which 519 villages with 18,498 households are to be electrified by mini/micro hydropower and the remaining 33,182 villages with 343,349 households by PV.



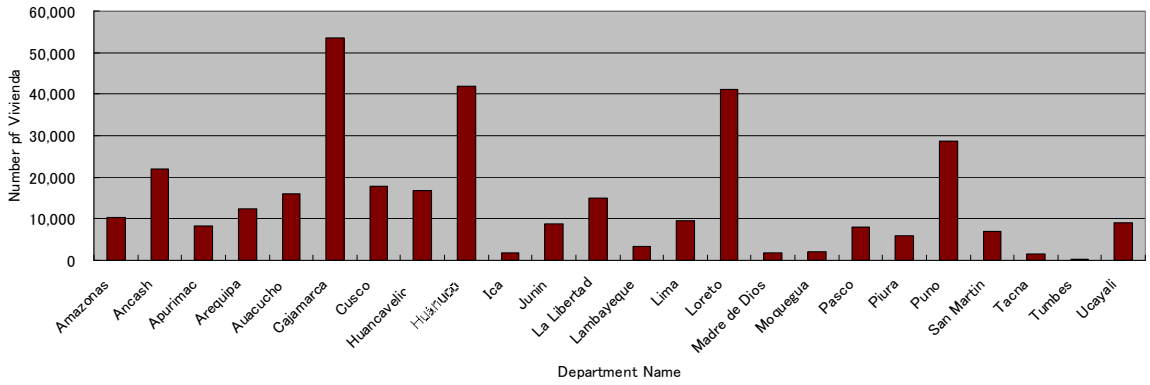
Number of Villages to Be Electrified by Mini/micro Hydropower: 519 villages



Number of Households to Be Electrified by Mini/micro Hydropower: 18,498 households



Number of Households to Be Electrified by PV: 33,182 villages



Number of Households to Be Electrified by PV: 343,349 households

Regarding mini/micro hydropower, when the candidate power house location is decided, it is possible to electrify the neighboring villages of the power station. So, the target villages for electrification should be all the unelectrified villages regardless of the number of households.

As for PV, in order to determine the priority of electrification, it is necessary to consider certain level of demand, tariff revenue, investment effect, maintenance system and other factors; therefore, the greater the number of households the more efficient the electrification by PV. This Master Plan selected 10,829 villages (corresponding to 261,520 households) with 10 or more households out of the above 33,182 villages.

(2) Long-term Rural Electrification by Renewable Energies

An electrification plan for 519 villages with 18,498 households by mini/micro hydropower and 10,829 villages with 261,520 households by PV is shown in the long-term rural electrification plan by renewable energies shown below. This plan was prepared with 30,000 households as yearly upper limit for PV, considering the limits of organizational capacity and physical installation, and for mini/micro hydropower, based on the number of households electrified according to the assumed implementation schedule.

Long-term Rural Electrification Plan by Renewable Energies

		Phase I (Period for infrastructure)			Phase II (Period for initial electrification)		Phase III (Period for development of electrification)						Phase IV (Period for completion of electrification)		
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
No. of households to be electrified	Solar				10000	20000	30000	30000	30000	30000	30000	30000	30000	21520	Total 261520
	Hydro						1930	2006	1840	1085	3551	8086			18498
	Total				10000	20000	31930	32006	31840	31085	33551	38086	30000	21520	280018

*Fgures shown in each year are the number of households which have been electrified in the respective years

The financial requirement for the above plan is some US$178 million for PV and some US$39 million for hydropower, adding up to some US$218 million. The yearly fund requirements are shown in the table below. The method of caluculation will be explaiend later.

(Unit: US$)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Solar Power	6,820,000	13,640,000	20,460,000	20,460,000	20,460,000	20,460,000	20,460,000	20,460,000	20,460,000	14,676,640	178,356,640
Micro Hydro	0	0	4,671,000	4,675,000	3,661,000	5,056,000	12,612,500	8,523,500	0	0	39,199,000
Total	6,820,000	13,640,000	25,131,000	25,135,000	24,121,000	25,516,000	33,072,500	28,983,500	20,460,000	14,676,640	217,555,640

The long-term plan is divided in 4 phases considering the following..

- Phase I: Period for Infrastructure (2008-2010)

  Phase I is an important period, when legal/institutional preparation should be made, CERER created, strategic alliance formed 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 that 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 complete 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.

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.

However, there are possibilities that it would take much time for capacity building and organizing to create micro-enterprises by initiative of local inhabitants and there are a large number of villages and households to be electrified, so that it is considered that it may be difficult to attain the target number of households to be electrified each year shown in the long-term rural electrification plan. Therefore, although the eventual goal is management and operation by micro-enterprise of local inhabitants, such a transitional measure can be considered that a central organization like ADINELSA, in cooperation with CERER and regional/local governments, organizes local inhabitants as users' association like electrification cooperative, along with installation of solar panels.

That idea is only transitional measure, so that it has to be conditioned to create a micro-enterprise after some determined time (e.g. within half a year) and, in the case of inobservance, it is desirable to take punitive action such as removal of the installed solar panels from the disobedient village .

It can be considered to be practical to implement in parallel the electrification by the above alternative, the way of micro-enterprise proposed by JICA Study Team and the conventional method of capacity building by vendors of solar panels. Anyhow, it is inevitable to seek more appropriate ways to secure sustainability, while endeavoring to come as close as possible to the goal of electrification.

(3) Calculation Method for Yearly Fund Requirements

Yearly fund requirements were estimated by the following methods.

i) Solar Power

The amount of fund requirement for each year was calculated on a unit construction cost of US$682/household, multiplied by the number of target households to be electrified proposed in the long-term rural electrification.

Yearly Number of Target Households by 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

ii) Mini/micro Hydropower

Estimation of construction cost (including hydropower plant and mini-grid) was made for each 29 sites to be developed. The amount was allocated according to the assumed construction schedule shown in the next page.

Draft Development Schedule for Mini/micro Hydropower Projects

No.	Project No.	Project Name	Region	Beneficiary		Installed Capacity (kW)	Discharge (m^3/s)	Preparatory Period / Introductory Period / Promotional Period	Remarks
				Number of Villages	Number of Households			2009 2010 2011 2012 2013 2014 2015 2016 2017 2018	
1	3	P.C.H La Majada	Cajamarca	11	420	60	0.085		
2	4	P.C.H Quebrada Honda		5	194	30	0.050		
3	5	P.C.H Yerba Buena		12	535	80	0.112		
4	19	P.C.H Aichiyacu	Loreto	10	190	30	0.085		
5	20	P.C.H Balsapuerto		14	487	80	0.090		
6	21	P.C.H San Antonio		37	1,420	200	0.200		
7	22	P.C.H Santa Catalina		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		22	715	100	0.093		
10	25	P.C.H Porotongo	San Martin	12	329	50	0.133		
11	26	P.C.H Selecachi		14	214	30	0.045		
12	27	P.C.H Quebrada	Ucayali	14	386	55	0.070		
13	28	P.C.H Rio Iparia		40	1,948	280	0.770		
14	29	P.C.H Shinipo		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		13	426	60	0.090		
19	8	P.C.H Yanama		8	206	30	0.050		
20	9	P.C.H Cayay	Huanuco	18	405	60	0.120		
21	10	P.C.H Chontabamba		13	447	65	0.090		
22	11	P.C.H Quechuarpata		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		11	426	60	0.090		
26	15	P.C.H Shima		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		6	569	100	0.201		

Legend

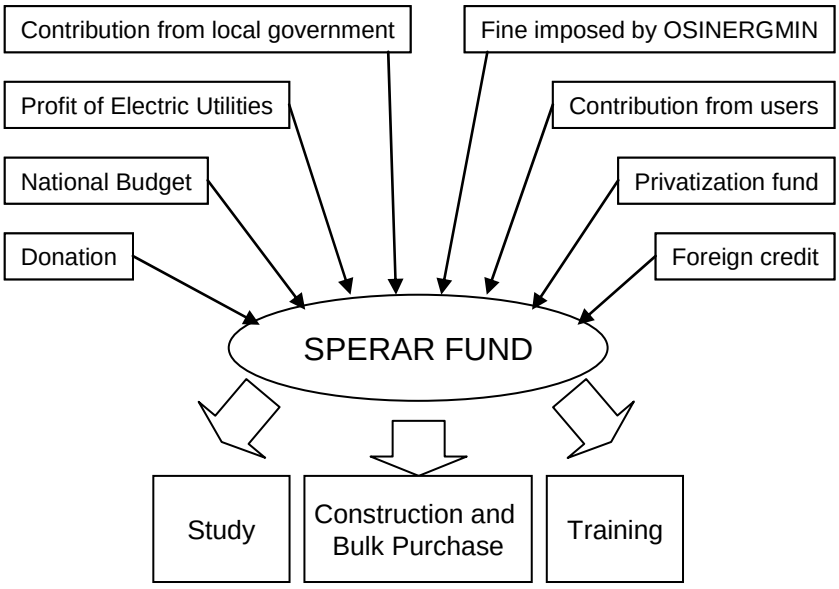
- Execution Period for Capacity Building
- Execution Period for Site Survey and Pre-FS
- Execution Period for Feasibility Study
- Execution Period for Detailed Design
- Construction Period
- Possible Execution Period for Capacity Building, Site Survey/Pre-FS ahead of

(4) Financing for Implementation of Master Plan

This Master Plan proposes to create SPERAR Fund to promote rural electrification by renewable energies.

i) Financial Sources

Financial sources for SPERAR Fund shall basically be the fiscal resources mentioned at the Article 7 of the General Law of Rural Electrification – Law No.28749.



Financial Sources for SPERAR Fund

ii) Fund Requirements

The required amount for rural electrification by renewable energies was calculated at US$217,556 thousand in total. Yearly fund requirements gradually increases from US$6,820 thousand in 2011 which corresponds to the beginning year of the work implementation, and reaches the maximum amount of US$33,073 thousand in 2017.

The above fund requirement was compared with the outstanding balance of the budget of MEM/DGER to reveal that the “budget” is enough to cover the required amount at the beginning and that there would be a need for additional financing for amounts corresponding to the required amounts for hydropower projects since the commencement of its construction works in 2013.

iii) Financing

It is considered that rural electrification with solar power can be implemented with the actual level of the national budget amount. On the other hand, it is necessary to secure budget for the required costs corresponding to hydropower projects. For this purpose, the following sources can be considered:

National budget (including 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 8 largest 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 governments to implement rural electrification by renewable energy, in order to secure the necessary budget.
Contribution by users	If it still requires further financing,, another source is to increase the contribution rate of the users. In 2006, there was an income of 151,572,000 Soles (US$52,266,207) in this category. If it is increased by 1%, it would bring about more than US$500,000/year, and it would cover the one tenth of the required amount for hydropower development for 4 years from 2013.
Foreign credit	Economy of Peru has been steadily expanding during recent years, and it is no more necessary to rely on foreign credits for development. But in the case of decrease of tax amount due to possible shrinkage of economy in short/mid term, or if soft loans from international financing institutions are available, it would be wise to consider the possibility of utilizing such funds. 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 micro hydropower projects into one package to form a project.

iv) Use of the Fund

The funds required to implement the Master Plan can be broadly divided into four categories: study, construction, operation and maintenance, and capacity building. Funds from SPERAR Fund are to be appropriated for implementation of the required study, construction of electrification facilities and capacity building.

Study	Pre-investment study as a part of SNIP procedure is indispensable because the public budget is used for project implementation. And construction of 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.
Construction	In line with the policy of the Peruvian Government to implement rural electrification 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 agreement. The contribution rate shall be determined according to the budgetary amount of the local government considering the distribution of CANON.
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 results in 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 access to electricity services. Electrical 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, the sooner application of this mechanism is strongly expected.
Capacity building	Capacity building is indispensable to heighten the sustainability of electrification project by renewable energies. Therefore, funds required for capacity building should also be provided from the SPERAR Fund as a part of the project cost.

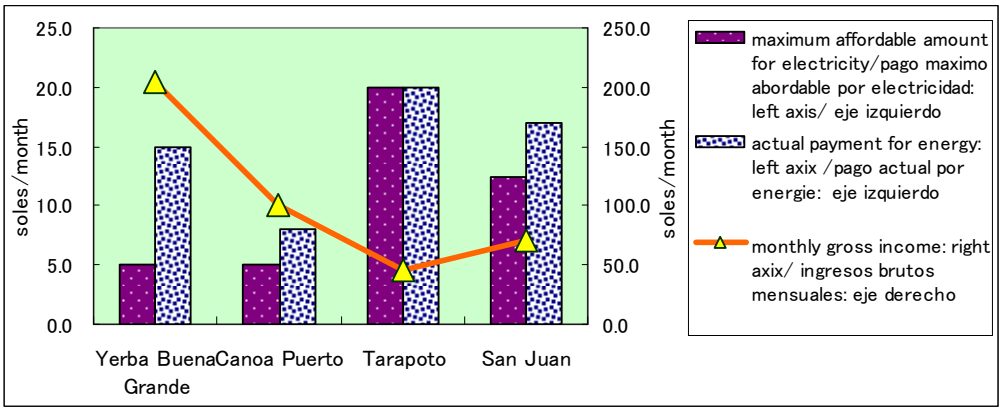
5. Socio-economic, Environmental and Gender Aspects in Rural Electrification

(1) Social and economic aspects

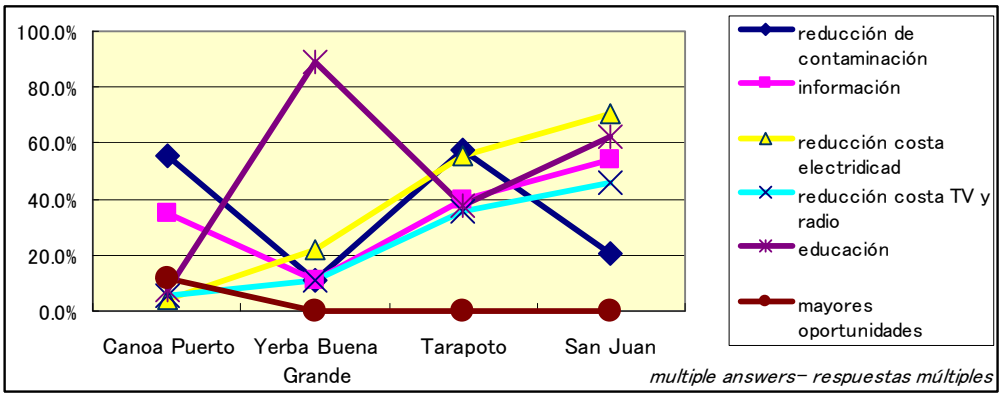
Inhabitants living in such remote and isolated areas as electrification is implemented by renewable energy are generally characterized by lower income and education level, and a certain number of inhabitants live in a traditional way of life including weaker gender equality. These are not preferable condition for sustainable use and self-reliant management of electric facilities. Therefore, mitigation planning was examined and proposed in this Master Plan.

It is indispensable for rural electrification, especially by renewable energy, to understand users' living conditions directly and to make plans according to them at the beginning of the 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 communities

In this Master Plan study, community survey was conducted in Pre-FS sites and neighboring non-electrified and electrified communities to obtain information relating to the use and the impact of electricity, expectation of electricity as well as their economic and social conditions. The important data obtained in the Pre-FS sites is shown in figures below.



Affordability, actual payment for energy of Pre-FS sites



Expectation after electrification of Pre-Fs sites

The overall goal of rural electrification is that all the people living in the concerned community enjoy the positive effects of electrification to the most extent. Electrification project must mitigate its negative impact and increase positive effect on social and physical conditions as much as possible. To achieve it, bottom-up approach and self-reliant system are proposed in this Master Plan.

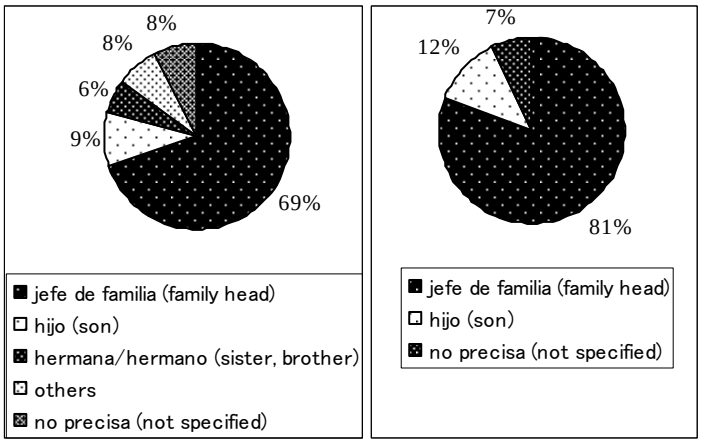
The Master Plan proposes to the implementers to follow the procedure in order to enhance the positive effect of the electrification most effectively and to avoid unnecessary conflict between implementer and users as well as among users. They are:

a. Collection of social and economic data of the target community (on site)
b. Understanding of positive and negative aspects of social, economic and cultural conditions
c. Preparation of draft implementation plan in consideration of constraints and potentials
d. Information exchange among stakeholders by holding public hearing
e. Making implementation plan with mitigation plan in conformity with the information obtained in public hearings; participation of future users in planning is advisable.
f. Execution of raising public awareness and capacity building programs
g. Establishment of the system of technical support and monitoring

It is also necessary to prepare the conditions and supporting system so that the users can satisfy their electricity; for example, (i) establishment of supply chain not only of spare parts but also of electric appliances; and (ii) support of use of electricity for income generation including for production.

(2) Gender

The community survey revealed that the extent of woman's participation in social matters is different by region but it is not sufficient in any region. In the electrified communities, almost all women had nothing to do with (i) decision of household electrification, (ii) reception of training in facility operation/maintenance, and (iii) facility operation/maintenance of PV system.



Note: Result of the survey in the electrified communities

Person who got training (left) and person who changes distilled water of batteries of PV system (right)

By enhancing the participation and responsibility of both genders, the positive effect of electrification increases. The master plan proposes that the implementer shall understand, inform, involve and prepare the scheme to give responsibility of electrification to both genders from the first step of basic information collection at the community in concern: (i) interviewing to both women and men; (ii) calling both women and men to the public hearing; (iii) training to both women and men; and (iv) facilitating to the micro-enterprises to select female and male members.

(3) Environment

The scale of power generation determines if a project is required to conduct EIA studies according to the Ley 25844 *Ley de Concesiones Eléctricas* (Executive order in Electrical Concession Law).

When the study involves hydropower with capacity less than 20 MW, it is not required to prepare an EIA study. However, General Department of Environmental Energy Issues (*Dirección General de Asuntos Ambientales Energéticos* - DGAAE), in charge of EIA in MEM, can require to the implementer the presentation of means of environmental management even if the capacity is less than 20 MW if environmental impact may be supposed to occur. General Department of Electrification (*Dirección General de Electricidad* - DGE) gives authorization of the project implementation after examination of all required documents including environmental issues. When the study involves hydropower with capacity lower than 500 kW, which will be the main target of the Master Plan, DGE only requests a summary about the project, but it does not give any authorization. On the other hand, there are no environmental regulations in Peru concerning PV system for electrification.

Apart from the scale of power generation, the following issues require the authorization of the government institutions. They are the cases that: (i) the project will be implemented inside the nature

protected areas or *áreas naturales protegidas* (ANP) and buffer zones (approbation of INRENA is indispensable); (ii) the project will be implemented in the archaeological sites (approbation of INC); and, (iii) treatment of the solid waste, especially used batteries used for the PV system (OSINERGMIN supervises this issue and Ministry of Health supervises treatment companies). The master plan proposes the establishment of a system of collection, treatment, recycling and re-use of the used batteries.

While Peruvian law prescribe that the implementer does only submit the summary of the project to DGE for the electrification projects less than 500 kW, "Guideline for Environmental and Social Considerations" of JICA requires evaluation of possible impact. In the evaluation elements of this guideline, several environmental elements were evaluated as the category "not strong impact is expected but impact sometimes occurs", if the projects are implemented as proposed in the Master Plan. They are: "the poor, indigenous and the ethnic minorities", "inequitable distribution of both adverse impacts and benefits", "conflict of interest among the stakeholders" and "gender" for social aspects and "solid wastes" and "water use" for technical and physical aspects.

The Master Plan proposes that the implementer should take measures to reduce or mitigate those impacts by understanding of social and economic condition and consensus building among stakeholders for social aspects and selection of construction methods, appropriate supervision and monitoring of construction and operation stages for technical and physical aspects.

6. Prefeasibility Study (Pre-F/S)

In preparing a long-term rural electrification plan by renewable energies, JICA Study Team conducted prefeasibility studies on the following 4 sites to establish standard design and costs as well as management model.

i) Solar power (San Juan, Puno region)
ii) Solar power (Tarapoto, Loreto region)
iii) Mini/micro hydropower (Yerba Buena, Cajamarca region)
iv) Mini/micro hydropower (Balsapuerto, Loreto region)

The table below shows the outline of the study results. The results of each prefeasibility study are summarized in the summary sheet on the following pages.

		Target households	Installed capacity	Construction cost (US$)	EIRR (%)	Power tariff (Soles)
Solar power	San Juan	100	50Wp/household	120,889	12.3	9.53
Solar power	Tarapoto	45	50Wp/household	43,825	6.3	9.89
Hydropower	Yerba Buena	465	80kW	920,120	10.2	6.47
Hydropower	Balsapuerto	357	50kW	806,267	11.2	6.63

* Initial investments come from subsidy
* Construction cost for San Juan includes the costs of electrification of BCS, school and health clinic.

Pre-F/S Summary Sheet 1 | **Solar Power Project at San Juan, Puno Region**

1. Project area

Village	Location	Elevation	Average temperature	Annual precipitation
San Juan	170km to North of Puno city	4,000m	10℃	594mm

2. Situation of the area

Major industries:stockraising of llama, sheep, cow, milk sales, cultivation of potato, cañahua, quinua

Households	Income	Energy expenses	Willingness to pay	Desired use of electricity
150 hh	77.1 soles	17 soles	12 soles	Light, radio, TV

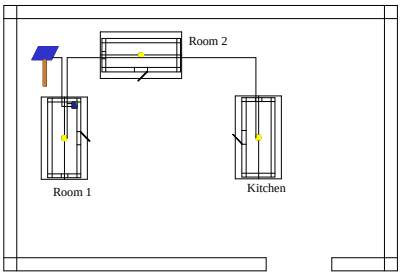
3. Electrification plan

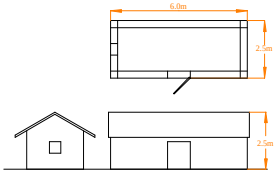
(1) Target: 100 households (SHS for 50 households, BCS for 20 households, Electricity services by school and health clinic for 30 households)

(2) Outline of electrification facilities

i) SHS

Power demand (day)		Voltage	Output of PV module	Battery	Controller	Converter
Fluorescent LED (night light) Radio	12W×3: 3 hours (1 for 2 hours) 2W×1: 8 hours 4 hours	12V	50Wp	100Ah	10A	DC/DC Input 12V





ii) BCS

Target	PV module	Controller
20 households	130Wp×2	20A

iii) School and health clinic

	Power demand	Output of PV module	Battery	Controller	Inverter
School	Fluorescent 12W×12 TV 60W×3 Computer 300W×3 DVD 40W×1 Printer 300W×1	1.5kWp (130Wp 3×4)	800Ah 2V×24	DC 48V 40A	2,500W
Health clinic	Fluorescent 12W×8 Vaccine fridge Computer 300W×1 600W×1(DC12V) Printer 300W×1 Telecommunications TV 60W×1 30W(DC12V) DVD 40W×1	1.0kWp (130Wp 3×3)	600Ah 2V×24	DC 48V 40A	1,000W

4. Construction cost, economic evaluation, managing organization (the subsidy below for OM with all initial investment subsidized)

Const. cost	Economic eva.	Tariff (monthly/hh)	Subsidy (monthly/hh)	Managing org.
US$120,889	EIRR 12.3%	9.53 soles	2.03 soles	Micro-entreprise

Pre-F/S Summary Sheet 2	**Solar Power Project at Tarapoto, Loreto Region**

1. Project area

Village	Location	Elevation	Average temperature	Annual precipitation
Tarapoto	2 hours by boat from Iquitos	100m	27.5℃	2,400mm

2. Situation of the area

Major industries: cultivation of banana, cassava, maize, timber, fishery

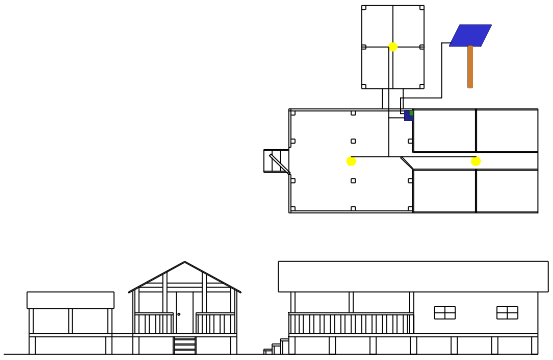
Households	Income	Energy expenses	Willingness to pay	Desired use of electricity
83	52 soles	20 soles	17.5 soles	Radio, TV, light

3. Electrification plan

(1) Target: 45 households (SHS)

(2) Outline of electrification facilities (SHS)

Power demand (day)		Output of PV module	Battery	Controller	Converter
Fluorescent LED (night light) Radio	12W×2: 3 hours (1 for 2 hours) 2W×1: 8 hours 4 hours	50Wp	100Ah	10A	DC/DC Input 12V



4. Construction cost, economic evaluation, managing organization (the subsidy below for OM with all initial investment subsidized)

Const. cost	Economic eva.	Tariff (monthly/hh)	Subsidy (monthly/hh)	Managing org.
US$43,825	EIRR 6.3%	9.89 soles	0	Micro-enterprise

Pre-F/S Summary Sheet 3 **Mini Hydropower Project at Yerba Buena, Cajamarca Region**

1. Project area

Village	Location	Elevation	Average temperature	Annual precipitation
Yerba Buena	30km to North-East of Cajamarca	3,500m	13℃	980mm

2. Situation of the area

Major industries: cultivation of maize, potato, dairy and milk sales

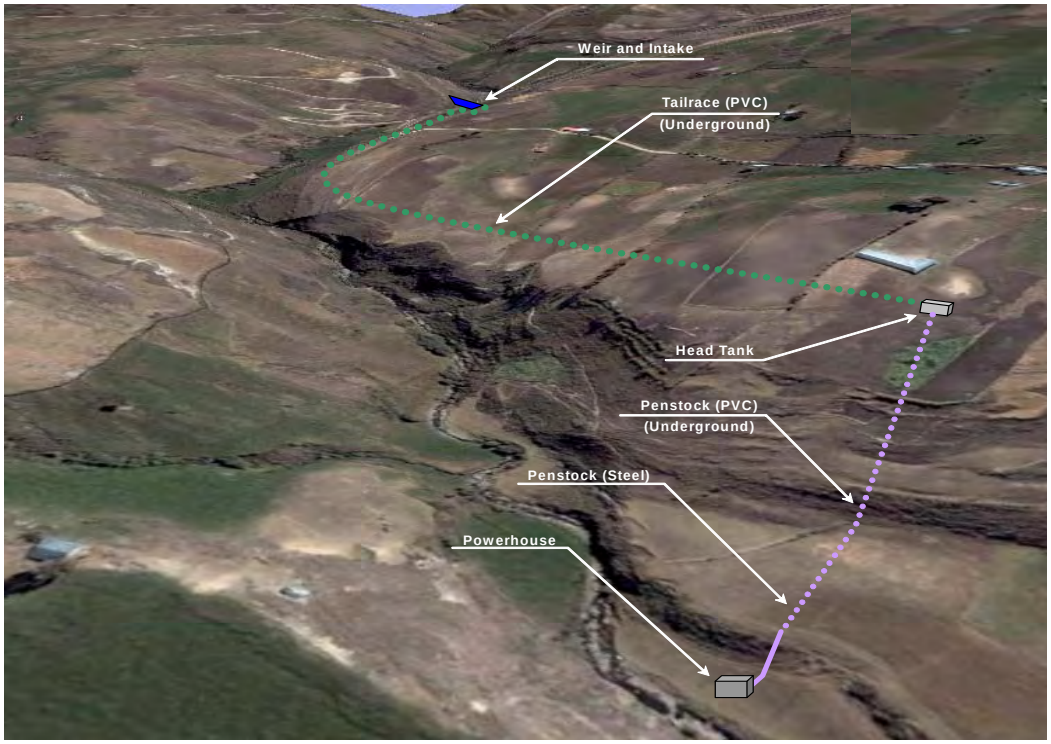
Households	Income	Energy expenses	Willingness to pay	Desired use of electricity
12 villages 582 hh	204 soles	15 soles	5 soles	Light, radio, TV

3. Electrification plan

(1) Target: 465 households (connection ratio: 0.8)

(2) Outline of electrification facilities

Power demand (month)	Installed capacity	Headrace	Transmission line
Household: 15kWh Commerce: 10% of household demand Small industries: 10% of household demand Street lighting: 5% of household demand Other public facilities: 10% of household demand Extra: 15% of household demand Distribution loss: 10% of total demand	80kW (Plant factor: 25%)	1.3km	23.75km



4. Construction cost, economic evaluation, managing organization (the subsidy below for OM with all initial investment subsidized)

Const. cost	Economic eva.	Tariff (monthly/hh)	Subsidy (monthly/hh)	Managing org.
US$920,120	EIRR 10.2%	6.47 soles	0	Micro-enterprise

Pre-F/S Summary Sheet 4 | **Mini Hydropower Project at Balsapuerto, Loreto Region**

1. Project area

Village	Location	Elevation	Average temperature	Annual precipitation
Balsapuerto	50km to East of Yurimaguas 2days by boat (15 min. by plane)	300m	13℃	980mm

2. Situation of the area

Major industries: cultivation of banana, rice, maize

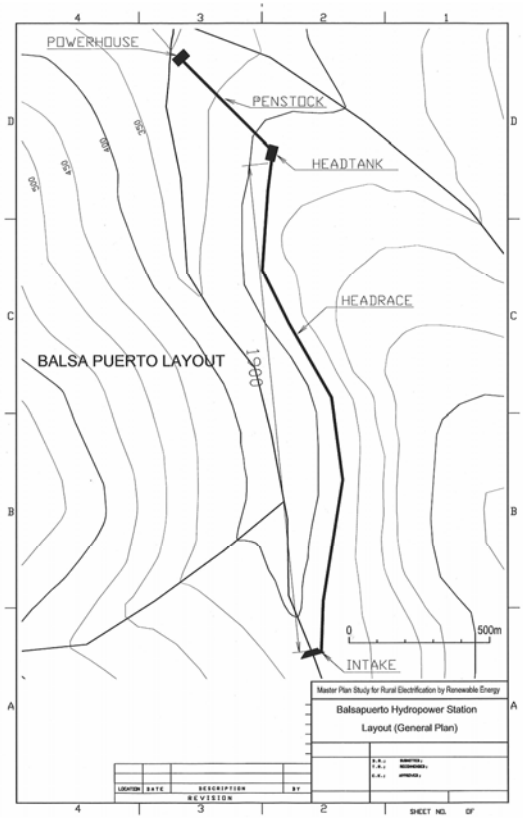
Households	Income	Energy expenses	Willingness to pay	Desired use of electricity
14 villages, 534 hh	478.5 soles	8 soles	5 soles	TV, radio

3. Electrification plan

(1) Target: Stage I: 357 households of 427 households (connection ratio:0.8)

(2) Outline of electrification facilities

Power demand (month)		Installed capacity	Headrace	Transmission line	Access road
Household:	15kWh	50kW (Stage I) (Plant factor: 25%) (Civil works include those for 30kW expansion of Stage II)	1.9km	25.72km	14.3km
Commerce:	10% of household demand				
Small industries:	10% of household demand				
Street lighting:	5% of household demand				
Other public facilities:	10% of household demand				
Extra:	15% of household demand				
Distribution loss:	10% of total demand				



4. Construction cost, economic evaluation, managing organization (the subsidy below for OM with all initial investment subsidized)

Const. cost (stage I)	Economic eva.	Tariff (monthly/hh)	Subsidy (monthly/hh)	Managing org.
US$806,267	EIRR 11.2%	6.63 soles	0.14 soles	Micro-enterprise