~ Project ~

Tech4CDM

Rural Electrification

In PERU

Project financed by

SIXTH FRAMEWORK PROGRAMME

The TECH4CDM project, developed over 2008 and 2009, and financed by the European Union under the Sixth Framework Programme of R&D, has as its primary goal, the promotion of renewable and efficient energy technologies, paying special attention to overcoming technological barriers, as well as the analysis of the Clean Development Mechanisms (CDM) of the Kyoto Protocol that may assist in projects based on wind energy, cogeneration, solar thermal and rural electrification through renewable energies.

Both European and Latin American institutions participate in the project, which is coordinated by the Spanish Institute for Energy Diversification and Saving (IDAE). The technological partners participating in the project include: the European Photovoltaic Industry Association (EPIA), the Spanish Wind Energy Association (AEE) and the Solar Thermal Industry Association (ASIT). In the case of cogeneration, the participation of COGEN Spain is essential, as well as that of the Spanish Office for Climate Change (OECC) for the part related to the CDM.

The 5 countries where the project activities are being carried out are Argentina, Chile, Ecuador, Mexico and Peru, and in each of these, local partners contribute, assuring the maximum use of these collaborating forces. Participating entities include: the Secretariat of Energy and the Industrial Union of Argentina, the National Energy Commission (CNE) of Chile, the Ministry of Electricity and Renewable Energy (MEER) of Ecuador, the National Commission for the Efficient Use of Energy (CONUEE) of Mexico and the Centre for Energy Conservation and Environment (CENERGIA) of Peru.

Project activities include the completion of a series of studies of the technologies situation in each country. This document summarizes the main features.

More information at www.tech4cdm.com

Contents

1. PERU

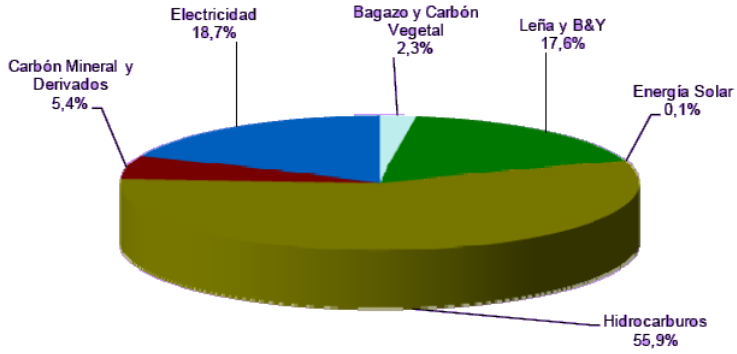
Most relevant information of Peru is shown on the next table:

PERU	2000	2005	2007	2008
General Data				
Population, total (millions)	26,00	27,84	28,51	28,84
Population growth (annual %)	1,5	1,3	1,2	1,1
Surface area (sq. km) (thousands)	1.285,2	1.285,2	1.285,2	1.285,2
Energy and Environment				
Energy use (kg of oil equivalent per capita)	482	498	..	..
CO2 emissions (metric tons per capita)	1,1	1,3	..	..
Electric power consumption (kWh per capita)	678	831	..	..
Economy				
GDP (current US$) (billions)	53,29	79,39	107,29	127,43
Agriculture, value added (% of GDP)	8	7	7	7
Industry, value added (% of GDP)	30	34	37	38
Services, etc., value added (% of GDP)	62	58	56	55
GDP growth (annual %)	3,0	6,8	8,9	9,8
Inflation, GDP deflator (annual %)	3,7	3,0	2,0	1,1
Exports of goods and services (% of GDP)	16	25	29	29
Imports of goods and services (% of GDP)	18	19	22	27
Foreign direct investment, net inflows (BoP, current US$) (millions)	810	2.579	5.343	..

Peruvian information (Source: World Bank).

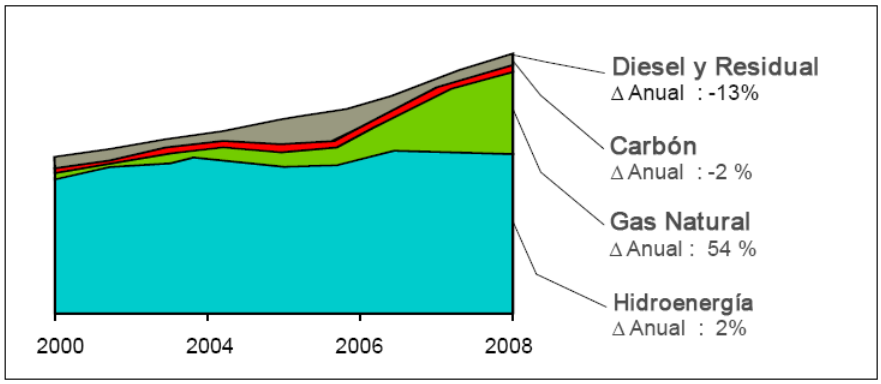
2. PERUVIAN ENERGY CONTEXT

The final energy consumption in Peru in 2007 was 518,982 TJ, surpassing a consumption of 20,861 TJ for 2006. With 56.9% of the total, Hydrocarbons are the most used energy source, followed by electric power, with a very important hydro energy component:



Final energy consumption, year 2007 (Source: MEM).

As to electric energy, the installed capacity in 2007 reached 7,059 MW, with an energy production of 29,857 GWh. As a matter of fact, hydraulic energy is the most contributing source to electric generation in Peru, although the use of natural gas in electric energy generation has significantly increased during the past five years, as shown in the following chart:



Evolution of energy sources used for electricity generation (Source: MEM).

Furthermore, annual electricity demand, with an annual average of8%, is due among other aspects to the strong development of mining and manufacturing activities at a prior stage of the international crisis. Even if the country's macroeconomic

conditions maintain this growth level and in the last five-year period investments on electricity have grown at an annual rate of 27%, it is still necessary the execution of new projects to ensure electric power supply.

Relevant agents of Peruvian energy sector

Ministry of Energy and Mines (MEM):

An integral part of Executive Power, the Ministry of Energy and Mines is the central body governing the energy and mines sectors. Its purpose is to formulate and evaluate policies of national scope regarding sustainable development and environmental matters of mining-energy activities, in tune with the general policy and the government plans.

The Supervisory Organism of Investment in Energy and Mines (OSINERGMIN):

OSINERGMIN is a public body whose mission is to regulate, within a national scope, the compliance with legal and technical regulations related to activities in the electricity, hydrocarbon and mining subsectors, as well as the compliance with legal and technical regulations related to environment conservation and protection in the performance of the said activities.

The National Institute for the Defence of Competition and Intellectual Property (INDECOPI)

INDECOPI is a specialized public body whose functions are the market promotion and protection of consumer rights.

Peruvian Committee for Economic Operation of the System (COES):

COES is a non-profit private body with Public Legal capacity, conformed by all the National Interconnected Electric System Agents (SEIN), generators, transmitters, distributors and free users, and whose decisions are mandatory for Agents. Its purpose is to coordinate SEIN short-, mid- and long-term exploitation at the minimum cost, assuring the system's security and the best exploitation of energy resources, as well as planning the development of SEIN transmission and Short-Term Market management.

General Directorate of Rural Electrification (DGER):

To increase the national electrical borders through the execution of electrification plans and projects in rural areas and isolated sites; to coordinate with regional and local governments and public and private agencies involved in the electrification process; and to serve as a dynamic element in overall rural development.

Centre for Energy Conservation and the Environment (CENERGÍA):

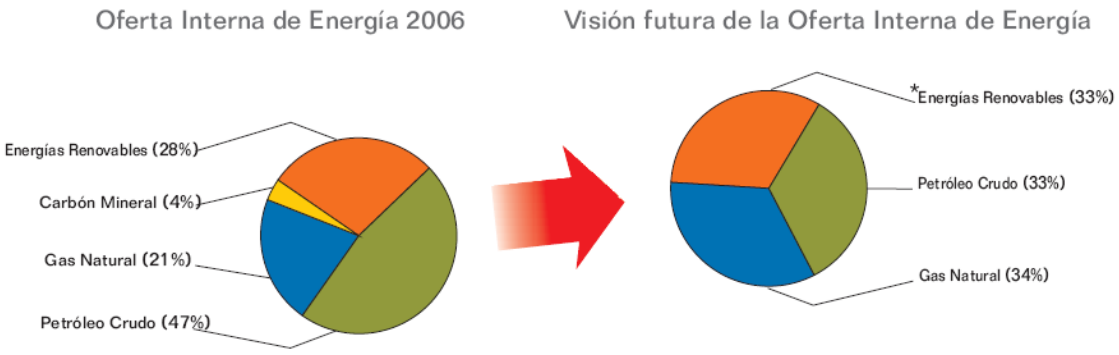
This is a non-profit body that promotes energy efficiency for all the economic activities in Peru. It does research on behalf of energy sector regulatory institutions, and implements projects aimed at establishing good practices for energy use in firms by carrying out studies on prevention and mitigation measures of negative impacts on the country environment as a result of productive activities and services. CENERGIA is pioneer in developing productive activities and services in the country.

Peruvian energy policy

The energy policy in Peru is developed according to the following main guidelines:

- To diversify the energy mix to ensure a reliable and timely supply for energy demand, in order to guarantee the country's sustainable growth.
- To promote private investment in the energy sector with clear and stable rules.
- To promote and implement energization jobs in rural and isolated zones in the country to enlarge the demand coverage and improve people's standard of living.
- To promote an efficient use of energy.
- To promote regional energy integration.

The purpose of the Peruvian government is to shift from an energy mix based essentially on hydrocarbons and achieve the ensuing energy distribution, where renewable energy, oil and natural gas are present in equal shares:



A future approach to the energy mix (Source: MEM).

The approval of both laws on the promotion of electric energy generation from renewable energy sources, and another regarding the efficient energy use accounts for the effort the Peruvian government is making in the renewable energy and energy efficiency sectors.

Regulatory and legal framework

Peru is a country with specific laws regarding renewable energy and energy efficiency:

- Legislative Decree No. 1002, dated May 2008, "Law for the Promotion of Electricity Generation with Renewable Energies".
- Law No. 27345, dated September 2000, "Law for the Promotion of an Efficient Energy Use".

Respectively, the development of new electric generation through the use of Renewable Energy Resources (RER) and the promotion of an efficient use of energy are declared of national interest and public necessity.

1. Renewable Energies

In order to promote the use of RER, the "Law for Investment Promotion on Electricity Generation and Renewable Energies" (Law 1.002) was enacted in May of 2008, along with its corresponding Regulations through Presidential Decree No. 050-2008-EM dated October 2008.

The main investment incentives set forth by the Law and its Regulations are:

- Objective national consumption percentage of electric power, fixed every 5 years, to be supplied with RER-based electric generation, excluding hydroelectric plants. For the first five-year period the said percentage amounts to 5%.
- Through energy auctions to be supplied with RER, the awarded investor is guaranteed a steady price (offered in auction) for energy poured into the grid during the supply contract term for up to 20 years. For the first auction the total installed capacity quota amounts to 500 MW.
- Priority to load dispatch and access to transmission and distribution networks.

These incentives are applicable to such renewable resources as biomass, wind, solar, geothermal, tidal or hydroelectric up to 20 MW.

There are also tax incentives, such as accelerated depreciation benefits of up to 20% annual, for investments in hydroelectric projects and other renewable resources, as established by Legislative Decree No. 1058 (June, 2008). The "Regulation for Anticipated Recovery of the Tax on General Sales (IGV)" is also offering tax incentives for these resources.

Regarding rural electrification, it is the MEM, through the General Directorate of Rural Electrification (DGER-MEM), the one with competence pursuant to the Law N°28749, "Law on Rural General Electrification".

Finally, to point out that Peru has a law for promoting geothermal energy (Law No. 26848 and its corresponding Regulations).

2. Energy Efficiency

Energy efficiency is deemed to be a permanent and long-term activity, for which a series of action lines have been set forth as part of the national strategic plan. Through Law No. 27345 regarding the "Promotion of Efficient Energy Use" and its corresponding Regulations, subsequently approved in year 2007, it is envisaged to

develop a national culture for an efficient energy use in coordination with all the country's educational and economic sectors.

The most outstanding aspects of the law and its corresponding regulations are:

- A culture of efficient energy use (UEE), developing educational actions at all levels.
- UEE sector programs: residential, production and services, public and transportation, among others.
- UEE dissemination, replicating successful actions and experiences all over the country. And likewise promoting cogeneration and distributed generation.
- Development of capacities and opportunities, certification of consultants and energy services utilities.

Other regulations have been approved after the enactment of Law N° 27345, supporting development of efficient energy use, i.e., Decree on "Energy Saving Measures for the Public Sector": This decree compels to the replacement of less efficient bulbs with more efficient ones. Such is the case of incandescent lights, being replaced by compact fluorescent bulbs. This affects also electromagnetic ballasts, to be replaced with electronic ones. Moreover, the public sector shall purchase lighting equipment showing an energy efficiency eco-label in accordance with the guidebook on energy efficiency.

In addition to the various legislative texts, other actions are being developed within the field of efficient energy use promotion. Next are the most representative ones:

2009 – 2018 Referential plan for efficient energy use

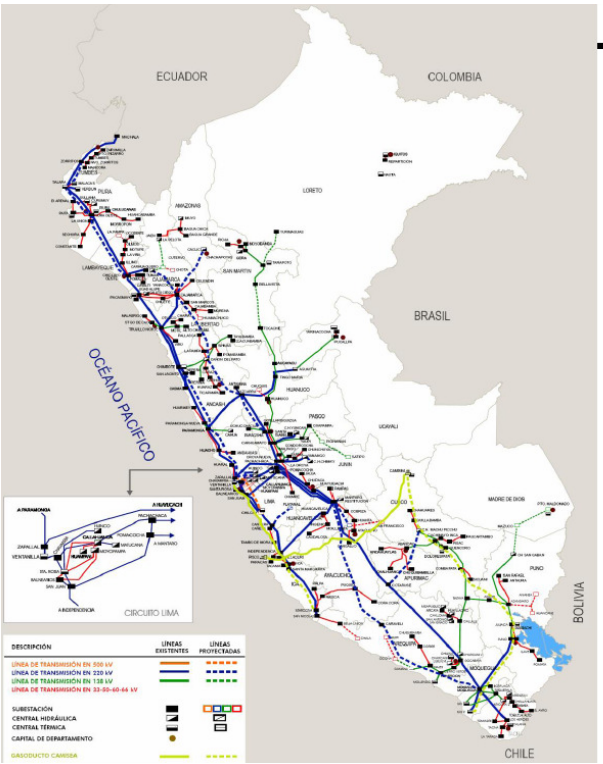
The plan promotes the implementation of energy efficiency actions in all consumption sectors through good practices and an efficient use of technology.

Minimum energy efficiency standards guidebook and energy efficiency eco-label guidebook

In coordination with INDECOPI and the relevant institutions, the MEM proposes the "Minimum energy efficiency standards guidebook" and the "Energy efficiency eco-label guidebook", so as to provide relevant, comparable and reliable information regarding energy efficiency of household energy consuming equipment. These guides will allow better end user orientation for choosing more efficient equipments, thus motivating manufacturers to adopt energy efficiency improvement methods.

The Peruvian electrical system

The National Electrical System covers 80% of the national surface area, with an installed capacity of 7,059 MW. The National Electric Power Interconnected System (SEIN) has an installed capacity of 5,983 MW and a production of 27,709 GWh, with a maximum confirmed demand of 3,966 MW in the year 2007. The national electrical system and main data for 2007 are stated in the following chart:



Sistema Eléctrico Nacional 2007

En el ámbito nacional

Cobertura Eléctrica	:	80,0	%
Consumo per cápita	:	943	kW.h/hab
Potencia Instalada	:	7 059	MW
Producción	:	29 857	GW.h
Ventas	:	24 621	GW.h
N° de Usuarios	:	4,4	Mio
Facturación (C.Final)	:	1 825	Mio US$

En el SEIN

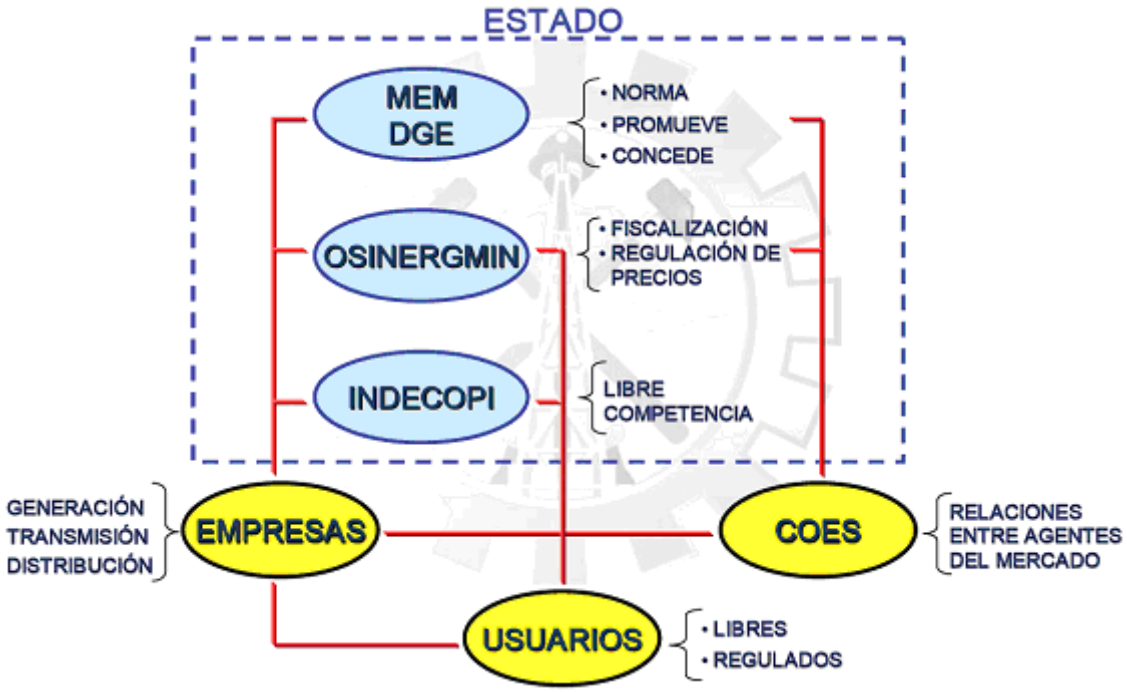
Potencia Instalada	:	5 983	MW
Producción	:	27 709	GW.h

Líneas de Transmisión

220kV	:	5 677	km
138kV	:	3 636	km

National Electrical Grid, 2007 (Source: CENERGIA).

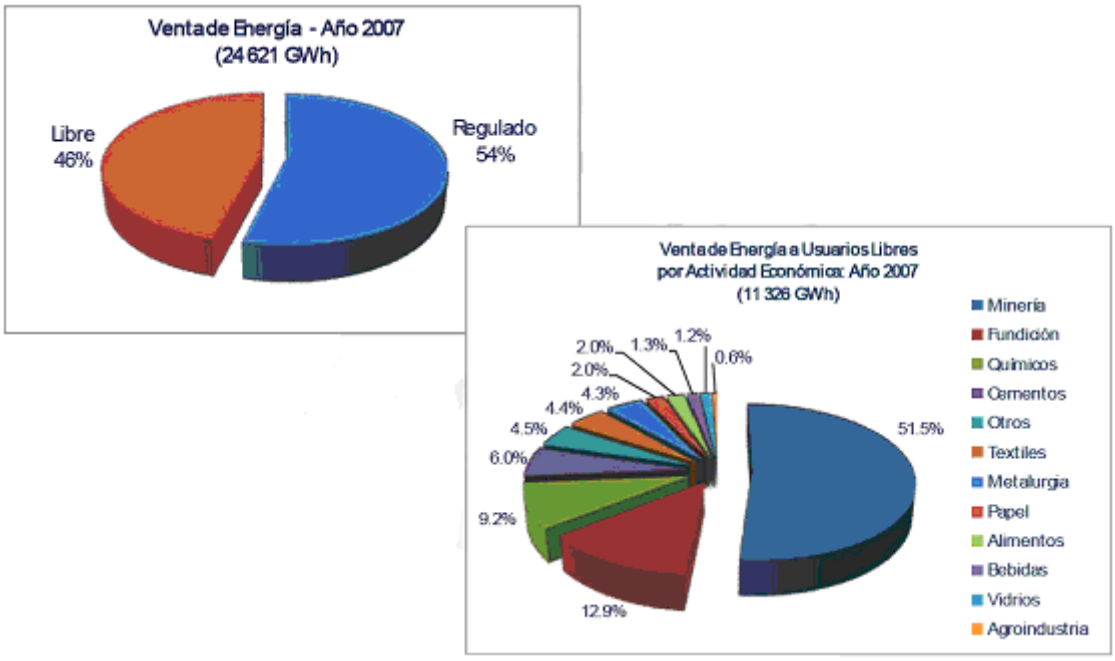
The organisation of the State engages government bodies such as MEM, OSINERGMIN and INDECOPI that interact with electric firms, either private or public, system operator and users, as shown in the following figure:



Electrical system organization (Source: CENERGIA).

Regarding the SEIN's effective capacity, the projected offer as to year 2008 is 5,207 MW, which would represent a capacity reserve of 844 MW.

The electric market consists of free (46%) and regulated (54%) users, as shown in the following chart.



Electric Market, 2007 (Source: CENERGIA).

3. ANALYSIS OF THE RURAL ELECTRIFICATION SECTOR

The renewable technologies that permit electrical supply through isolated or autonomous systems (without connection to a public electrical network) or mini-networks, are some of the most attractive options for increasing the rate of electrification in rural areas, where due to distance and low populations, network extension is typically not a viable economic option.

Decentralized rural electrification (without connection to a public network), is based on the installation of autonomous systems– through photovoltaic (PV), wind, mini-hydraulic and biomass energies – within the rural homes, or by creating mini-electrical networks to be fed by renewable energies (RE) or in combination with the conventional energy sources (liquid gas or diesel).

The renewable technology based on isolated systems or mini-networks is variable in terms of the scale and services offered, but some of the more important shared characteristics include:

- "On-site" energy generation.
- Flexibility to adapt to the diverse geographical areas.
- Optimized use of natural resources.
- Easy installation and maintenance.
- Minimum installation and maintenance costs: free fuel.
- Respectful of the environment (greenhouse effect reducers).

Many technologies based on renewable energies are used in rural communities for various application purposes (domestic use, public wiring, signalling, telecommunications, medicine refrigeration, irrigation and purification, drying, food preservation, crop processing, etc).

A wide variety of services and products for isolated applications currently exist in the European market.

These technologies have been designed to satisfy energy needs in rural areas, through responsible component selection (generally standardized) and having minimal maintenance needs and maximum performance output.

Within the range of products and services available to the consumer are photovoltaic components, small wind turbines, towers, hydroelectric turbines, inverters, power controllers, isolated photovoltaic systems, software, solar and wind powered water pumps, water storage tanks, batteries support structures, etc.

There are also commercial packs or kits with included installation and maintenance. These options include, for example, packs for public wiring packs or for ice making for conservation of perishables, isolated photovoltaic systems- normally designed for standard use, such as lighting, refrigeration and water pumping- and professional kits- designed mainly for repetitious operations such as television, monitoring, vigilance systems, lighting and signalling.

Finally, there are also made to order commercialized systems, including, optionally, a storage system (batteries), as well as the necessary devices configured for the specific applications. These systems, generally based on wind and photovoltaic energy, are mainly used for the supply and storage of water (including water pumps, cleaning, disinfection, purification, distribution and storage), the supply of energy in schools, hospitals, stores, telecommunications, internet and small businesses. For example, a package adapted to a health clinic would include conventional lighting, high intensity light bulbs, an autoclave (for sterilizing surgical instruments), a vaccine refrigerator, a water pump and a short wave radio.

Regarding rules and regulations, the majority of the technologies described in the previous sections comply with a series of international acceptance standards developed by major European regulatory bodies such as the European Committee for Electrotechnical Standardization (CENELEC) or the International Electrotechnical Commission (CEI).

Recently the CEI published a series of technical specifications designed to assist in the creation of rural electrification projects in isolated areas where normally there is no access to public electricity networks.

These specifications serve as guidelines and their goal is to improve quality, safety and sustainability of the electrification systems in developing countries without being specific to these countries.

As they are still in the developmental phase, they have been published as a series of technical specifications and not as international Regulations or Standards.

Published under the title "*recommendations for small renewable energy and hybrid systems for rural electrification*", the specifications cover the following sections:

- CEI 62257-1:2003 Part 1: General introduction to rural electrification
- CEI 62257-2:2004 Part 2: From requirements to a range of electrification systems
- CEI 62257-3:2004 Part 3: Project development and management
- CEI 62257-4:2005 Part 4: System selection and design
- CEI 62257-5:2005 Part 5: Protection against electrical hazards
- CEI 62257-6:2005 Part 6: Acceptance, operation, maintenance and replacement.

Rural electrification in Peru

- **Current status:**

At the end of 1993, the coefficient of national electrification in Peru was some 57%, showing annual sustained growth which by the end of 2005 had reached a value of 78.1% and by 2006 reached 78.7%. Some 22% of the national population still had no access to electrical service; thus, some 6 million Peruvians were living in undeveloped conditions. In hopes of reversing this situation, the state, through the Ministry of Energy and Mines put into play a program utilizing diverse technologies for rural electrification, based on the selection of energy sources, those same sources that were considered in the first term of network extensions by the National

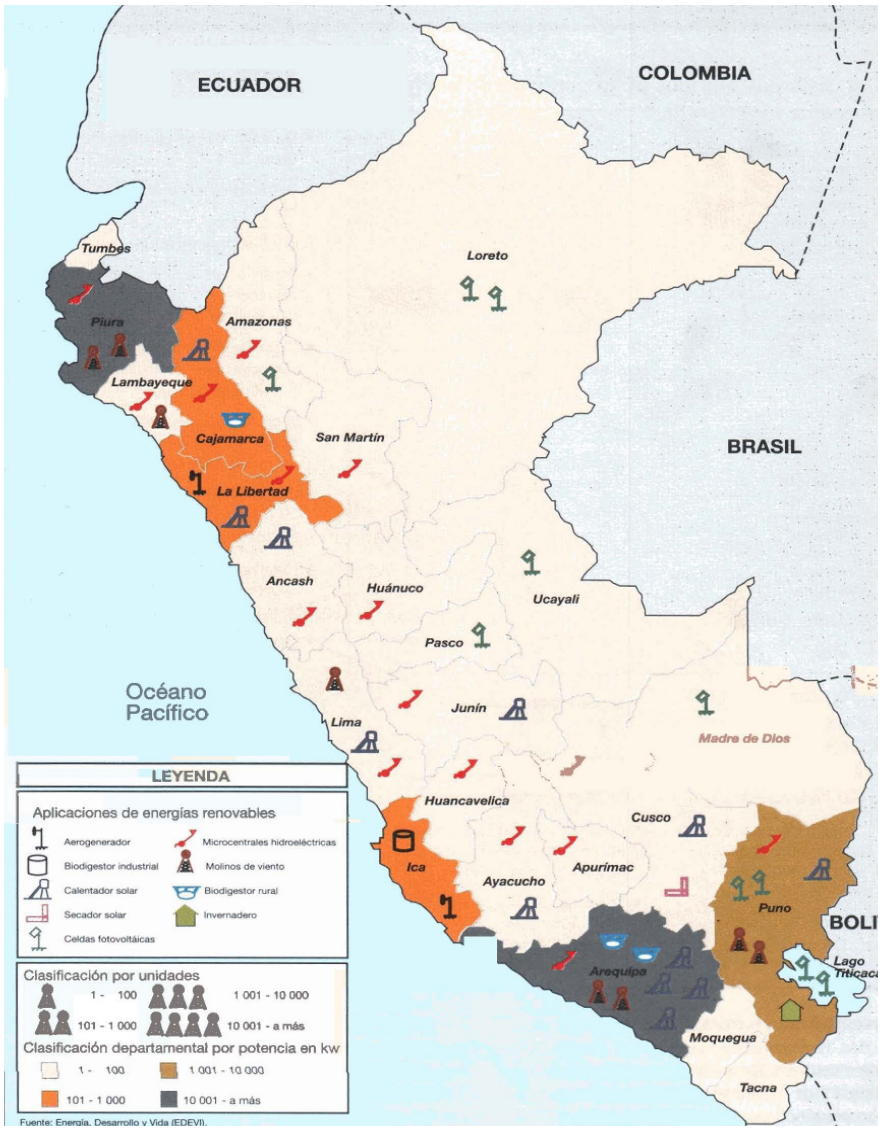
Interconnected Electric System (SEIN), and/or isolated systems from which the rural electric systems are developed.

The technical impossibility or inconvenience of connection to the large electric systems necessitates the use of hydraulic energy sources through the construction of small hydroelectric centres and their associated electric systems, mainly in the areas located from the Andes to the western and eastern slopes where there are hydroelectric resources and waterfalls; and to a lesser degree, the installation of small power plants (for temporary and/or emergency use).

A lack of water resources has made solar energy the third alternative technology used to solve the needs of rural electrification through the implementation of photovoltaic systems for domestic or communal use, preferably in geographical areas with high solar potential such as the forest regions.

Finally, wind energy is the fourth alternative whose application is relatively new and is being studied for rural electrification use, preferably in intermediate valleys and in coastal areas.

The rural electrification project distribution according to the used Technologies is shown in the next figure:



Rural electrification project distribution by energy source. (Source: Energía. Desarrollo y Vida)

As for the range of the installed power, for each technology they are as follows: the hydraulic micro centres are in the order of 20 and 200 kW. The domestic photovoltaic systems installed use photovoltaic panels of between 50 Wp and 85 Wp. The batteries used are typically of the non-solar type and are mainly located in the Peruvian forest region. The wind turbines are between 100 W and 5 kW and are generally scattered. The batteries used are of the automotive type.

Investment costs related to the micro hydraulic centres range from between 2500 and 3500 US dollars per kW installed. As for the wind turbines, on the smaller scale, the investment cost ranges from 3500 – 5000 US dollars per kW installed. And for the

photovoltaic systems, the investment cost is between 10 and 12 US dollars per W installed.

Operational and maintenance costs are estimated between 0.01 and 0.02 US dollars per kWh generated in the case of the micro hydraulic centres. In the case of the wind turbines, the operational and maintenance costs are estimated between 0.02 and 0.035 US dollars per kWh generated and for the photovoltaic systems, the operational and maintenance costs are minimal, estimated at less than 100 US dollars annually for those systems using solar batteries of minimum maintenance.

The National Plan of Rural Electrification (PNER) is a fundamental planning tool for management which should serve as a basis for the goals of the electrification policies of the country. Its main objectives are:

- To situate Peru within the top third of Latin America in terms of electrical coverage over the middle term.
- To promote the productive use of electricity.
- To elaborate coordinated plans with local and regional governments.
- To develop studies permitting the application of renewable energies.
- To achieve financing through public and private entities, as well as favourable credits.
- To optimize administrative management and institutional strengthening.

The PNER contains 1529 projects and programs identified by the national government (DEP/MEM, FONER, electric companies and other state entities), Regional and Local Governments. The execution of this set of projects considered in the PNER plan will benefit some 4.8 million inhabitants, with a total investment of 928.9 million US$. It will allow for contributions, complementary to the company investments from the generation, transmission and distribution sectors, so as to reach a coefficient of national electrification of some 93.1% by the year 2015. During the period between 2006 and 2009, some 710 million Nuevos Soles were invested, providing 1.33 million inhabitants with electrical energy service as a result of the PNER application.

The General Directorate of Rural Electrification (DGER) is also taking other actions in the rural electrification sector, such as the publication in its web site of the Geographical Information System (SIG) and the Information System on Rural Electrification (SIER). This will allow for an increased understanding of the investments made in the completed projects as well as the programming of Investments for projects put in place by PNER.

"Productive Uses of Electrical Energy in Electrified Rural Areas" is another project started by DGER and the National Rural Electrification Fund (FONER) with the goal of achieving an intensive use of electricity in productive activities of the electrified rural populations. In this way, productivity is increased and other business benefits are offered, improving the quality of life in the rural communities as economic improvement is generated.

The master Plan of Rural Electrification with Renewable Energy, also carried out by DGER is of special interest. This plan has the objective of rural electrification, through the use of renewable photovoltaic energy and mini/micro hydroelectric centres, in areas that are not covered over the next 10 years by the National Interconnected Electric System.

Other actions developed in the rural electrification field are:

- Plan of Economic Stimulus: execution of 42 works of rural electrification with a total investment of 262 millions Nuevos Soles, address to a beneficiary population of 277 thousand people.

- Rural electrification program include on the Program of Development of the Valley of the Rivers Apurimac and Ene: developed by the MEM, in the period from 2007 to 2009 the network of distribution was extended, covering to 540 localities.

- Massive Program I: installation of 20 thousand photovoltaic systems in an isolate area of 100 thousand habitants for the period 2009 and 2010. The budget reaches 49 million Soles.

• Regulatory Framework of the Sector

The regulatory framework for the rural electrification installations are defined by the following documents:

The General Law of Rural Electrification (Law N° 28.749 from 2006) and their regulations (2007): Declaring the national need and the public use of electrification in rural and isolated locations and the country borders. Similarly, it regulates the resources destined to the completion of rural electrification projects. This law establishes the priority of the use of renewable energy resources: solar, wind power, geothermic, hydraulic and biomass, in rural electrification.

Legislative Decree N° 1.001 regulates the investment in Rural Electric Systems located in Grant Areas and permits the MEM to execute rural electrification projects. At the same time, these actions must comply with Law N° 27.293 of the National System of Public Investment. Through this regulation, financing agreements have been undertaken with 5 concessionary companies for the execution of some 31 electrification projects.

Law of creation of the Social Electric Compensation Fund (Law N° 27.510 from 2001) and its modification (Law N° 28.307), establishes a reduction in rates for the urban-rural population in accordance with that established in the Law of Electrical Concessions (Law N° 25.844).

The rates for Rural Electrification are determined by OSINERGMIN. For the determination of these rates, the following regulations have been established:

- Resolution OSINERGMIN N° 670-2007-OS/CD sets the information content for the Rural Electric Systems (SER).

- Resolution OSINERGMIN N° 181-2009-OS/CD sets the rates for electrical distribution in the Normal Sector (SER).

In the calculations determining the rural electrification rates, aspects such as investment type, public or private, installation costs and distribution sector are considered.

• Barriers to rural electrification

Technological Barriers:

- **Technical Adequacy of Equipment:**

The equipment is typically designed for working conditions that are very different from the reality of these communities. Problems often arise with the operation and maintenance of equipment. The accumulator batteries are especially sensitive, often having a greatly reduced lifespan due mainly to inadequate use of environmental conditions. The technological goal is to offer electrical supply with useful and appropriate equipment for the location, with long-lasting and reliable installation that is economically viable.

- **Lack of qualified project developers, installers and maintainers:**

There is a scarcity of qualified project developers, installers and maintainers, having repercussions in the installation quality, with inadequate system configuration. This inadequate rural system configuration is determined by detailed studies and analysis of the area in question, including a charge analysis (domestic and productive), evaluation of the existing resources and the distance of the public electricity network or the ability of the consumers to make payments. Any subjective conjecture may be detrimental to the system development and may result in operational failure.

- **Lack of replacement pieces:**

The infrastructure and availability of replacement pieces in remote areas may be insufficient to guarantee uninterrupted energy service. Sometimes low quality components are used, with the understanding that the final user will not be aware of this, or have the freedom to choose otherwise, and often, they need to request a micro credit in order to pay for the system. Due to all of these reasons, a long life span is vital for the systems. Therefore, it is necessary to improve and implement the existing international rules and standards of the renewable energy industry.

Other Barriers:

- **Inadequate use or failure to apply the current international norms or standards:**

The quality of the components and systems should guarantee the long term functioning and safety of the same, and should respect the environment of the area being electrified. Therefore, the industrial standards for rural electrification must be improved and applied in an effective manner so as to prevent the use of poor quality equipment in rural markets.

- **Lack of awareness, understanding and information regarding renewable energy technology and its benefits:**

If legislators, providers, project managers or final users do not have access to the necessary information and a clear understanding of renewable energies, it is unlikely that they will select an appropriate electrical service supply.

On the other hand, social awareness regarding the use of renewable energies is often scarce in the target populations and there is a lack of user and manager capability in the installations.

- **Lack of physical infrastructures:**

Many of the populations are found in isolated sites and are difficult to access.

- **Socioeconomic aspects:**

The rural electrification projects have a very important cultural component, that is, the rural communities lacking electrical supply require a specific training for the use of these technologies: capability, handling and operation, maintenance and equipment management. For these communities used to having technologies based on fossil fuels, an added problem is the lack of trust when changing technology type. On the other hand, the link between lower electrification level and greater poverty index increases the difficulty of developing these projects, despite the fact that part of these projects is financed by PNER. These communities generally have few resources to cover the remainder of the investment.

4. RESULTS

Proposed Measures

- **Technical adequacy of equipment:**

The technological goal is to offer electrical supply with useful and appropriate equipment for the location, with long-lasting and reliable installation that is economically viable. A joint collaboration between the primary manufacturers of rural electrification equipment and the local sector representatives is necessary.

- **Lack of qualified project developers, installers and maintainers:**

The development of training programs oriented to the promotion of technological transfer between international engineering firms having experience in electrification projects and the local engineering agencies would be a useful measure.

- **Lack of replacement pieces:**

The improvement and implementation of the current international regulations or standards for the renewable energy industry is a measure to be taken in order to overcome this barrier.

- **Inadequate use or failure to apply the current international norms or standards:**

The quality of the components and systems should guarantee the long term functioning and the safety of the same, and should respect the environment in the area being electrified. Therefore, the industrial standards for rural electrification should be improved and applied in an effective manner so as to avoid the use of poor quality equipment in rural markets.

- **Lack of awareness, understanding and information regarding renewable energy technology and its benefits:**

To design informative programs regarding the functioning, maintenance and benefits of this technology especially directed towards the users and managers of the installations.

- **Lack of physical infrastructures:**

It is necessary to increase access to developing populations through the creation of roads.

- **Socioeconomic aspects:**

The projected installations must fit the reality of the rural community and they should look to productive uses of the energy for the community so as to reduce the economic barriers of these projects. If intensive use of the electricity is achieved in productive activities of the population, this will increase productivity and offer additional economic benefits, improving the quality of life in the rural communities upon generating increased economic revenue.

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