Republic of Peru

Ex-Post Evaluation of Japanese ODA Loan Project
"Electric Frontier Expansion Project Phases I & II"

External Evaluator : Global Group 21 Japan, Inc.
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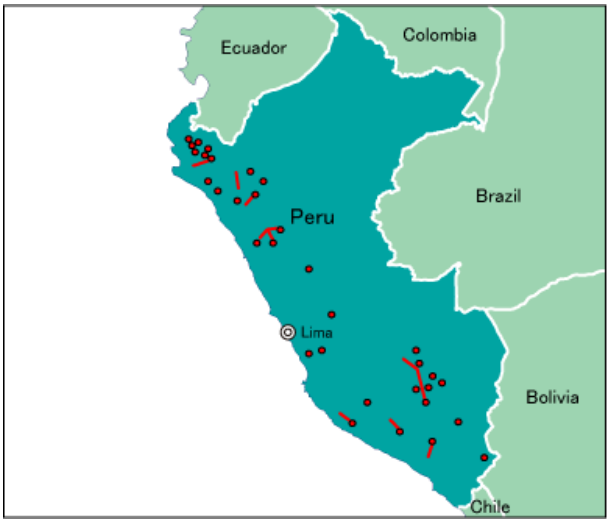
0. Summary

The Project was implemented as part of the National Plan for Rural Electrification, which has been eagerly promoted by the Government of Peru, for the purpose of increasing the electrification rate in rural areas. The necessity for this type of project is large, and the relevance of the Project is high as it conforms to Japan's ODA policies. The rural electrification sub-projects under the Electric Frontier Expansion Project (hereinafter referred as "the Project") were completed with the actual project cost ending up at some 60% of the original budget. As the project period was substantially extended due to the substitution of a power plant by transmission lines and the tight financial situation faced by the Government of Peru, the efficiency of the Project is rated as medium. In contrast, the effectiveness of the Project is rated as high as the planned number of new contract users of electricity of 80% has been met, illustrating the positive contribution to improvement of the rural electrification rate in Peru. Electrification of health posts and schools brought about social benefits. The benefits of electrification for rural inhabitants range from increased hours of active life due to lighting, including more efficient household chores as well as better learning by children. The use of electricity for commercial and production activities appears to be limited. The inability to deploy a sufficient number of personnel to maintain the distribution grid over a vast area because of the low level of electricity consumption and earnings forms the background for frequent and long power outages. In view of such reality, the sustainability of the Project is judged as medium. Based on the above evaluation results, the overall ex-post evaluation status of the Project is high.

1. Project Description



Location of the Project

Electric Pole and Transformer in a Rural Area (Cajamarca)

1.1 Background

Peru in the 1990's witnessed a breaking away from a period of economic confusion as the economic stabilisation policies and structural adjustment policies adopted by the Fujimori administration bore fruit. In 1993, a public investment plan was formulated and the government earnestly pursued the prioritisation of public investment in the rehabilitation and development of socioeconomic infrastructure.

In the power sector, one major challenge was posed by the slow electrification of rural areas. The national electrification rate and power consumption per capita were both low at 65% and 698 kWh respectively in 1995. This power consumption per capita was approximately half of the average for Latin America. The electrification rate in the Andes and Amazon areas of 20% is especially low even though these areas account for 45% of the national population, making the progressive electrification of these areas an urgent task. In response, the Government of Peru formulated the National Plan for Rural Electrification which envisaged annual investment of some US$ 200 million to conduct rural electrification to increase the national electrification rate to 75% by 2000.

Against this background, loan agreement for the Phase I yen loan which formed part of the said National Plan was concluded in November, 1997, followed by the Phase II yen loan in April, 1999. A further yen loan was agreed in March, 2009 for the Electric Frontier Expansion Project Phase (III) which succeeded the two previous phases.

1.2 Project Outline

The Project aimed at increasing the rural electrification rate through the expansion of transmission lines and rural electrical systems[1] as part of the National Plan for Rural Electrification promoted by the Government of Peru, thereby contributing to improvement of the living standard and vitalisation of the local economy in rural areas of Peru. Under the first and second phases of the Project, nine sections of transmission line were construction and 33 rural electrical systems were expanded in 14 regions nationwide.

Table 1 Summary of Loan Agreements

Approved Loan Amount/ Disbursed Loan Amount	Phase I: 10,140 million yen / 6,410 million yen Phase II: 13,157 million yen / 6,743 million yen
Exchange of Notes/ Loan Agreement	Phase I: September, 2007 / November, 1997 Phase II: April, 1999 / April, 1999
Terms and Conditions	Main Loans Phase I: Interest Rate: 2.7% Repayment Period: 25 years Grace Period: 7 years Procurement: General Untied Phase II: Interest Rate: 2.2% Repayment Period: 25 years Grace Period: 7 years Procurement: Compound Consultant Portion Phase I: Interest Rate: 2.3% Repayment Period: 25 years Grace Period: 7 years Procurement: General Untied Phase II: Interest Rate: 0.75% Repayment Period: 40 years Grace Period: 10 years Procurement: Compound
Borrower / Executing Agency	Government of the Republic of Peru/Ministry of Energy and Mines
Final Disbursement Date	Phase I: February, 2008

[1] In Peru, a rural electrical system (Sistema Eléctrico Rural) is also called a small electrical system (Pequeño Sistema Eléctrico). In general, this system is constructed and expanded in several stages. A more advanced stage means the electrification of a wider area. Under the Project, 33 systems were expanded.

	Phase II: January, 2007
Main Contractors (Over 1 billion yen)	Ice Ingenieros Consultores y Ejecutores S.A. (Peru)
Main Consultants (Over 100 million yen)	Phase I: Dessau International (Canada) Phase II: JV between Cesel S.A. (Peru) and Nihon Koei (Japan)
Feasibility Studies, etc.	None
Related Projects	Electric Frontier Expansion Project Phase (III)

2. Outline of the Evaluation Study

2.1 External Evaluator

Hajime Sonoda (Global Group 21 Japan)

2.2 Duration of Evaluation Study

The ex-post evaluation study for the Project was conducted over the following period.

Study Period : November, 2010 to September, 2011
Field Survey : 4th to 29th December, 2010
4th to 11th May, 2011

2.3 Constraints during the Evaluation Study

During the course of the study, vital information was collected through a series of interviews with the executing agency (Ministry of Energy and Mines; hereinafter referred as MEM) and other stakeholders, including operation and maintenance (O&M) bodies (local electric companies, etc.) and relevant documents were gathered. In addition, two rural electrification systems were selected from each of the Cajamarca Region and Cusco Region out of 33 such systems nationwide and the necessary information was collected through field visits[2], interviews and document gathering at O&M bodies (local electric companies) and interviews, workshops and a questionnaire survey targeting the beneficiaries. While the questionnaire was sent to eight O&M bodies, some of them failed to provide sufficient data.

3. Results of the Evaluation (Rating: B)

3.1 Relevance (Rating: ③)

3.1.1 Relevance with the Development Policies of Peru

As described in 1.1 Background, the Project was part of the National Plan for Rural Electrification based on the public sector investment policy of the Government of Peru. As such, the Project was highly compatible with Peru's official development policy.

At the time of the completion of the Project, the Garcia administration (2006 - 2011) was emphasising the promotion of rural electrification as one of its important social policies, aiming at increasing the national electrification rate to 90% by 2011[3]. The current National Plan for Rural Electrification has adopted a target of increasing the rural electrification rate to 88.4% by 2020.

[2] Cajamarca Region was selected because there exists one technical cooperation project by JICA related to rural electrification, while Cusco Region was selected due to the concentration of rural electrical systems under the Project.
[3] Políticas Gubernamentales 2006 – 2011 (Dr. Alan García Pérez, Presidente de la República)

The high relevance of the Project with the official development policy is very evident as it was implemented as part of the National Plan for Rural Electrification which has been ongoing since the time of the project appraisal up to the present.

3.1.2 Relevance with Development Needs of Peru

As described in 1.1 Background, both the electrification rate and power consumption per capita were low in Peru as of 1995 and promotion of the electrification of rural areas was a very pressing task.

By 2009, according to the MEM[4], the national electrification rate had increased to 78.5% while the rural electrification rate had also increased to 45.0%. This was followed by an increase of the power consumption per capita to 1,010 kWh in 2008. However, there are still many areas which require a substantial increase of the rural electrification rate as illustrated by the fact that the rural electrification rate is less than 20% in six of the 24 regions nationwide in 2007.

In view of these facts, the Project was highly relevant with the development needs of Peru.

3.1.3 Relevance with Japan's ODA Policy

The old ODA Charter of Japan adopted in 1992 stipulated that Japan would provide assistance for the development of infrastructure which is an important precondition for the socioeconomic development of any country. Based on this policy, Japan actively provided ODA for Peru in recognition of the positive reform efforts of the Fujimori administration in the 1990's to ensure sustainable economic growth and to eliminate poverty. In view of the diverse development needs of Peru, Japan decided to offer loans every year, in principle, from 1996 onwards with the qualitative as well as quantitative enhancement of cooperation in mind. In FY 1999, the development of economic infrastructure was identified as a priority field for Japan's ODA for Peru and active cooperation for the power sector, etc. was called for, partly to respond to the local need for such cooperation. Accordingly, the Project was compatible with Japan's ODA policies at the time of its appraisal.

Based on the above, this project has been highly relevant with the country's development policies, development needs, as well as Japan's ODA policy, therefore its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

According to the plan put forward at the time of appraisal, the Project (phase I and II) would consist of the following three components.

1) Construction of the El Valor Diesel Power Plant: Construction of a thermal power plant with an output of 10 MW in the Bagua-Jaen area which is currently isolated from the national transmission grid

2) Transmission lines : Construction of transmission lines totalling some 577 km in nine sections across the country

3) Rural electrical systems: Expansion of the rural electrical systems in 33 areas in 14 regions across the country

[4] National electrification rate is based on National Plan for Rural Electrification (2008 – 2017), power consumption per capita is based on Evolución de Indicadores del Mercado Eléctco 1995 – 2008 (MEM), rural electrification rate by regions is based on Annex No.1 of National Plan for Rural Electrification (2011 – 2020).

The procurement procedure for the El Valor Diesel Power Plant commenced as far back as 1999 but the original plan was cancelled as a result of the review, conducted by the Government of Peru in 2001 and 2002, of the power supply system in the northwestern part of Peru. One transmission line section which is connected to the national grid was then planned as the most economical alternative to the construction of a power plant to supply power and this transmission line was constructed under the Project. This modification is judged to be appropriate and relevant to the original project objectives.

In regard to the transmission line component, one transmission line (Piura Transmission Line) and part of the transmission line serving one particular rural electrical system were removed from the scope of the Project approved at the time of appraisal. This was because of the need to prevent the occurrence of power outages due to disasters caused by El Niño in 1997 and the necessary work was conducted using local funds without waiting for funds to be made available under the Project.

The expansion of rural electrical system was conducted in 33 areas as originally planned. The number of wattmeters actually procured was reduced from the planned 140,000 to 123,000 (achievement rate: 88% of the original plan). The reason for this was that some of the originally targeted villages were removed from the scope of the Project or replaced by other villages due to the implementation of the work to expand the rural electrical system in these villages using other funding sources during the planned project period. The work under the Project involved the initial procurement of wattmeters and the installation of a meter box at each targeted household while the cost of the actual installation of the meter was paid by each household user who also signed an electricity contract at its own responsibility.

Table 2 Comparison of Planned and Actual Project Outputs

Planned at the Time of Appraisal	Actual
< Phase I Project > • El Valor Diesel Power Plant • Transmission line: 177 km in 3 sections • Rural electrical systems: 21 areas serving some 65,000 new users (households) < Phase II Project > • Transmission line: 400 km in 6 sections • Rural electrical systems: 12 areas serving some 75,000 new users (households)	< Phase I Project > • El Valor Diesel Power Plant: removed from the scope of the Project • Transmission line: 271 km in 3 sections • Rural electrical system: 21 areas serving some 55,000 new users (households) < Phase II Project > • Transmission line: 424 km in 6 sections • Rural electrical systems: 12 areas serving some 68,000 new users (households)

Source: Reference materials prepared at the time of appraisal and those provided by the MEM

Substation and Transmission Line Constructed Under the Project (Cajamarca)

3.2.2 Project Inputs

3.2.2.1 Project Cost

The planned project cost at the time of appraisal was approximately ¥29.7 billion (Yen loan: ¥23.3 billion) and the actual cost ended up at approximately ¥16.9 billion (Yen loan: ¥13.1 billion) which was equivalent to only 57.0% of the original budget.

According to the project executing agency, the project cost was estimated on the basis of the international prices of the various materials and equipment to be procured. The actual project cost was much lower because (i) the timing of this estimation coincided with the hike of international prices and (ii) the necessary materials and equipment were procured through competitive tender. While the removal of one transmission line section (planned cost: ¥300 million) from the scope of the Project was also a factor for the lower project cost while the replacement of the El Valor Diesel Power Plant (planned cost: approximately ¥1.1 billion) by transmission lines (actual cost: approximately ¥1.7 billion) was a factor for the higher project cost.

Table 3 Planned and Actual Project Costs

	Planned at the Time of Appraisal			Actual		
	Foreign Currency Portion (million yen)	Local Currency Portion (thousand USD)	Total (million yen)	Foreign Currency Portion (million yen)	Local Currency Portion (thousand USD)	Total (million yen)
< Phase I >						
Power Plant	954	1,605	1,134	0	0	0
Transmission Lines	428	6,554	1,162	1,409	5,139	2,013
Rural Electrical Systems	1,959	29,898	5,308	3,639	1,994	3,873
General Administration	0	1,358	152	0	1,340	157
Land Acquisition	0	454	51	0	822	97
Customs Duties and Taxes	0	20,596	2,307	0	11,163	1,312
Consulting Service	664	1,067	784	529	919	637
Physical Contingency, etc.	516	6,260	1,216	0	0	0
Phase I Total	4,521	67,792	12,114	5,577	21,376	8,089
< Phase II >						
Transmission Lines	1,846	18,329	4,412	1,854	4,760	2,390
Rural Electrical Systems	2,597	33,625	7,305	2,627	11,545	3,927
General Administration	0	1,836	257	0	1,538	173
Land Acquisition	0	2,218	311	0	1,057	119
Customs Duties and Taxes	0	21,888	3,064	0	12,164	1,370
Consulting Service	73	6,777	1,022	758	862	855
Physical Contingency, etc.	444	5,195	1,172	0	0	0
Phase II Total	4,961	89,868	17,543	5,239	31,926	8,833
Grand Total for Phases I and II	9,482	166,660	29,657	10,816	53,302	16,922

Foreign Exchange Rates

At the time of appraisal : Phase I : US$1 = S/.2.25 = ¥112.0
Phase II : US$1 = S/.2.85 = ¥140.0
At the time of evaluation: Phase I : US$1 = S/.3.5 = ¥117.5
Phase II : US$1 = S/.3.3 = ¥112.6

Sources: Prepared by the evaluator using reference materials at the time of appraisal and those provided by the MEM

3.2.2.2 Project Period

The original plan was to implement the Project in 62 months from November, 1997 to December, 2002. In reality, the implementation of the Project took 124 months from November, 1997 to February, 2008. The overall project period was, therefore, 200% of the originally planned period, making postponement of the final disbursement date for both phases essential.

The main reason for this substantial delay was the change of the planned construction of a thermal power plant in Phase I to the construction of a transmission line. This change was decided in 2001,

forcing lengthy negotiations on land purchase with landowners as well as coordination with the existing plans of large electricity users (mining companies) to install power receiving facilities at their own expense. Moreover, the change of the government system to review public works necessitated an additional Environmental Impact Analysis and Feasibility Study, further delaying the construction of the transmission line. It was finally completed in 2008.

The construction period of other transmission lines and rural electrical systems was extended to three and to four years from the planned two years, primarily because of financial restrictions imposed by the Government of Peru on external borrowings. In the Phase II Project, an unsuccessful tender for the construction work delayed the start of the work. Consequently, the Phase I Project (excluding the additional transmission line described above) was completed in 2002 with a two year delay compared to the original plan. The Phase II Project was similarly delayed by four years compared to the original plan and was completed in 2006.

Based on the above, although the project cost was less than planed , the project period cost was substantially larger than planned, therefore efficiency of the project is fair.

3.3 Effectiveness (Rating: ③)

3.3.1 Quantitative Effects

3.3.1.1 Results from Operation and Effects Indicators

Here, effectiveness of the Project is evaluated using such operation and effects indicators as the number of users with a contract, improvement of the electrification rate, power consumption volume and frequency/duration of power outages. As the principal purpose of the Project was to improve the rural electrification rate, the number of users with a contract and improvement of the electrification rate were considered to be the most important indicators for the purpose of evaluating the effectiveness of the Project.

(1) Number of Users with a Contract

At the time of appraisal, the creation of some 140,000 new users with a contract was planned. The actual number of wattmeters procured was 124,000. As of the end of 2009, the number of new users with a contract was estimated to be approximately 114,000 which was 81% of the originally planned number (Table 4). 95% of users with contract are domestic users and other users include schools, churches, businesses, health posts and other public facilities. Some of the domestic users also use electricity for their own commercial activities, including retailing, restaurants and handicrafts, etc.

Table 4 Planned and Actual Number of Users with a Contract and Number of Wattmeters Procured

	Phase I	Phase II	Total
Number of Users with a Contract (Planned)	64,973	75,375	140,348
Number of Wattmeters Procured	55,343	68,163	123,506
Actual Number of Users with a Contract (2009 Estimate) (Ratio to Originally Planned Figure)	51,000 (78%)	63,000 (84%)	114,000 (81%)

Source: Prepared by the evaluator using following information;
Number of Users with a Contract (Planned) : Reference materials at the time of appraisal
Number of Wattmeters Procured : MEM
Actual Number of Users with a Contract : Answers to the questionnaire to electric companies (including some estimation based on the number of wattmeters procured)

According to the executing agency and local electric companies responsible for the O&M of facilities, there are several reasons for the under-performance in terms of the number of wattmeters procured and the number of new users with a contract compared to the original targets declared at the time of appraisal.

- At some of the villages selected for the Project at the time of appraisal, the electrification work started before the actual implementation of the Project as the demand of the villagers was so strong that alternative funds were made available by the regional or district governments. Accordingly, these villages were removed from the scope of the Project. This situation was partly prompted by the fact that there was a time gap of several years between the selection of villages through the preliminary study prior to appraisal and the commencement of the detailed design for the Project. Even though some rural electrification systems eventually incorporated some villages which had not been selected initially, the overall number of target villages decreased, resulting in a fall of the actual number of new users with a contract.

- It was necessary for the households targeted by the Project to buy a wattmeter and to sign a contract to be able to receive the electricity service.[5] Some low income households were unable to sign the contract immediately while a few households are believed to have extended the power cable from a neighbouring household to use electricity without a contract.[6] This situation explains the fact that the number of users with a contact as of 2009 did not match the number of wattmeters procured. Meanwhile, the actual number of users is believed to be slightly higher than the number of users with a contract considering the existence of users without contract.

(2) Increase of Electrification Rate

Table 5 shows the estimated increase of the electrification rate by the Project in the 14 regions where the rural electrical systems were expanded as well as the overall increase of the national electrification rate using data on the urban and rural population and the number of users with a contract created by the Project[7]. In short, the Project is judged to have increased the national electrification rate by 2.2 points and the rural electrification rate by 8.8 points. By region, the increase is particularly noticeable in both the Amazonas Region and Piura Region where the rural electrification rate increased by more than 20 points.

[5] The purchase of a wattmeter involved payment of some US$ 90 by instalments. Under the present legal system, wattmeters for rural electrification projects are provided to local residents free of charge.

[6] A survey involving four rural electric systems in the Cajamarca Region and Cusco Region found that the domestic users without a contract accounted for 2% and 13% of the actual users respectively. Although these households receive electricity via a neighbour or another source, they are not stealing electricity because of payment of the electricity tariff by the sources.

[7] Estimated by the number of users by the Project and urban / rural population in each Region in 2009.

Table 5 Increase of Electrification Rate by the Project (Phase I and Phase II)

Region	Increase of Electrification Rate (Urban + Rural) (points)	Increase of Rural Electrification Rate (points)
Amazonas	10.7	20.0
Ancash	4.4	11.9
Aplimac	1.1	2.0
Alequipa	1.1	10.1
Ayacucho	4.1	9.0
Cajamarca	2.6	3.8
Cusco	3.8	8.3
Huanuco	5.6	9.8
Junin	0.7	2.0
La Libertad	2.2	9.0
Lambayaque	3.2	16.0
Lima	0.2	7.4
Piura	6.9	26.8
Puno	1.6	3.0
National	2.2	8.8

Source: Prepared by the evaluator using various materials

Installed Wattmeter

(3) Electricity Consumption

A study conducted by the JICA in 2007 on the Project (Phase I) estimated the average electricity consumption by new domestic users in Phase I to be 20 kWh per month. Data obtained from the electric companies responsible for the O&M of facilities show that the average electricity consumption among domestic users of the Project in 2009 was 15.5 kWh per month in the Cajamarca Region and 21.9 kWh in the Cusco Region. In the Cajamarca Region, 56% of domestic users consumed less than 10 kWh per month[8]. The corresponding figure for the Cusco Region was 31%. It appears to be safe to assume, therefore, that the monthly electricity consumption by new domestic users created by the Project was low at around 20 kWh. According to the MEM, this figure matches the average level of electricity consumption in rural areas in Peru but fails to reach the target level of electricity consumption (30 kWh/month) for rural electrification stipulated by the MEM.

Some 5% of users with a contract use electricity for various purposes but not domestic purposes. These users are schools, churches, municipal offices, health posts and other public facilities as well as private businesses. On the other hand, 24% of users in the Cajamarca Region and 7% of users in the Cusco Region use electricity for some kind of activity to earn their livelihood (shops, small factories, side jobs and others).

(4) Frequency of Outages

In rural areas in Peru, the quality of the electricity service is not generally high as many outages caused by bad weather frequently occur, following by lengthy repair work each time. With the 33 rural electrical systems featured by the Project, each user with a contract experienced an average of 36 outages lasting for a total of 86 hours in 2010 even though these figures are lower than the national average figures for all rural electrical systems in Peru.[9] Based on the averages for 2006 – 2010, two of

[8] The use of two 60 W electric bulbs for four hours a day and a small 50 W television for three hours a day totals a monthly electricity consumption of approximately 20 kWh.

[9] The data has several limitations: i) while the Project involved only a limited part (stage/stages) of rural electrical systems, the data was for the entire rural electrical systems and ii) while the data included outages

these 33 systems suffer exceptionally frequent outages. According to the MEM, these outages are caused by operational problems involving a nearby power plant (not included in the scope of the Project) or the heavy use of electricity by a large user (mine) and not by the facilities constructed under the Project.

Table 5 Frequency and Duration of Outages per Customer

Project Phase	Phase I	Phase II	Project Average (Phase I and II)	National Average
SAIFI (2010)	38.0	32.0	35.8	44.5
SAIDI (2010)	93.0	72.4	85.5	103.6

SAIFI: System Average of Interruption Frequency Index … Average number of interruptions experienced by a customer per year
SAIDI: System Average of Interruption Duration Index … Average hours of interruptions experienced by a customer per year
Source: Prepared by the evaluator using data by the OSINERGMIN (Supervisory Agency for Energy and Mining Investment)

3.3.1.2 Results of Calculations of Internal Rate of Return (IRR)

At the time of appraisal of the Phase I Project, the financial internal rate of return (FIRR) of the planned investment for the transmission lines and rural electrical systems was calculated to be 4.8% for reference purposes but the assumptions and process of this calculation are unknown to the evaluator. For this ex-post evaluation, the FIRR of the expansion of four rural electrical systems in the Cajamarca Region and Cusco Region has been calculated based on the following assumptions.

Project life : 20 years
Benefits : Income from electricity sales; the electricity tariff and level of electricity consumption are assumed based on the actual figures up to 2010
Costs : Construction cost and maintenance cost (the annual maintenance cost is assumed to be 1.5% of the investment amount)

Table 7 Results of Calculations of Internal Rate of Rerurn

	SER Chilete II (Cajamarca)	SER Celendin II & III (Cajamarca)	SER Paruro II (Cusco)	SER Pisac I (Cusco)
FIRR	-11.6%	-6.2%	-17.9%	-15.4%
EIRR	20.3%	25.6%	16.1%	15.9%

SER : Rural Electrical System

In every case, the resulting FIRR shows a negative value as the low level of electricity consumption does not generate sufficient income from the sale of electricity to recoup the initial investment amount. No comparison with the earlier calculation result is conducted here because of the possibility of the use of different calculation methods.

Although the economic internal rate of return (EIRR) was not calculated at the time of appraisal, it has been calculated on a trial basis as part of the ex-post evaluation for the expansion of the same four rural electrical systems mentioned above using the likely cost of using alternative energies as a benefit in line with the calculation method normally used by the MEM. The resulting EIRR was between 16% and 26%[10].

which occurred with medium voltage distribution lines for rural electrical systems, it did not include those with low voltage distribution lines serving actual users, suggesting that the actual number of outages is higher.

[10] MEM conducts an economic evaluation according to the methodology given by the Ministry of Economic and Finance, where economic benefit of the project is estimated based on the cost of alternative energy saved by the project and others.

The MEM considers that rural electrification projects in Peru are economically viable in general when the investment amount per user is less than around US$ 1,800 as the resulting EIRR is thought to exceed 10%. The calculated investment amount per user with a contract in the case of the 33 subject rural electrical systems of the Project shows that the said investment amount is not higher than US$ 1,800 for 31 systems with an overall average for the Project of US$ 807. Accordingly, the investment under the Project in rural electrical systems is judged to be economically viable in general. The remaining two systems where the investment amount per user exceeds US$ 1,800 suffer from a much smaller number of actual users than the planned due to the replacement / exclusion of target villages or other reasons.

3.3.2 Qualitative Effects

The household survey conducted in the Cajamarca Region and Cusco Region produced a result indicating that more than 60% of households newly connected to the electricity service are generally satisfied with the service. Only some 10% expressed dissatisfaction, primarily because of the high level of the electricity tariff[11] despite their small electricity consumption, frequent outages, insufficient arrangements for the handling of complaints or enquiries and payment of the street lighting charge even though the number of street lights is small or street lights are non-existent.

90% of households make some effort to reduce their electricity consumption, including the restricted use of lighting to night-time only, non-use of lighting when not required, disconnection of the television when not in use and the use of fluorescent lamps. 15% of households cited a reduction of the overall energy cost as a reason for their satisfaction with the electricity service.

Based on the above results, this project has largely achieved its objectives, therefore its effectiveness is high.

3.4 Impacts

3.4.1 Intended Impacts

The Project was expected to contribute to improvement of the living standard and vitalisation of the local economy in rural areas through an increase of the rural electrification rate. The present ex-post evaluation of the impacts has primarily focused on the impacts on the daily life of ordinary households, impacts on economic activities and impacts on local communities based on the beneficiaries survey conducted in the Cajamarca Region and Cusco Region.[12]

(1) Impacts on Daily Life Through the Use of Electrical Appliances

New users of electricity have mainly benefited from the use of lighting appliances. More than 70% of the users surveyed answered that the largest benefit came from lighting appliances among various electrical appliances because of (i) the increase of active hours due to lighting at night, (ii) higher efficiency of domestic work and more efficient learning by children. On average, each household now uses approximately three electric bulbs. Bulb type fluorescent lamps are used by more than half of the households. These bulbs have replaced oil lamps and candles. Electric lighting is used for nearly three

[11] The electricity tariff is determined for each rural electrical system to reflect the actual generation, transmission and distribution costs. The tariff tends to be higher in rural areas because of the generally high distribution cost. There is a mechanism in place which reduces the electricity charge for users of 100 kWh a month or less. In the case of those using 30 kWh or less a month, the actual charge is half of the standard charge. The existence of this system, however, is not widely known in rural areas.

[12] The evaluator conducted key informant interviews, workshops and a questionnaire survey featuring 223 households using electricity and 53 small businesses (classified as domestic electricity users in terms of the contract) for four rural electrical systems in the Cajamarca Region and Cusco Region.

hours a day at night and these hours are spent for domestic work, viewing of television, family talks and school homework.

Many of the benefiting households mentioned improved external communication through the use of television, radio and mobile phone. These changes have been basically welcomed. Some respondents have pointed out a decline of the migration of young people from the village, facilitation of the socialisation of school age children and young adults through the diffusion of the Spanish language and positive as well as negative impacts on the traditional values. According the survey;

- Some 70% of households have a television set even though nearly half of these households have access to only one channel. On average, people watch television for some 10 hours a week. In addition to watching news programmes, the television is also used for such entertainment as watching DVDs.

- 70% of households have a battery-operated radio which people take with them to the fields during farming hours. Nearly half of households have a radio using the commercial electricity supply. 70% of households responded that the number of hours spent listening to the radio has increased since electrification and the radio is mostly used to listen to the news.

- Approximately one-third of households now have a mobile phone which is mainly used for communication with family members and friends.

Lighting appliance, radio and power outlet at an electrified household

(2) Impacts on Economic Activities

The beneficiaries survey identified 95 small business users of electricity among 1,319 users with a contract in 14 villages. More than 60% of them run a small shop and use electricity for lighting, refrigeration and freezing. Others are the owners of restaurants, woodworking shops, flour mills and other types of businesses which widely vary from one village to another depending on the local characteristics. Some of these small businesses existed prior to the electrification of their villages. While electrification has resulted in new businesses, there are also examples of electrification leading to an increased turnover, higher productivity and improved quality for existing businesses. Some 10% of domestic users use electricity to improve their livelihood through piecework at home.

In general, the use of electricity for business and income generation activities is restricted by the constraints listed below and the impacts of electrification on economic activities have been limited depending on the local conditions.

- Limited access of villagers to production and supply of raw materials and also to markets

- Insufficient knowledge and experience of villagers regarding the starting up and subsequent management of a business

- Constraints associated with the available power supply capacity (limited transformer capacity, supply of only single phase AC, etc.)

- Insufficient knowledge of villagers on production technologies, production facilities and equipment using electricity

The field visits by the evaluator found, for example, a village where a flour milling machine purchased three years earlier had not yet been used due to the insufficient capacity of transformer. Another example was a flour mill run by diesel power generation due to an unavailability of three phase AC, which shows that the Project failed to give a sufficient supply capacity of electricity as the demand for small business exceeded the projection at the time of planning. There were also villagers who had abandoned the idea of starting a business because they did not know about the existence of equipment which could be operated on single phase AC, who had purchased equipment for three phase AC while only single phase AC is available.

In the Cajamarca Region, the Project for the Promotion of the Appropriate Use of Electricity in Areas of the Electric Frontier Expansion Project was implemented in association with the Project, exploring various techniques and their feasibility of increasing the impacts of electrification on economic activities. It is planned to incorporate the outcomes of this project in the Phase III Project (see the boxed text).

Cajamarca Region: Project for the Promotion of the Appropriate Use of Electricity in Areas of the Electric Frontier Expansion Project (March, 2010 to February, 2011)

There are areas where the growth of electricity consumption is insufficient in the Cajamarca Region which is included in all three phases of the Electric Frontier Expansion Project. The Regional Government of Cajamarca with the assistance of the JICA implemented the Project for the Promotion of the Appropriate Use of Electricity in Areas of the Electric Frontier Expansion Project (hereinafter referred to as the Promotion Project) in the region for a period of 12 months. The purpose of the Promotion Project was to improve the level of knowledge of the use of electricity among local people in order to promote the appropriate use of electricity by educating them on the benefits and appropriate use of electricity and presenting business models for the application of electricity to small businesses. The Regional Government conducted the following activities in cooperation with a Peruvian consultant team employed by the JICA, local electric companies and other stakeholders.

- Baseline survey on 1,540 households in 79 villages (on the current situation of electricity use, level of understanding of the use of electricity and other issues)

- Dissemination of information to domestic users and small business users by means of television, radio, printed materials, events and seminars

- Courses introducing the appropriate use of electricity for mothers' groups (use of a juicer at home and others)

- Technical training, dissemination of information and technical assistance regarding the use of electricity for dairy businesses, carpenters, stonemasons and other small businesses

- Training of electrical technicians for village youth

- Promotion of collaboration and coordination between industrial/commercial users and electric companies, facilitation of the electrification of businesses

The Promotion Project revealed that a rapid increase of electricity consumption could not be expected among ordinary households and that there is much potential demand in industrial sectors which has not been fully tapped because of the insufficient availability of information and inadequate communication with local electric companies. In order to provide a place to link up potential industrial users, the regional government, local electric companies, NGOs, technical institutions and other stakeholders, an Energy Platform was created to facilitate the realisation of the industrial demand through the active collaboration of all stakeholders. A local electric company established a permanent section responsible for the promotion of the industrial use of electricity. Meanwhile, a Financial Platform was also created to assist the fundraising of industrial users for investment in equipment to connect them to the grid.

Potential industrial users include rice mills and milk collection points which still rely on their own diesel power generating facilities despite the fact that the grid has been extended nearby. Under the Promotion Project, six rice mills and 26 milk collection points controlled by Nestle commenced the technical examination of possible grid connection with the assistance of a local electric company. It is expected that the electricity consumption by one electrified rice mill or milk collection point will be equivalent to that of some 150 households or 50 households respectively. Moreover, the local consumption of electricity is expected to further increase by an amount equivalent to the electricity consumption of some 800 households if 17 woodworking shops which have undergone technical training actually start to use electricity. If such potential industrial use of electricity is fully realised, the overall electricity consumption in the target areas will increase by more than 40%.

Although it is planned to utilise the lessons learned from the Promotion Project in the target areas of the Phase III Project, it will be some time before the positive outcomes of this project are manifested. Evaluation of the Promotion Project should be conducted in due course to fully assess its outcomes and effects.

(This outline is written by the Evaluator)

(3) Impacts on Communities

In villages where street lighting has been introduced as a result of electrification, the number of thefts and other crimes has fallen which is a welcome consequence of electrification. However, a few villagers are not fully satisfied because of the small number of street lights installed under the Project[13].

Public facilities account for some 12% of electricity consumption (in both the Cajamarca Region and Cusco Region), providing better public services for education, administration and medical care. For example, local health posts are now capable of storing vaccines and using a range of medical equipment, making it possible for doctors to stay and provide continuing services. At schools, electrification has made it possible to use AV equipment and PCs. The availability of lighting has not only improved the learning conditions but has also made it possible to hold PTA meetings at night. The convenience has improved at municipal offices, community halls and other facilities as they can be accessed and used by local people for longer hours. Local farmers have especially welcomed the fact that PTA and community meetings can be held at night when they are not busy working as a result of street lighting and the installation of a lighting system at public facilities.

[13] Number and locations of street lights are decided from technical and economic viewpoints based on the technical norms established by the government.

Woodworking shop now using a power tool

PC room at an electrified primary school

3.4.2 Other Impacts

3.4.2.1 Relocation and Compensation

The compensation paid under the Project to local residents consisted of compensation for air rights along the transmission/distribution routes at a rate of 5 – 10% of the actual land price and compensation for trees cut based on the diameter of each tree. Even though it was necessary to slightly alter the planned transmission route in some areas because of land acquisition problems, no major problem was reported in connection with land acquisition or compensation for air rights for land along the transmission routes. No relocation was needed for the Project[14].

3.4.2.2 Impacts on Natural Environment

For the Project, a study to check any adverse impacts on historical remains, etc. was conducted for each of the transmission lines and the rural electrical systems to obtain the approval of the National Institute of Culture (INC) of Peru along with an environmental impacts assessment (EIA). According to the MEM, No serious problems were found by either study.

3.5 Sustainability (Rating:②)

3.5.1 Institutional Aspects of Operation and Maintenance

Of the transmission lines and rural electrical systems constructed or expanded under the Project, 14 rural electrical systems and one transmission line are owned by the Power Infrastructure Administration Corporation (called ADINELSA) and each of these is operated by a local electric company or the municipal government.[15] The ownership of other facilities has been transferred to the local electric companies which operate them. However, five rural electrical systems expanded in the

[14] Details on the EIAs are omitted as there are a lot of EIAs that were carried out for each of sub-project.

[15] ADINELSA is a state-owned company which is responsible for the administration of electrical infrastructure projects with a low level of profitability. While a policy of privatising local electric companies was pursued in Peru in the 1990's, this process of privatisation did not progress much except for two distribution companies in Lima. Projects (many of which involved a power supply business) which were completed around this time with the prospect of low profitability were transferred to ADINELSA and the actual facilities were operated by local electric companies or municipal governments while receiving a subsidy from ADINELSA.

Phase II Project have not been transferred to local electric companies as of May, 2011 because of delayed settlement with construction companies.[16]

The actual O&M of rural electrical systems is conducted by an electric company (or the municipal government) either directly or through a contract with an external company. Because of the difficulty of making sufficient profit in rural areas with low electricity consumption, local electric companies are generally unable to deploy sufficient human resources in these areas in terms of both quantity and quality.[17] There are many cases where a distribution line stretches a very long distance compared to the number of users and it can often take more than half a day to reach a distant village. This makes a quick response to outages difficult.

In Peru, the Supervisory Agency for Energy and Mining Investment (Organismo Supervisor de la Inversión en Energia y Mineria; OSINERGMIN) which is Peru's state energy and mining investment regulator supervises the operation and management of projects and electric companies.[18] In urban areas, technical norms are stipulated for outages, voltage and frequency and electric companies are required to comply with these standards. Although these standards have not been applied to rural areas because of the difficulty of maintaining the quality of electricity, a new rule was introduced in 2010 to fine electric companies which experience a number of outages above a specified level. Payment of this fine takes place in the form of a contribution to a fund designed to support rural electrification projects managed by the MEM.

Electric companies employ villagers, such as shop owners, to assist the collection of the electricity charge in many villages. However, any enquiries or complaints must be made directly to the office of the electric company by means of telephone, physical visit or other. Many users feel that this arrangement is inconvenient.

The responsibility of an electric company extends as far as the wattmeter at each user and each user is responsible for the internal wiring of the home or business premises. Because of the virtual absence of trained technicians in villages, this wiring work is usually conducted by the individual users themselves or local persons with the relevant skill.

3.5.2 Technical Aspects of Operation and Maintenance

No serious technical issue is found in regard to the O&M of the transmission lines and rural electrical system by electric companies. According to these companies, the ability of technicians recruited externally on contract is not particularly high. The choice is to either provide them with intensive training or to recruit those with better skills with higher pay. Either way, the low profitability of rural electrical systems makes it difficult for electric companies to find the necessary funds.

The wiring of the homes of users with a contract is often conducted using a rudimentary method with little consideration of technical soundness. The results of interviews with local residents and

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[16] In the case of distribution businesses transferred to local electric companies, the service areas have been incorporated to the concession areas of the individual electric companies which are responsible for the maintenance and commercial operation of the facilities and also for additional investment to serve new users. However, as local electric companies are reluctant to make additional investment prior to the completion of the transfer procedure, there is a risk of a slow response to the demand of potential new users due to population increase and other reasons.

[17] The standards set by the OSINERGMIN require local electric companies to establish an O&M office at a rate of at least one office per 5,000 users and to deploy a technician at each office. Local electric companies do employ technicians to meet this standard.

[18] The OSINERGMIN was established based on the Law on the Framework for Regulatory Organizations for Private Investment (promulgated on 29th July, 2000) as an organization to supervise investment in the energy sector. It has several functions, including the function to supervise the fulfilment of legal, contractual and technical obligations, the function to regulate the tariff and the function to settle disputes between companies or between a company and a consumer(s).

technicians of electric companies suggest that such amateurish wiring has led to some electric leakage incidents although there are no reports of frequent incidents of electric shock.

3.5.3 Financial Aspects of Operation and Maintenance

In the case of power distribution businesses in rural areas where the level of electricity consumption does not match the scale of the facilities (total length of distribution lines), the income from the sale of electricity is generally not enough to cover the maintenance cost, resulting in an operating loss.[19] Electric companies to which rural electrical systems have been transferred ensure an operating profit by compensating for the loss incurred by rural operation with the profit from urban operation (Table 8). In the Phase I Project, the transfer of rural electrical systems took the form of "assets" transfer and the resulting depreciation cost became a heavy burden for electric companies. Having learned from this, rural electrical systems were transferred to electric companies in the form of "grants" in the Phase II Project.

In the case of the rural electrical systems owned by ADINELSA, while ADINELSA receives a government subsidy, it pays the theoretical O&M cost to the body responsible for O&M. The involvement of ADINELSA in the Phase I Project was decided as a measure to deal with the hardly profitable rural electrical systems to reduce the financial burden on electric companies which were in the midst of the privatisation process.

Table 8 Financial Achievements of Electric Companies (2009, in thousand Nuevo Sol)

	Operation Income	Operation Expense	Operational Revenue	Net Revenue
Electrocentro	247,313	205,182	42,131	27,056
Electronoroeste	241,718	213,335	28,383	19,231
Electronorte	190,193	161,869	28,325	13,553
Electro Puno	80,537	71,107	9,430	10,117
Electros Sur Este	165,376	143,603	21,773	20,877
Hidrandina	403,768	353,080	50,688	38,183
Seal	233,483	200,780	32,703	18,543
ENOSA*	209,008	155,818	53,190	15,605

(Source) Anuario Estadístico 2009 (OSINERGMIN)
As for ENOSA, the figures are for 2008 based on the Annual Report 2008.

3.5.4 Current Status of Operation and Maintenance

The body responsible for O&M (either electrical company or municipal government) conducts the checking, maintenance and repair or the rural electrical system based on its own annual maintenance plan and also conducts any incidental repair work necessitated by outages, etc. As mentioned earlier, the number of outages of the 33 rural electrical systems expanded under the Project is lower than the national average. Nevertheless, an average of 36 outages lasting for a total of 86 hours occurred with

[19] An interim evaluation study conducted by the JICA in 2007 to evaluate the Phase I Project found that the O&M cost (consisting of the electricity purchase cost, outsourcing cost of O&M and general administration cost of an electric company) was approximately 120% of the income from the sale of electricity for 17 rural electrical systems expanded under the Phase I Project. A rural electrical system which relies on the grid is destined to produce an operating loss as the O&M cost is higher than the income from the sale of electricity due to a small number of users with a contract compared to the facility size (total length of the transmission and distribution lines required) and the generally low level of electricity consumption per user. As an electric company cannot allocate many resources to areas of low productivity, the quality of the O&M work and the overall service suffers. This low profitability of operation is the largest stumbling block to the proper O&M of rural electrical systems. The fundamental solution lies with increased income from the sale of electricity through an increase of the number of users and their electricity consumption and the creation of new industrial demands for electricity.

each of these 33 systems in 2010. It is estimated that some 70% of the outage incidents and some 40% of the outage duration were caused by failures of the medium voltage distribution lines for these rural electrical systems.[20] The actual number of outages should be more when outages caused by failures of the low voltage distribution lines are included.

Based on opinions expressed by the MEM, electric companies and the OSINERGMIN, there are several factors for the frequent and lasting outages.

- While the total length of the distribution lines is quite long, only the minimum protection devices have been installed from the viewpoint of economy.
- Electric companies have only limited human resources, means of transportation and means of communication.
- Users with a contract do not have either the means of communication with an electric company or know where to contact.
- The number of thefts of electrical cables has been increasing in recent years against the background of the price hike of copper.
- The number of outages caused by factors involving power generation or transmission, which are beyond the scope of rural electrical systems, has been increasing.[21]

In summary, some minor problems in terms of the institutional and technical aspects were observed; therefore sustainability of the Project is ranked as fair.

4. Conclusion, Recommendations and Lessons Learned

4.1 Conclusion

The Project was implemented as part of the National Plan for Rural Electrification, which has been eagerly promoted by the Government of Peru, for the purpose of increasing the electrification rate in rural areas. The necessity for this type of project is large, and the relevance of the Project is high as it conforms to Japan's ODA policies. The rural electrification sub-projects under the Electric Frontier Expansion Project (hereinafter referred as "the Project") were completed with the actual project cost ending up at some 60% of the original budget. As the project period was substantially extended due to the substitution of a power plant by transmission lines and the tight financial situation faced by the Government of Peru, the efficiency of the Project is rated as medium. In contrast, the effectiveness of the Project is rated as high as the planned number of new contract users of electricity of 80% has been met, illustrating the positive contribution to improvement of the rural electrification rate in Peru. The benefits of electrification for rural inhabitants range from increased hours of active life due to lighting, including more efficient household chores as well as better learning by children. The use of electricity for commercial and production activities appears to be limited. The inability to deploy a sufficient number of personnel to maintain the distribution grid over a vast area because of the low level of electricity consumption and earnings forms the background for frequent and long power outages. In view of such reality, the sustainability of the Project is judged as medium. Based on the above evaluation results, the overall ex-post evaluation status of the Project is high.

[20] This estimation is based on data provided by the OSINERGMIN.

[21] According to the OSINGERMIN, the number of outage incidents in Peru is on the rise following the expansion of electrical systems and increase of the electricity demand.

4.2 Recommendations

4.2.1 Recommendations for the Government of Peru and Project Executing Agency

The following efforts must be made to increase the income from the electricity sale of the rural electrical systems included in the Project and thereby to improve the profitability of their operation.

- To promote the appropriate use of electricity by domestic, commercial and industrial users, the MEM will review the Promotion Project implemented in the Cajamarca Region with the assistance of the JICA and other similar projects with a view to disseminating the acquired knowledge and experience from these projects.

- The MEM will facilitate the following efforts by the local electric companies;

    - To establish a permanent section responsible for the promotion of the industrial use of electricity so that the potential industrial power demand can be unearthed in rural areas and electricity supply to meet this demand can be swiftly arranged.

    - To commence activities designed to develop strategic links among potential industrial users, electric companies and local governments as well as related NGOs, technical institutions and other organizations.

- The MEM will swiftly complete the transfer of the five remaining rural electrical systems expanded under the Phase II Project to electric companies.

The MEM should carefully take the following necessities into careful consideration for forthcoming rural electrification projects in Peru.

- Based on a detailed prediction of the domestic and commercial / industrial electricity demand in each area, the MEM should select those villages suitable for rural electrification using the distribution grid and plan the necessary facilities to secure the optimal transmission and distribution capacity.

- Extensive education and training should be provided for farmers who have never previously used electricity using opportunities presented by a field survey at the planning stage or a field survey and supervisory work conducted by a consultant at the implementation stage. This education and training should cover such themes as the institutional arrangements for electricity use (tariff structure, customer service and others), safety (domestic wiring and safety devices), types, benefits as well as the level of electricity consumption of household electrical appliances, ways to save electricity and the commercial / industrial use of electricity.

- Basic wiring work inside a house should be included in the scope of projects so that a safe and efficient electricity service can commence immediately after project completion. Training during this process could be able to produce local technicians.

- The MEM should closely communicate as well as coordinate with local governments and electric companies at both the planning stage and implementation stage of rural electrification projects while trying to minimise any decrease or reshuffling of the target villages for electrification and ensuring efficient project implementation.

4.2.2 Recommendations for the JICA

The JICA should evaluate the outcomes and effects of the Promotion Project implemented in the Cajamarca Region with a view to disseminating and utilising the experience of this project.

4.3 Lessons Learned

Rural electrification projects using the transmission and distribution grid commonly face a difficult prospect of earning sufficient income from the sale of electricity to cover the maintenance cost. The general rule is that the wider the target area is to include remote villages, the higher the income shortfall is. Accordingly, the following considerations are vital to improve the financial sustainability of these projects and to ensure the quality of the supplied electricity through adequate maintenance.

- The domestic and commercial / industrial demand such as small shops, workshops, agro-processing, etc. should be adequately projected so that target villages suitable for electrification through connection with the power grid are selected along with the planning of the supply capacity which corresponds to the predicted power demand.

- In order to realize the potential electricity demand of commercial / industrial sectors, emphasis should be placed on educational activities and strategic links should be established involving local governments, industries, electric companies and other stakeholders.

- Adequate external monitoring of the quality of the electricity service should continue.

- Economic incentives should be provided for those responsible for the O&M of various facilities to maintain the quality of the electricity service.

Comparison of the Original and the Actual Scope of the Project

Item	Original	Actual
1. Project Outputs	< Phase I Project > • El Valor Diesel Power Plant • Transmission line: 177 km in three sections • Rural electrical system: 21 areas serving some 65,000 new users (households) < Phase II Project > • Transmission line: 400 km in six sections • Rural electrical system: 12 areas serving some 75,000 new users (households)	< Phase I Project > • El Valor Diesel Power Plant: removed from the scope of the Project • Transmission line: 271 km in three sections • Rural electrical system: 21 areas serving some 55,000 new users (households) < Phase II Project > • Transmission line: 424 km in six sections • Rural electrical system: 12 areas serving some 68,000 new users (households)
2. Project Period	November, 1997 to December, 2002 (62 months)	November, 1997 to February, 2008 (136 months)
3. Project Cost Foreign Currency Local Currency Total Of Which JICA Loan Exchange Rate	 ¥9,482 million US$ 166,660,000 (S/.425 million) ¥29,657 million ¥13,157 million US$ 1 = S/.2.25 = ¥129	 ¥10,816 million US$ 53,302,000 (S/.181 million) ¥16,922 million ¥6,736 million US$ 1 = S/.3.40 = ¥115