

Republic of Peru

FY 2018 Ex-Post Evaluation of Japanese ODA Loan

"Electric Frontier Expansion Project (Phase III)"

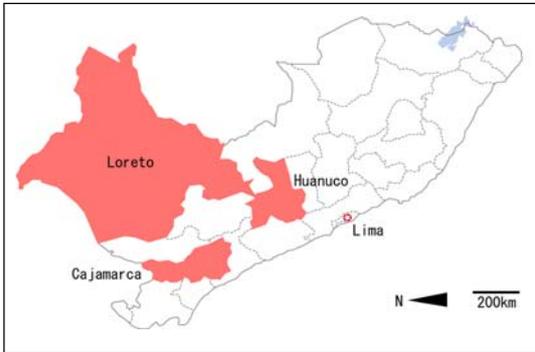
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0. Summary

The objective of the Electric Frontier Expansion Project (Phase III) (hereinafter referred to as "the Project") is to improve the electrification ratio in target areas by developing the transmission and distribution grids in Peru's Regions of Cajamarca, Huánuco and Loreto, thereby contributing to improved standard of living of local residents and stimulation of social and economic activities. The promotion of electrification in rural areas was an important issue for Peru and the target regions both at the time of appraisal and the ex-post evaluation, making the Project highly consistent with the policies and development needs of Peru. Additionally, the Project is consistent with Japan's ODA policy at the time of appraisal, which positioned reduction in poverty and correction of social disparity as important spheres of aid. Therefore, the Project is highly relevant. Project outputs were somewhat lower than planned, and project cost was higher than planned. The project period far exceeded the plan, and some part of the Project in the Loreto Region was incomplete at the time of the ex-post evaluation. Therefore, efficiency of the Project is low. The Project made an important contribution to improving the electrification ratio in target areas, and overall, the reliability of the power supply is high. Although power consumption seems to be lower than expected, the expected impact of improving the living standard of local residents is clearly evident. Therefore, effectiveness and impacts of the Project are high. No major problems have been observed in the technical and financial aspects of operation and maintenance of the Project, but some problems were observed in the institutional and organizational aspect, and the current status of operation and maintenance, with interruptions being particularly frequent in some parts of the Huánuco Region. Therefore, sustainability of the Project effects is fair.

In light of the above, the Project is evaluated as partially satisfactory.

1. Project Description



Project Locations



Distribution facilities provided by the Project

1.1 Background

In the 1990s, in electric power sector of Peru, the lag in electrification of rural areas was a major issue. The electrification ratio in Peru in 1995 was 65% and the per-capita power consumption was 689 kWh, which were both low, with power consumption being approximately half that of the Central and South American average. Within Peru, in the Andes and Amazon areas, home to 45% of Peru's population, the electrification ratio was only 20%, and promoting electrification was an issue which needed to be addressed urgently. To address this situation, the Government of Peru formulated *the National Plan for Rural Electrification* in 1993, and while updating this plan each year, has implemented electrification projects in an endeavor to improve the electrification ratio. As a result, the national electrification ratio increased to 78% by 2005, but the electrification ratio of rural areas was still low at 32%. The *National Plan for Rural Electrification* updated in 2006 aimed to raise the national electrification ratio to 93% by 2015, and had as its policy the promotion of electrification projects by constructing rural electrification systems (hereinafter referred to as "RESs") with priority in three regions; Cajamarca, Huánuco and Loreto¹. These regions had the lowest electrification ratio nationwide and the highest rates of poverty. Against this backdrop, and as part of *the National Plan for Rural Electrification*, JICA signed ODA Loan agreements with the Republic of Peru for Phase I of the Electric Frontier Expansion Project in 1997, and Phase II of the Project in 1999, marking the start of support for rural electrification. The Project (Phase III) follows on from the two previous phases, and an ODA Loan agreement was signed in March, 2009.

1.2 Project Outline

The objective of the Project is to increase the rural electrification ratio of target areas through the development of distribution grids in the regions of Cajamarca, Huánuco and Loreto, thereby

¹ Rural power systems group together multiple villages, taking into account topography and distance, and provide distribution facilities.

3. Results of the Evaluation (Overall Rating: C²)

3.1 Relevance (Rating: ③³)

3.1.1 Consistency with the Development Plan of Peru

The General Law for Rural Electrification promulgated in 2006 positioned rural electrification as an essential requirement for comprehensive rural development⁴, and laid down the policy of; working to increase the demand for power and the productive use of power and by providing training to local residents; decentralizing electrification projects; and utilizing new technologies and renewable energies. Moreover, as discussed in "1.1 Background", the Government of Peru formulated its *National Plan for Rural Electrification* in 1993, and has been working to improve electrification ratio.

At the time of the ex-post evaluation, the *National Plan for Rural Electrification (2016-2025)* gives, as elements of policy: the promotion of electrification by constructing rural power systems; education and training to promote the productive, efficient and safe use of power; the utilization of renewable energies; support for the formation of projects by local government; and the optimization of promotion of projects. The plan aims to provide electricity to 3.3 million residents over the 10-year period, and by electrifying remote areas using renewable energies, enter the top third of Central and South American countries in terms of the national electrification ratio.

Therefore, the Project is highly relevant to the development policies of Peru, both at the time of the appraisal and at the time of the ex-post evaluation.

3.1.2 Consistency with the Development Needs of Peru

As discussed in "1.1 Background" above, at the time of the appraisal, the Regions of Cajamarca, Huánuco and Loreto were the regions with the lowest electrification ratio nationwide. Over the subsequent 10-year period, the Project contributed to a dramatic improvement in the electrification ratio of the target three regions (refer to Effectiveness), with some 420,000 people estimated as remaining without electricity supply over the three regions in 2017. In addition, the development plans of the three regions all emphasize the need for rural electrification⁵. The importance and necessity of the power services provided by the Project to residents in target areas remains unchanged at the time of the ex-post evaluation.

² A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

³ ③: High, ②: Fair, ①: Low

⁴ As un-electrified areas in rural areas rely on batteries, kerosene lamps, candles for energy supply and lighting, in addition to the expenses related to batteries, kerosene lamps and candles, production activities have to be restricted. Besides, it is considered that medical and educational services are inferior to electrified areas.

⁵ Loreto Region's development plan states, as targets for part of infrastructure development, raising the electrification ratio from 78% in 2014 to 85% in 2021 by expanding the distribution grid and using solar power. In Cajamarca Region's development plan, rural electrification including the Project is identified as a part of economic development. In Huánuco Region's development plan, rural electrification is given high priority, and it aims to achieve an electrification ratio of 57% by 2021.

In light of the above, the Project has been highly relevant to Peru's development needs at the time of appraisal and at the time of ex-post evaluation.

3.1.3 Consistency with Japan's ODA Policy

One of JICA's priority spheres for aid is reducing poverty and correcting social disparity. Within this broad sphere, one development issue being addressed is giving priority in particular to measures to counter poverty in mountainous areas, and the implementation of the Project, which includes mountainous areas within its target areas, conforms to JICA's ODA policy. According to the 2009 version of the Ministry of Foreign Affairs' *ODA Data Book* by Country, the development issues given the highest priority in Japan's ODA policy for Peru are reducing poverty, development of economic infrastructure and environmental countermeasures. In the *Country Assistance Program for Peru* (2000), anti-poverty measures, social sector assistance, development of economic infrastructure and environmental conservation were identified as priority spheres. The Project corresponds to reducing poverty and anti-poverty measures.

Therefore, the Project is highly consistent with Japan's ODA policy.

In light of the above, the Project has been highly relevant to Peru's development policy and development needs, as well as Japan's ODA policy. Therefore, its relevance is high.

3.2 Efficiency (Rating: ①)

3.2.1 Project Outputs

The planned and actual outputs of the Project are shown in Table 1. A total of 32 rural electrification projects and one transmission line project were implemented in the Project. Each rural electrification project involved constructing all or part of a total of 11 RESs, and in some cases, multiple projects were executed for the same system.⁶ The number of rural electrification projects for the target three regions was lower than planned by one project, but this was because two adjoining projects in Loreto Region were executed together as one project. As the electrification target areas is unchanged, this does not indicate a reduction in project outputs.

The length of distribution lines and number of connections dropped to 90% and 82% of planned figures, respectively. These reductions occurred mainly in Cajamarca and Huánuco Regions, but according to the executing agencies (Regional Government of Cajamarca, Ministry of Energy and Mines), this was because some of the rural areas subject to electrification were electrified by other projects, and some of the houses in rural areas subject to electrification became vacant.

According to MEM (hereinafter referred to as "MEM"), the Project was planned as social

⁶ RESs are constructed in stages starting with areas located closest to power stations and transmission lines, gradually expanding the area to be electrified. A total of 11 RESs were encompassed by the Project, and multiple-phase projects for the same system were also included in the Project.

infrastructure; therefore, demand for the industrial use of electricity (woodworking shops, welding and machining shops, and food industries that mainly require three-phase current) was not expected. As a consequence, in the Project, power supply by three-phase current was limited to some areas, such as villages with larger populations. In order to have power reach as many areas as possible with a limited budget, power is supplied to remote locations with "single-phase single lines"⁷. In addition, in order to curb costs, devices to limit areas of interruptions (automatic reclosers) were not installed.

Table 1 Planned and Actual Outputs

	Planned	Actual
Construction of Rural Electrification Systems (RESs)		
Number of rural electrification projects (each project involves partially or entirely constructing RESs)	Cajamarca Region 19	Cajamarca Region 19
	Huánuco Region 8	Huánuco Region 8
	Loreto Region 6	Loreto Region 5
	Total 33	Total 32
Transmission lines (medium-voltage lines) (km)	Cajamarca Region 2,132	Cajamarca Region 1,778
	Huánuco Region 926	Huánuco Region 870
	Loreto Region 678	Loreto Region 721
	Total 3,736	Total 3,369 (90% of planned)
Number of new connections	Cajamarca Region 56,161	Cajamarca Region 43,508
	Huánuco Region 18,995	Huánuco Region 16,226
	Loreto Region 8,111	Loreto Region 8,188
	Total 83,267	Total 67,922 (82% of planned)
Construction of transmission facilities		
60kV Transmission line (Huánuco Region)	23.0 km	21.5 km
Substation (Huánuco Region)	1 location	1 location
Consulting service	Detailed design, procurement assistance, construction supervision	As planned

Source: Documents provided by JICA and executing agency

Note: The longitude of distribution lines and the number new connections for Loreto Region are actual figures including the residual construction component which has yet to be completed.

In newly electrified villages, power companies (to which the facilities of the Project were transferred) held briefings for local residents before the supply of power started. At the briefing residents were informed about how to utilize electricity, how to save electricity, the details of electricity bills and how to pay these bills, and safety when using electricity. The scope of the Project extended to electricity meters, with the wiring within residences connected to the meters being the responsibility of individual customers⁸.

⁷ Single-phase single wire uses the earth instead of a power line, and distribute single-phase current with a single power line. According to the Ministry of Energy and Mines, this method has the following weaknesses: the power supply capacity is limited; maintaining earth requires time and effort; and it is difficult to balance the three phases, to achieve stable operations. Therefore, it is not being used in rural electrification projects at the time of the ex-post evaluation. It is possible to upgrade single-phase single wire distribution grids to three-phase current by adding wires and transformers.

⁸ In some cases, power companies to which facilities have been transferred in newly electrified villages provide training in wiring work. Some people have become able to perform wiring work by being employed in construction work in

Distribution lines and the substation in the Huánuco Region were basically constructed according to plan while the length of transmission line was slightly shorter.

3.2.2 Project Inputs

3.2.2.1 Project Cost

The planned project cost was 13,243 million yen, of which 4,926 million yen was earmarked as ODA Loan for Cajamarca and Loreto Regions. The Project in Huánuco Region was executed with funding provided by the Government of Peru. The actual cost ended up at ¥14,351 million (108% of planned figure), higher than planned. The actual ODA loan amount was ¥4,925 million (within plan). Taking into account that the main output, which was the number of new connections, was approximately 80% of the planned figure, the efficiency of the cost for the Project was fair.

Table 2 Planned and Actual Project Cost

(unit: million yen)

	Planned			Actual		
	Total	ODA Loan	Fund from Peru	Total	ODA Loan	Fund from Peru
Construction component	9,080	4,006	5,074	10,120	3,682	6,438
Price escalation	430	201	229	0	0	0
Physical contingency	476	210	266	0	0	0
Consulting service	630	509	121	1,873	1,243	630
Land acquisition, right of way compensation	352	0	352	170	0	170
Administrative expenses	215	0	215	Unknown	0	Unknown
Customs duties and taxes	2,045	0	2,045	2,164	0	2,164
Commitment charge	15	0	15	12	0	12
Total	13,243	4,926	8,317	14,351	4,925	9,426

	Planned			Actual		
	Total	ODA Loan	Fund from Peru	Total	ODA Loan	Fund from Peru
Project Cost by Regions						
Cajamarca Region	7,974	4,171	3,803	8,904	4,170	4,734
Huánuco Region	3,837	0	3,837	2,649	0	2,649
Loreto Region	1,432	755	677	2,798	755	2,043
Total	13,243	4,926	8,317	14,351	4,925	9,426

Source: Documents provided by JICA and executing agency

Note: The construction component costs (actual total) include costs expected for the residual work to be handled by the Loreto Region (equivalent to approximately ¥380 million).

The project cost for Huánuco Region was approximately 80% of the planned figure, but the

urban areas, and there was no evidence of opinion that wiring within housing was particularly difficult.

project costs for Cajamarca and Loreto Regions were 110% and 180% of planned figures respectively. In the latter two regions, the extension of the construction schedule (which will be discussed later) resulted in an increase in construction and consulting service costs. Moreover, in Loreto Region, bid prices exceeded those assumed by the executing agency in all contract lots. According to the Regional Government of Loreto, many of the project target areas in the region are remote areas or areas that are difficult to access (Amazon River catchment area: areas where there is no road access, etc.), and there is a possibility that the project cost at the planning stage was estimated at lower than actual figures, with estimates of construction schedules and costs of transporting materials being too low. In addition, in Loreto Region there was a period during which some construction work was suspended (which will be mentioned later), and facilities were damaged during this period, which resulted in an increase in the project cost.

3.2.2.2 Project Period

The Project was scheduled to be executed over a 29-month period from March 2009 to May 2011. The actual project period (Loan Agreement – provisional reception of the facility) is shown in Table 3. The 32 RES projects and one transmission line/substation project included in the Project were independent projects, and individual projects started operation according to their respective completion dates. The average project period for the entire 33 projects was more than 50 months (more than 172% of planned). The project period from the signing of the loan agreement for Loreto Region which was incomplete at the time of the ex-post evaluation was 122 months, some 397% of the planned duration. In light of the above, the efficiency of the project period is low.

Table 3 Project Period of the Project

Project Scope		Completion Dates (Project Period)
Cajamarca Region	19 RES projects	September 2012 (43 months)
Huánuco Region	8 RES projects	March 2011 (25 months)
	transmission line / substation project	April 2014 (62 months)
Loreto Region	3 RES projects	September 2018 (115 months)
	2 RES projects	Incomplete as at April 2019 (122 months)

Source: Documents provided by executing agency

The RES projects of the Huánuco Region were completed in shorter periods than planned (see footnote 10). On the other hand, with regard to the construction of transmission lines and the substation, the target areas were near a boundary of two regions, and residents of some villages who were dissatisfied with changes to boundaries of the regions that has been implemented

independently of the Project, protested against the passage of transmission lines as terms of negotiation. This resulted in construction work being suspended. The construction agreement was rescinded, and the executing agency rebuilt its relationship with local residents. With the assistance of the army, the executing agency made an agreement with another contractor and restarted construction work.

In Cajamarca Region, distribution line routes were changed due to difficulties in reaching agreement with some residents and the geology of planned construction sites being different to that originally assumed, and it took time to re-obtain the "Certificate of Absence of Archaeological Remains" required as a result. The construction period was also extended due to the time required to reconstruct access roads which collapsed as a result of heavy rainfall.

In Loreto Region, construction work was suspended for some seven months due to the majority of target villages being submerged due to large-scale flooding. Moreover, the personnel assignment and financial capacity of consultants as well as contractors were inadequate to enable work to be carried out appropriately in target areas with poor access (Amazon River catchment area), preventing work from being able to be carried out to the end. This led to



Theft damages of distribution facility (Loreto)

contracts being rescinded in October 2014 and June 2016, respectively. In the subsequent months, the Regional Government of Loreto directly managed one project to completion. Work for the remaining four projects was continued under separate agreements, and although two projects were completed by September 2018, the remaining two projects sustained due to the considerable damage to facilities during the period in which construction was suspended, causing an increase in project costs. This required reapproval of the project plan and additional financial resources, and as of April 2019 these two projects are yet to be completed⁹.

According to MEM, the Project was the first time for the Regional Governments of both Cajamarca and Loreto, which became executing agencies, to execute rural electrification projects, and compared to MEM, which has accumulated a considerable amount of experience in this field,

⁹ As of February 2019, reapproval of the project plan for one of the two projects implemented by the Regional government of Loreto (SER Nauta) is complete, and preparations for application are underway for the other project (SER Requena). Budgets for both projects have yet to be estimated. In these projects, current was to be provided to the grid once the entire project was completed, so in some target areas distribution facilities were not electrified and maintenance was not carried out for several years after completion, and during this period, the facilities deteriorated and sustained damage and theft. The projects in Cajamarca and Huánuco Regions and the project directly managed in Loreto Region, operation of the distribution grids started in sequence from the villages where the grid was complete, and as a consequence, appropriate maintenance was carried out by the power distribution companies, and similar problems did not occur.

the implementation of the projects was not very efficient. In addition, in Cajamarca and Loreto Regions, projects were implemented not in the form of area-by-area agreements (agreements which include both materials procurement and construction work as a package in the same agreement) originally planned at the time of appraisal, but under separate agreements for materials procurement (five agreements in each region according to type of materials) and construction work (four agreement in Cajamarca Region and two agreements in Loreto Region). As a consequence, the different aspects of management, including the work of giving instructions for the delivery of materials as construction progresses and delivering these to construction contractors, securing locations for the appropriate storage of large quantities of materials and ensuring means of transport for said materials, are complex, making project supervision difficult¹⁰.

3.2.3 Results of Calculations for Internal Rates of Return (Reference only)

At the time of appraisal, with project cost and operation and maintenance costs as costs, and the savings resulting from alternative energy, and revenues from electricity sales resulting from the use of electric lighting, televisions and refrigerators, etc. as benefits, and assuming a project life of 20 years, the Economic Internal Rate of Return (EIRR) was estimated as 22.8%. However, the details of the calculation process are unclear.

In the ex-post evaluation, for Cajamarca Region, in which the projects using ODA loans were completed and adequate data were obtained, the EIRR was calculated using the method employed by MEM for rural electrification projects at the time of the ex-post evaluation to obtain the result of 15.1%¹¹.

Based on the above, the project cost exceeded the plan, and the project period significantly exceeded the plan. Therefore, efficiency of the Project is low.

¹⁰ At the time of appraisal of the Project, it was assumed that all projects would be implemented in the form of contracts including material procurement and construction works as a package, but the Regional Governments of Cajamarca and Loreto both proposed to JICA that the agreements should be separated into materials procurement and construction work contracts, and JICA agreed to these proposals. These proposals were based on the apprehension that construction contractors to whom contracts were awarded would individually procure materials on the international market, which would result in delays in implementation. However, the executing agencies of both regions had no experience in such large-scale materials procurement and storage and transport of said materials in rural electrification projects, and in practice, smooth implementation was difficult. In contrast, in Huánuco Region, MEM employed contracts including material procurement and construction works as a package as planned at the time of appraisal, based on the experience in the preceding phases of the Project. In Huánuco Region, materials procurement and construction were performed in the same contracts, and the management of these two aspects was handled by the contractors, leading to smooth implementation of the projects. According to interviews at the time of the ex-post evaluation, executing agencies of Cajamarca and Loreto Regions now consider that, based on the experience of the Project, it would have been better to adopt packaged contracts rather than separate contracts for materials procurement and construction work.

¹¹ The Economic Internal Rate of Return was calculated taking the project cost and operation and maintenance expenses as costs, and the social benefit (the amount consumers would be willing to pay) of electrical appliances (electric lighting, radio/TV, refrigerators) as benefits, and a project life of 20 years. As the details of the calculation method at the time of appraisal were unclear, no comparison was made with the calculations made at the time of appraisal. It was impossible to obtain reliable data for power consumption in Loreto and Huánuco Regions.

3.3 Effectiveness and Impacts¹² (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

Since the objective of the Project was to improve the electrification ratio of target areas, the effectiveness of the Project was analyzed in terms of the extent to which the electrification ratio of each region was increased as a result of the Project (indicator: household electrification ratio) and whether highly reliable electricity services are being provided to newly connected households (indicator: annual duration of interruptions per user). The effectiveness of transmission facilities constructed in Huánuco Region was analyzed in terms of the state of operation and utilization of facilities. At the time of appraisal, "facility availability factor", "peak load" and "electric energy sold" were suggested as operation and effect indicators, but the measurement subjects for these indicators were unclear, and difficulties in obtaining data meant that these indicators were not analyzed. As reference information to gain a clear picture of the state of utilization of the Project, the level of electricity consumption by newly connected households was analyzed (indicator: average electricity consumption).

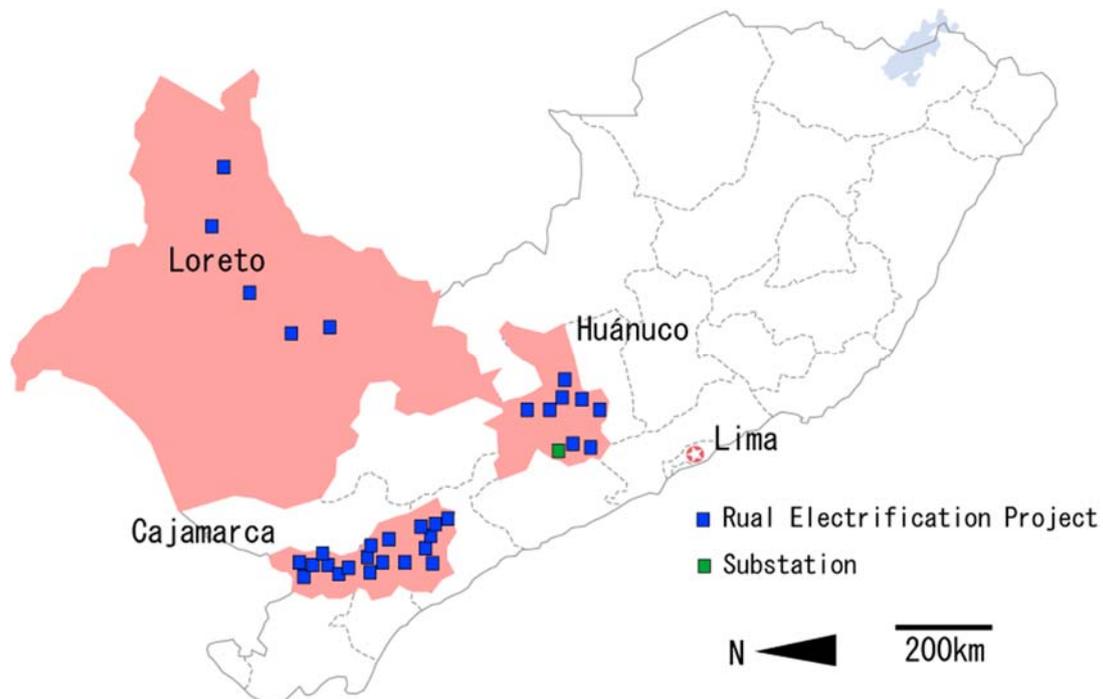


Figure 1 Distribution of Target Areas and Rural Electrification Systems (RESs) of the Project

(1) Improvement in Electrification Ratio

As shown in Table 4, the household electrification ratio in the target three regions has improved

¹² Impact was also taken into account in the rating of effectiveness.

dramatically since 2007. In the Project, targets were set for 2013, and actual figures for Cajamarca and Huánuco Regions both exceeded these targets¹³. The Project is estimated to have boosted the household electrification ratio in Cajamarca Region by approximately 6% and in Huánuco Region by approximately 9%, and it would have been difficult to achieve the planned figures without the Project¹⁴. In Loreto Region, the household electrification ratio exceeded the target for 2013, but delays in the completion of the Project mean that it has not contributed to an improvement in the electrification ratio at this point in time. As of 2018 the household electrification ratio for Loreto Region is approximately 80%, of which approximately 3% is estimated to be attributable to the Project. Taking into account that the relative weight of Loreto Region in the entire project is small (approximately 20% on a project cost basis), the effectiveness of the Project as a whole with respect to improving the electrification ratio is high.

Table 4 Contribution of the Project to Improved Electrification Ratio

	Household Electrification Ratio				No. of Newly Connected Households due to the Project (a)	Total no. of Households (2017) (b)	Contribution to electrification ratio (a) ÷ (b)
	Actual			Target			
	2007	2013	2017	2013			
Cajamarca Region	46.6%	75.8%	89.3%	73.0%	43,508 (2018)	736,152	6%
Huánuco Region	46.8%	75.1%	86.8%	69.7%	16,226 (2011)	189,886	9%
Loreto Region	61.8%	76.1%	79.3%	74.6%	5,647 (2018)	189,611	3%

Sources: Electrification ratio and total number of households: National Bureau of Statistics and Censuses

Number of newly connected households due to the Project: Executing agency of each region

Note: Actual data for 2018 could not be obtained for the number of newly connected households in Huánuco Region.

(2) Reliability of Electricity Service

According to data from the Regulatory Agency for Investment in Energy and Mining (hereinafter referred to as "OSINERGMIN"), the annual duration of interruptions per user and average duration of each interruption in the 11 RESs of the Project (entire systems including elements outside the phases constructed in the Project) are shown in Table 5¹⁵. According to OSINERGMIN, the operating standards for the systems of the Project are interruptions that do not exceed 80 hours per year. The average annual duration of interruptions for the 11 systems (weighted average by number of users) was 44.8 hours, around half of the standard. Therefore, the effectiveness of the Project in terms of reliability of electricity services is high. The average

¹³ At the time of appraisal, planned figures were set for 2013, assuming completion of the project in two years' time. Since the actual completion dates for the Project vary according to the region, and in the ex-post evaluation, an across-the-board comparison was not made for completion in two years' time.

¹⁴ The Project was completed in Cajamarca Region in 2012 and in Huánuco Region in 2011.

¹⁵ OSINERGMIN was established as an institution for supervising investment in the energy sector in 1996, and has the function of supervising legal, contractual and technical performance, a function of regulating the setting of tariffs, and a function of resolving disputes between companies and consumers. Data for each RES was obtained from OSINERGMIN for the ex-post evaluation, but data for each phase could not be obtained.

duration for each interruption ranged from 1 to 6 hours depending on the system, and for the entire project averaged 2.8 hours.

Table 5 Interruption per User in the Target Systems of the Project (2017)

Region	Rural Electrification System	Annual Interruption Duration per User (Hours/Year)	Average Duration of Each Interruption (Hours)
Cajamarca	SER CAJAMARCA NORTE	26.8	2.7
	SER GUADALUPE	23.6	4.2
	SER CUTERVO	0.4	5.7
	CHOTA-SER	11.8	1.0
	BAGUA-JAÉN RURAL-SER	27.2	1.3
	SAN IGNACIO RURAL	0.0	-
Loreto	SER CABALLOCOCHA	79.8	2.0
	SER IQUITOS ZONA	0.6	1.0
Huánuco	SER HUÁNUCO	48.0	1.8
	SER AUCAYACU	295.0	5.2
	SER TINGO MARÍA	276.6	4.8

Source: OSINERGMIN

Note: "SER" is an abbreviation for Rural Electrification System (Sistema Eléctrico Rural)

According to interviews with executing agencies and the electric companies, generally speaking, the following constraints exist with respect to the operation of RESs, which are resulting in interruptions.

- Felling of trees which cause interruptions: Electric companies perform felling (protective felling) of trees in the vicinity of power lines which cause interruptions and accidents when they come into contact with medium-voltage distribution lines (bare wires). Interruptions of this type are frequent in the rainy season (interruptions caused by lightning also occur in the rainy season). During construction work, trees in the vicinity of power lines are felled and compensation is paid to landowners, but landowners request compensation again when re-felling trees that have regrown from tree stumps, which should be unnecessary, and it is often the case that landowners do not authorize felling¹⁶. This often occurs when ownership of land changes due to succession or sale. In addition, local electric companies have limited budgets, personnel and equipment, which prevents these tasks from being carried out at an appropriate frequency in some cases (refer to Sustainability). This is more often the case in low-lying areas where plants grow rapidly in the rainforest of the Amazon River catchment area (Loreto, Cajamarca Regions and some of Huánuco Region).

¹⁶ When making compensation payments, signatures of landowners are obtained on agreements clearly stating that new trees will not be planted under power lines, but some landowners do not respect these agreements, and it is often the case when ownership of land changes that these duties are not taken over appropriately. There are also some landowners who intentionally plant trees with the aim of obtaining compensation a second time.

- Emergency response in remote areas: the electric companies station emergency response teams in each area, but it takes time to respond if interruptions occur in remote areas and areas which cannot be accessed by vehicle.
- The Project focused on providing electricity to remote areas wherever possible, and in order to curb expenses, automatic reclosers to limit the area of interruptions were not installed. As a consequence, interruptions at terminal portions of the grids affect entire grids, creating a tendency for the area of interruptions to increase.



State of power usage within houses (left: Huánuco Region, right: Loreto Region)



Left: Example of electricity use in store (Loreto Region)

Right: Example of electricity use in an elementary school (Cajamarca Region)

Duration of interruptions for almost all RESs were within standards, but the duration of interruptions for two RESs (SER AUCAYACU and SER TINGO MARÍA) in the tropical rainforest areas of Huánuco Region reached more than 300% of the standards. Electro Centro, the power company that operates these two RESs, gave the following explanation. Due to budgetary

constraints up until now, felling only involved trees which caused interruptions, and protective felling trees was not adequately carried out, causing an increase in interruptions. Up until now, Electro Centro has outsourced facility maintenance and protective felling trees in the same outsourcing agreements, but in the future the company intends to perform outsourcing agreements for protective felling trees alone, and dramatically increase the budget for these activities.

(3) Effectiveness of Transmission Facilities

Under the Project, one substation was constructed in Huánuco Region to promote rural electrification. According to MEM, this transmission facility is connected to a large number of RESs, including one target RES of the Project. Over the three-year period from 2015 to 2017, the facility was operating at 100% of capacity (the facility did not stop once over the three-year period), and in 2017, transmitted 10,976 MWh of electricity, equivalent to the power consumption of approximately 45,000 households. The facility is being operated and utilized appropriately. Therefore, the effectiveness of the Project with respect to transmission facilities is high.

(4) Power Consumption of Newly Connected Households (Reference Information)

The average power consumption of households in the two RESs of Cajamarca Region and the three RESs of Huánuco Region for which data was obtained from local electric companies was 17.0 kWh/month. This figure represents two 30 W fluorescent lamps and a small 80 W television being used for four hours per day, and was two-thirds of the figure in the plan at the time of appraisal, which indicates that use of electricity has not progressed as much as was assumed. According to group interviews conducted with local residents (refer to Impact), all households use electric lamps, with the majority of households also using televisions and mobile phones, but usage of refrigerators, mixers and other electrical appliances is limited. Power consumption is thought to be largely influenced by the economic capacity of individual households, and increased by as much as 50% over two years to 2017 in some cases in the two RESs in Cajamarca Region. It is therefore possible that usage of electricity may increase in the future. The Government of Peru has a system through which it provides propane gas for cooking to households whose power consumption does not exceed 30 kWh/month, and local electric companies have indicated that this system curbs power consumption.

In summary, the Project made an important contribution to improving the electrification ratio in each region up until 2017. The annual average duration of interruption per user of the Project as a whole is approximately half of the standard, indicating that the power supply is highly reliable. Transmission facilities are being operated and utilized appropriately. Therefore, effectiveness of the Project is high.

3.3.2 Impacts

3.3.2.1 Intended Impacts

The Project was expected to bring about impacts such as an improvement in the living standard of local residents and the stimulation of social and economic activities. In the ex-post evaluation, the impact on the lives of residents, public facilities and economic activities was analyzed through interviews with residents in areas newly connected to electricity services after the Project, in addition to public facilities and commercial facilities¹⁷.

(1) Impacts on the Lives of Residents

Before the Project, residents relied mainly on kerosene lamps or candles, and aside from battery-powered radios, electrical appliances were hardly used at all. After the project, multiple electric lights (most of which are fluorescent lamps or LED lamps) are now used in all electrified households. In addition, mobile phones are now used in almost all households and televisions in the majority of households. Audio equipment is used in a third of households, and refrigerators, mixers, irons, rice cookers and the like are used in a small number of households. Ownership of electrical appliances depends largely on the economic level of the beneficiary. Almost all beneficiaries of the Project are farmers, and in poorer areas there are some households who only own electric lights. Refrigerators are mainly used in low-lying areas where the temperature is high. The use of such electrical appliances was reported to have the following benefits in the lives of households.

- Electric lighting: Health problems caused by soot and smoke from kerosene lamps and candles were eliminated¹⁸. Indoors became brighter, enabling housework and children's study to be performed more efficiently, and the danger of falling over and fires was reduced. In some villages home industries such as sewing and hat-making can now be carried out more efficiently for long periods of time. Before the Project, people went to bed early without doing anything, but as a result of the Project, sleeping time was reduced (before people were going to bed around 7 pm, but are now going to bed around 9 or 10 pm), resulting in an increase in the amount of time that can be used for housework, home industries and time spent as a family. There were also reports of children now doing their homework in the evening and as a result now helping in the fields during the daytime. The expense of lighting was reduced compared to kerosene lamps and candles.

¹⁷ Group interviews with local residents were conducted in the ex-post evaluation (126 people, 72 males and 54 females, in 15 villages of eight RESs), at schools (7 schools), medical facilities (2 facilities), stores and businesses (6 enterprises) in target areas. The target villages were selected to obtain a good overall balance, taking into account the number of projects completed in the target three regions (refer to Table 3) and the diversity of target areas (mountainous areas and low-lying areas in the Amazon River catchment area). Individual interviews were conducted in facilities and businesses in each of the selected villages.

¹⁸ There were reports from medical institution staff of reduced incidence of conjunctivitis and bronchitis.

- **Television:** The majority of households watch news and entertainment programs. In villages where the television signal does not reach, households watch movies and the like by connecting DVD players or USB drives. The following advantages were reported; people are now more aware of domestic and international events through news with images; people enjoy watching entertainment programs such as movies and series as a family, which enables them to relax; people are now able to acquire information useful in their lives through cultural and educational programs (for example information about farming, housework, health, and improving the livelihood of residents); and children now have a broader outlook and enlightened by watching television.
- **Mobile phones:** Mobile phones were being used in some villages before the Project, but the area of network coverage was limited, and users had to go into town to have their phones charged on a fee-paying basis, which was inconvenient. The Project resulted in the construction of new base stations for mobile phones, broadening network coverage, and nearly all households now have mobile phones. In some villages, it is possible to connect to the Internet over mobile phone networks. Mobile phones are mainly used for everyday communications with family, but they also play an important role as a major means of communication in the event of emergencies such as illnesses and accidents. Although infrequent, there are cases in which mobile phones are also used to coordinate work and take orders, etc.
- **Radio/audio equipment:** One third of households have electric radio and audio equipment, which are used to listen to the news and music. Battery-operated radios are taken out into the fields to do farm work, and are therefore still used by the majority of households.
- **Refrigerators:** Refrigerators are used by some households, mainly in tropical rainforest areas. The following advantages were reported; it is possible to conserve household food, the amount of food that spoils was reduced, and people are now able to eat fresh food. There are often cases where beverages and frozen desserts are stored for sale.
- **The installation of street lights within villages** has helped to prevent accidents involving people falling over, and theft (theft of livestock, etc.). In the majority of villages there are one or two small stores, and the use of lighting has enabled them to stay open later in the evenings. With the advent of electrification, local residents are now able to walk around at night after dark.

(2) Impact on Public Services

Through interviews with hospitals, educational institutions and administrative organizations,

the following desirable impacts on public services as a result of connection to the electricity and improvements to the electricity services were identified.

- Elementary and secondary schools: Schools are now able to use audio-visual materials on television, making it possible for students to gain knowledge more efficiently. Television is useful not only for students but education and training for parents and village inhabitants as a whole (for example, training about health), and teacher training. PC education using small laptop PCs for educational purposes or desktop PCs has started. Audio equipment has enabled school events to be carried out more smoothly. This equipment is also used in village gatherings. School principals are now able to manage their work more efficiently using office PCs and printers. Printers are also used to print out educational materials.
- Medical facilities: There were reports that the introduction of refrigerators enabled vaccines to be stored, which has enabled vaccinations, which previously had to be carried out in far-away facilities, to be carried out within the village, which improved vaccination rates. It is now possible to use sterilization equipment (instruments were previously boiled) and lighting for examinations, which has improved the efficiency of examinations and treatment. The availability of lighting has extended medical service hours, and enabled night-time emergencies to be handled. The efficiency of management work has been improved through the use of PCs.
- Administrative facilities: PCs and printers have been installed in city offices, improving the efficiency of operations. Photocopying of documents necessary for formalities previously had to be carried out in town, but this has become easier. Lighting was installed in meeting facilities in villages, enabling villagers to gather at night, eliminating the need for villagers to stop their daytime farm work for village meetings. The need to borrow generators for festivals and other village events was also eliminated.

(3) Impact on Economic Activities

In the more than 15 villages that were visited, one woodwork shop equipped with multiple woodworking machines (in the outskirts of an urban area), two households with small electric woodworking machines and three households with small welding machines were identified. All machines are operating with single-phase current. In some villages, large electrical woodworking machines and pumps were connected but these were unable to use with single-phase current, so there were calls for three-phase current, but generally speaking, there is little electricity usage for processing industries. In many villages, there are a small number of stores (see above), and some of these are staying open later after dark thanks to electric lighting. Some stores sell beverages and frozen desserts cooled in refrigerators. In some villages, home industry such as hat-making

and sewing is carried out, even at night.

With regard to the benefits of electrification outlined above, almost all residents were extremely satisfied. Opinions heard included: "We were waiting for the arrival of electricity for years" and "I can't imagine living without electricity now". By sectors, a large number of residents emphasize the following benefits, in the following order; health (reduction in health problems caused by kerosene lamps and candles), education (children's homework, PC classes, etc.), telecommunications (television, mobile phones). In light of the above, the Project is deemed to have brought about an adequately high social impact. However, the impact on economic activities is limited, and a large number of residents of Huánuco Region, where interruptions are frequent, called for power to be restored more rapidly in the event of interruptions.

In Cajamarca and Loreto Regions, the Project for Promotion of Appropriate Use of Electricity (Cajamarca Region: 2010-2011, Loreto Region: 2012-2013) was implemented with JICA's support with the objective of promoting the utilization of electricity in production activities. According to the governments of both regions, however, the scope of this project assumed power supply with three-phase current, and the single-phase current in the majority of the target villages of the Project did not enable the use of production facilities which use three-phase current, which meant the above project was not necessarily useful. Some of the target villages of the Project in Cajamarca Region and all of the target villages in Loreto Region were included within the above project, but field surveys revealed few residents who had clear recollections of having participated in the activities of this project.

3.3.2.2 Other Positive and Negative Impacts

(1) Environmental and Social Impacts

Environmental impact assessments as required by law were carried out for all projects (construction of RESs and construction of transmission facilities) contained within the Project. In this process, environmental monitoring plans including environmental management, waste disposal and dissemination of information were formulated and implemented. According to the executing agencies, no noteworthy environmental impacts were observed. No particular environmental impacts were observed in on-site visits. There was no migration of residents or acquisition of land in the Project, and compensation was paid for trees which needed to be felled. This compensation was paid appropriately in accordance with the regulations in Peru. While, there are some sectors in which compensation cannot be paid yet due to difficulties in locating land owners, and the executing agencies are making efforts to complete the compensation.

(2) Other Impacts

No other noteworthy impacts were observed.

In light of the above, the Project has achieved its objectives. Therefore, effectiveness and impacts of the project are high.

3.4 Sustainability (Rating: ②)

3.4.1 Institutional and Organizational Aspects of Operation and Maintenance

In Cajamarca and Loreto Regions, the distribution facilities constructed in the Project are owned by the regional governments concerned. These facilities were transferred by agreement to electric companies (four companies), and are being operated and maintained accordingly. In Loreto Region, however, the two incomplete projects have yet to be transferred. In Huánuco Region, the distribution and transmission facility constructed under the Project was transferred to an electric company, and is being operated and maintained by said company.

The operation and maintenance of RESs is performed directly by each electric company or outsourced, but the scope and number of outsourcing agreements varies according to the electric company. Normally each company formulates an annual plan for regular inspection and preventive maintenance for facilities and for protective felling of trees in the periphery of power lines, and performs maintenance work in accordance with these annual plans. In addition, emergency response teams are stationed in each area to deal with interruptions and the like. A team comprised of two technicians (and a driver) is deployed in the event of emergency. In remote areas in which there are no offices of local electric companies, there are sometimes resident technicians who support the commercial and technical aspects of operations. However, the allocation of funding to farming villages which generate little profit has a low priority (which will be mentioned later), and in some areas protective felling and the stationing of personnel for emergency response teams is not necessarily adequate.

OSINERGMIN supervises the operation of each electric company and each project. If interruptions exceed a given standard, each electric company is required to pay, as a fine, into a fund for rural electrification projects operated by MEM.

In light of the above, the operation and maintenance framework for the Project is clearly defined, but some problems remain in the stationing of personnel.

3.4.2 Technical Aspects of Operation and Maintenance

No serious problems were observed in the technical aspects of operation and maintenance of the transmission lines and RESs by the electric companies. In the event that operation and maintenance are outsourced, necessary training is implemented under the responsibility of the contractor. Wiring within residences is carried out by people with wiring experience who live locally and wiring technicians in the villages trained by electric companies. Although some cases of wiring which had been carried out with few technical considerations were observed, according

to interviews during on-site visits and technicians from the electric companies, there are no reports of electric shock accidents.

In light of the above, there are no problems with the technical aspect of operation and maintenance of the Project.

3.4.3 Financial Aspects of Operation and Maintenance

In RESs, the number of contracted users is few compared to the extension of the transmission and distribution grids, and the power consumption per household is minimal, with operation and maintenance costs destined to be greater than revenues from the sale of electricity. It is therefore thought that operating losses are recorded for those portions of operations alone¹⁹. By covering the losses made in rural areas with the profits made in urban areas, each electricity company is recording an operating profit for the company as a whole (table 6).

In light of the above, no particular problems were observed in the sustainability of the financial aspect of the Project.

Table 6 Financial State of Electric Companies which Perform Operation and Maintenance (Fiscal 2017)

(unit: thousand Nuevo Sol)

	Area Covered for the Project	Operational Revenue	Operational Expenses	Operating Income	Net Income
Electrocentro	Huánuco Region	572,671	462,664	8,670	9,626
Electronoreste	Cajamarca Region	579,607	479,969	99,638	68,288
Electro Oriente	Loreto Region Cajamarca Region	615,724	571,335	44,389	23,529
Hidrandina	Cajamarca Region	912,391	773,157	139,144	98,333

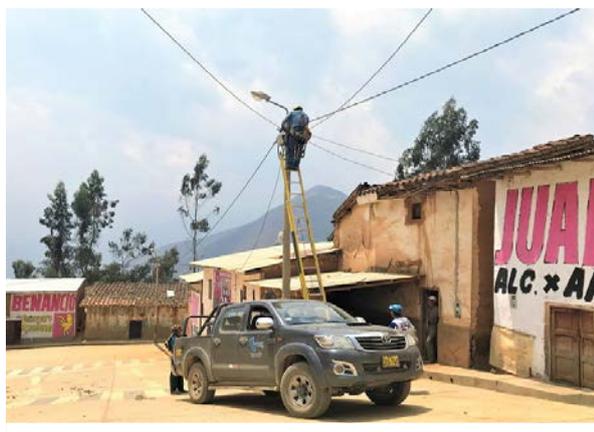
Source: Anuario Estadístico 2017 (OSINERGMIN)

3.4.4 Status of Operation and Maintenance

Each of the local electric companies performs maintenance inspections of facilities according to plans, and repairs and emergency response in the event of interruptions. If there are large numbers of interruptions or complaints, these companies are forced to pay fines to OSINERGMIN. The companies therefore endeavor to perform this work appropriately, including cases in which it is outsourced (if the work is outsourced, electric companies are made to pay part of these fines). However, priority is not given to the stationing of personnel in rural areas which have low profitability, the population in rural areas is sparse, and the total length of distribution lines is long, with it taking two days maximum for a return trip to remote villages. As a result, emergency

¹⁹ An interim evaluation study conducted by JICA in 2007 to evaluate the Phase I Project found that the expenses for operation and maintenance (comprising the cost of purchasing electricity, outsourcing cost of operation and maintenance, and administrative expenses of the power companies) was approximately 120% of the revenues from the sale of electricity for the 18 RESs expanded under the Phase I Project (according to the ex-post evaluation reports for Phase I and II Projects).

response takes time in some cases. The average annual interruption duration (refer to Effectiveness) of the Project is within OSINERGMIN standards, but annual interruption duration in the two RESs of Huánuco Region is particularly long. In light of the above, some problems remain in the state of operation and maintenance of the Project.



Maintenance of Street Lights (Huánuco Region)

In light of the above, although no major problems were observed in the technical and financial aspects of operation and maintenance of the Project, there are some problems in terms of the institutional and organizational aspect and state of operation and maintenance. Therefore, sustainability of the Project is deemed to be fair.

4 Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The Project is to improve the electrification ratio in target areas by developing the transmission and distribution grids in Peru's Regions of Cajamarca, Huánuco and Loreto, thereby contributing to improved standard of living of local residents and stimulation of social and economic activities. The promotion of electrification in rural areas was an important issue for Peru and the target regions both at the time of appraisal and the ex-post evaluation, making the Project highly consistent with the policies and development needs of Peru. Additionally, the Project is consistent with Japan's ODA policy at the time of appraisal, which positioned reduction in poverty and correction of social disparity as important spheres of aid. Therefore, the Project is highly relevant. Project outputs were somewhat lower than planned, and project cost was higher than planned. The project period far exceeded the plan, and some part of the Project in the Loreto Region was incomplete at the time of the ex-post evaluation. Therefore, efficiency of the Project is low. The Project made an important contribution to improving the electrification ratio in target areas, and overall, the reliability of the power supply is high. Although power consumption seems to be lower than expected, the expected impact of improving the living standard of local residents is clearly evident. Therefore, effectiveness and impacts of the Project are high. No major problems have been observed in the technical and financial aspects of operation and maintenance of the Project, but some problems were observed in the institutional and organizational aspect, and the current status of operation and maintenance, with interruptions being particularly frequent in some

parts of the Huánuco Region. Therefore, sustainability of the Project effects is fair.

In light of the above, the Project is evaluated as partially satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency and the Operation and Maintenance Agency

- The Regional Government of Loreto needs to secure funding from its canon tax (a tax levied on mining companies) and other sources, and urgently complete the two RESs which have yet to be completed. If the finances of the Regional Government of Loreto are inadequate, the Government of Peru, which is the ODA loan borrower for the Project, is expected to cooperate.
- Hidrandina (an electricity company) needs to perform protective felling trees in the two RESs (SER Aucayacu, SER Tingo María) in Huánuco Region which are particularly susceptible to interruptions, and perform appropriate operation and maintenance.

4.2.2 Recommendations to JICA

- There is a need to monitor the state of implementation of the abovementioned recommendations in Loreto Region where ODA loan was availed, and provide possible support with a view to their achievement.

4.3 Lessons Learned

Consideration of Form of Contract Agreement Based on Experience of Similar Projects and Evaluation of Capability of Executing Agencies

In order to consider the appropriate form of contract agreements in a project which has a high degree of difficulty in supervising implementation, for example those contracts which include procurement of large quantities of materials and construction work in a large number of locations, including remote locations, it is necessary to gain a clear picture on similar ODA loan projects as well as experiences and capacity of the executing agencies. In order to do this, it is necessary to gather and analyze thorough information on the implementation of similar projects, including preceding projects, and share the lessons to be learned with related institutions. It is also necessary to review the contract lot arrangement and form of agreement to ensure that the contract management work does not become an excessive burden on executing agencies.

Within the Project, in Huánuco Region, MEM, which was one of the executing agencies, based on the experience of preceding phases, was able to implement the Project smoothly using contracts that include both procurement of materials and construction work as a package. In contrast, in Cajamarca and Loreto Regions, the both regional governments were the executing

agencies, procurement of materials and construction work were performed under separate contracts. As a consequence, there were not only a large number of contracts, but the fact that the executing agencies took on the responsibility of appropriately storing large quantities of materials is thought to have been one factor which made the Project difficult to implement smoothly.

Staged Operation of Rural Electrification Facilities

If, after completion, rural electrification facilities are left non-operational for long periods of time without being electrified, facilities sustain damage due to appropriate maintenance of facilities and under-line trees not being performed, and occurrence of theft. It is likely that this may cause an increase in project costs. Therefore, from the perspective of manifesting the project effects as soon as possible, it is preferable that construction work be implemented in a process through which facilities can be completed in stages, enabling operation to start, and that facilities start operation immediately after completion of each stage. If it takes a long time from facility completion to the start of operation, it is necessary to ensure the security of facilities by stationing security personnel or taking similar measures.

In the Project, some of the facilities in Loreto Region, after completion and before operation, sustained damage, theft of wires, and growth of trees under power lines, and the cost of remedying these situations were considerable, causing the project cost to far exceed planned figures. As a consequence, the project plan needed to be reapproved by the Regional Government of Loreto, and additional funding is required. Consequently, the facilities are still incomplete as of April, 2019.

Social Support in Rural Electrification Projects

In rural electrification projects, it is important that electricity users who are essentially using electricity services for the first time understand the appropriate use of electricity and electrical appliances, response in the event of an interruption, and the importance of protective felling of trees. Dissemination of information for these purposes needs to be conducted in conjunction with the start of electricity services. With regard to protective felling of trees, it is preferable that the understanding of residents be gained with respect to the nature of under-line compensation and the objective of the felling trees (safety and prevention of interruptions), and the active involvement of electricity users by working together with village administration and community organizations.

In relation with the Project, technical cooperation was conducted by JICA to disseminate information for the productive use of electricity in Cajamarca and Loreto Regions, but as this was conducted several years before the start of provision of electricity services, there were hardly any residents who recalled the nature of this technical cooperation at the time of the ex-post evaluation.

With regard to protective felling of trees, there are cases in which it is difficult to implement it smoothly, with some landowners refusing to fell trees that have grown under power lines, despite having been paid compensation, and planting new trees under power lines and requesting re-compensation.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
① Outputs*		
Construction of Rural Electrification Systems (RESs)		
Number of rural electrification projects	Cajamarca Region 19 Huánuco Region 8 <u>Loreto Region 6</u> Total 33	Cajamarca Region 19 Huánuco Region 8 <u>Loreto Region 5</u> Total 32
Transmission lines (medium-voltage lines) (km)	Cajamarca Region 2,132 Huánuco Region 926 <u>Loreto Region 678</u> Total 3,736	Cajamarca Region 1,778 Huánuco Region 870 <u>Loreto Region 721</u> Total 3,369
Number of new connections	Cajamarca Region 56,161 Huánuco Region 18,995 <u>Loreto Region 8,111</u> Total 83,267	Cajamarca Region 43,508 Huánuco Region 16,226 <u>Loreto Region 8,188</u> Total 67,922
Construction of transmission facilities		
60 kV Transmission line (Huánuco Region)	23.0 km	21.5 km
Substation (Huánuco Region)	1 location	1 location
Consulting service	Detailed design, procurement assistance, construction supervision	As planned
② Project Period	March 2009 - May 2011 (29 months)	March 2009 – not completed as of the ex-post evaluation (April 2019) (122 months) RESs in Cajamarca Region September 2012 (43 months) RESs in Huánuco Region March 2011 (25 months) Transmission line / substation in Huánuco Region April 2014 (62 months) RESs in Loreto Region Partially not completed as of April 2019 (122 months)
③ Project Cost*		
Total	13,243 million yen	14,351 million yen
ODA Loan Portion (within the total)	4,926 million yen	4,925 million yen
Exchange Rate	1 US\$ = 111 yen = 3.16 Nuevo Sol (2008)	1 US\$ = 95.3 yen = 2.85 Nuevo Sol (average for 2010-2015)
④ Final Disbursement		8 March 2013 (Loreto Region) 12 June, 2013 (Cajamarca Region)

Note: RES: Rural Electric System