Ex-Post Project Evaluation 2010 : Package II-5

(Iran, Pakistan, Peru)

October 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

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Preface

Ex-post evaluation of ODA projects has been in place since 1975 and since then the coverage of evaluation has expanded. Japan's ODA charter revised in 2003 shows Japan's commitment to ODA evaluation, clearly stating under the section "Enhancement of Evaluation" that in order to measure, analyze and objectively evaluate the outcome of ODA, third-party evaluations conducted by experts will be enhanced.

This volume shows the results of the ex-post evaluation of ODA Loan projects that were mainly completed in fiscal year 2008, and Technical Cooperation projects and Grant Aid projects, most of which project cost exceeds 1 billion JPY, that were mainly completed in fiscal year 2007. The ex-post evaluation was entrusted to external evaluators to ensure objective analysis of the projects' effects and to draw lessons and recommendations to be utilized in similar projects.

The lessons and recommendations drawn from these evaluations will be shared with JICA's stakeholders in order to improve the quality of ODA projects.

Lastly, deep appreciation is given to those who have cooperated and supported the creation of this volume of evaluations.

October 2011
Masato Watanabe
Vice President
Japan International Cooperation Agency (JICA)

Disclaimer

This volume of evaluations, the English translation of the original Japanese version, shows the result of objective ex-post evaluations made by external evaluators. The views and recommendations herein do not necessarily reflect the official views and opinions of JICA. JICA is not responsible for the accuracy of English translation, and the Japanese version shall prevail in the event of any inconsistency with the English version.

Minor amendments may be made when the contents of this volume is posted on JICA's website.

JICA's comments may be added at the end of each report when the views held by the operations departments do not match those of the external evaluator.

Iran

Ex-Post Evaluation of Japanese ODA Loan Project
"Godar-e-Landar Hydroelectric Power Project
and
Masjid-e-Soleiman Hydroelectric Power Project (II)[1]"

External Evaluator: Izumi Sakaya, Global Group 21 Japan, Inc.

0. Summary

The Project was planned as one of the measures of electric power development policy of Iran to meet rapidly increasing demand of power. There is still a strong need for a further increase of the generating capacity of the electric power because of the continual increase of the demand. As the Project was compatible with Japan's ODA policies, its relevance is high. The scale of the generating capacity of the constructed Masjid-e-Soleiman Hydroelectric Power Plant is as planned and the overall project cost was within the planned cost. However, the completion of the Project was delayed by 4 years due to the cancellation of part of the yen loan and some other reasons. Accordingly, the efficiency of the Project is judged to be medium. Although the achievement rate of volume of power generation is around 80% of the original plan, it is due to shortage of rainfall and decreases in water discharge of upstream dams. In consideration of the high economic validity (internal rate of return) of the Project, its effectiveness is judged to be high. The Project contributes to steady power supply in Iran as a whole by providing the power through the national grid. The facilities constructed under the Project are in good working condition and Khuzestan Water and Power Authority (KWPA) which operates these facilities is believed to possess an adequate operation and maintenance management system, technical expertise and financial strength. As such, the sustainability of the Project is judged to be high.

In light of the above, the Project is evaluated to be highly satisfactory.

1. Project Profile

Location of the Project

Masjid-e-Soleiman Dam

[1] The yen loan was provided in two phases. At the time of the first phase, the name of the project was Godar-e-Landar Hydroelectric Power Project, and later changed to Masjid-e-Soleiman Hydroelectric Power Project in the second phase

1.1 Background

Around the year 1990, Iran suffered from serious shortage of electric power at peak hours, thus the Government had to impose planned power outage. Furthermore, increasing demand for power was expected with reconstruction of the economy after the Iran-Iraq War (1980-1988). Therefore electric power development projects were prioritized in the First Five Year Economic, Social and Cultural Development Plan (1989-1994), which was national development plan of Iran. Ministry of Energy implemented power development projects based on the Five Year Plan, and as in 1993, 17 thermal power plants were under construction and another 11 thermal plants and 8 hydro electric power plants were planned for construction.

Whereas Iran has abundant oil and natural gas which are prime energy resources for power generation, the country also has rich water resources in its mountain areas. It was considered to be important in the long run to promote hydroelectric power generation with the viewpoint of saving hydrocarbon resources. Especially it was identified by the master plan study in 1960s that the Karun River basin had extremely high potentials for development. The Masjid-e-Soleiman Hydroelectric Power Plant (hereafter HEPP) was planned as one of those development projects. After conducting a feasibility study in 1990, the Iranian Government officially requested for a yen loan for the Project in 1991 followed by the Loan Agreement in 1993 and the implementation of the Project from 1996 to 2006.

At the time of the appraisal of the Project in 1992[2], the total amount of foreign currency required for the Project was estimated at around 150 billion yen, which was planned to be provided in three phases. The first phase loan amounted to 38.6 billion yen (Phase 1 of the Project) for part of the civil works and consulting services. After that, the second loan for generators and other equipment was scheduled to be provided in 1994 and the third loan for the remaining civil works was planned to follow. However, because the United States of America strengthened its economic sanction against Iran and requested the Japanese Government to follow suit, the Japanese Government decided to cancel the second and third loans. Thus the Iranian Government financed the generators with its own resources. In the meantime, however, as the Project progressed, it became possible that the shortage of funds for civil works could have caused serious damage by floods with interruption of the construction. Therefore, the Iranian Government requested for another yen loan for the remaining civil works in 1998 and the Japanese Government provided an additional loan of 7.5 billion yen (Phase 2 of the Project) as "an emergency measure on the humanitarian ground.[3]"

1.2 Project Outline

The objective of this project is to upgrade Iran's capacity of supplying electric power by means of constructing a rockfill dam and an underground hydroelectric power plant with an installed generating capacity of 2,000 MW (of which the yen loan covers 1,000 MW, with annual power generation of 3,700 GWh) at some 20 km downstream of the existing Karun I Dam (also called Shahid Abbaspur Dam) along Karun River in the south west part of Iran, thereby contributing to steady power supply and a response to the increasing power demand.

Table-1 shows summary of loan agreement of the Project.

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[2] In this report "the appraisal" means to be an appraisal for Phase 1 of the Project, if not mentioned otherwise

[3] Based on JICA appraisal documents.

Table 1 Summary of Loan Agreement

Approved Loan Amount / Disbursed Loan Amount	Approved 46,108 million yen (Phase 1: 38,614million yen, Phase 2: 7,494million yen) Disbursed 45,955 million yen (Phase 1: 38,471million yen, Phase 2: 7,484million yen)
Exchange of Notes / Loan Agreement	Phase 1: May 1993/ June 1993 Phase 2: October 2000 / October 2000
Terms and Conditions	Phase 1: Interest Rate: 3.0% Repayment Period: 25 years (Grace Period:7 years) Conditions for Procurement: Mixed Phase 2: Interest Rate: 2.2% Repayment Period: 25 years (Grace Period:7 years) Conditions for Procurement: General Untied
Borrower / Implementing Agency	Government of the Islamic Republic of Iran / Iran Water and Power Resources Development Company (IWPC)
Final Disbursement Date	Phase 1: August 2005 Phase 2: January 2006
Main Contractors (contract amount of 1 billion yen or more)	Daelim Industrial Co., Ltd. (South Korea) and Sato Kogyo Co., Ltd. (Japan) (JV)
Consultant (contract amount of 100 million yen or more)	Nippon Koei Co., Ltd. (Japan) and Lahmeyer International GMBH (Germany) (JV)
Feasibility Study (F/S)	Feasibility Study was conducted jointly by Lahmeyer International GMBH (Germany) and Moshanir Power Engineering Consultants Services Co. in 1990. Special Assistance for Project Formation Study (SAPROF) was conducted by Nippon Koei Co., Ltd. (Japan) in 1992.

2. Outline of the Evaluation Study

2.1 External Evaluator

Izumi Sakaya (Global Group 21 Japan, Inc.)

2.2 Duration of Evaluation Study

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

Study Period: November, 2010 – September, 2011
Field Survey: January 13th to 28th, 2011 – May 28th April to 6th, 2011

Figure-1 Karun River Basin and Masjid-e-Soleiman HEPP

3. Results of the Evaluation (Overall Rating: A[4])

3.1 Relevance (Rating: ③[5])

3.1.1 Relevance with the Development Plan of Iran

As mentioned in "1.1 Background", the Project was one of power development projects based on the national development plan and, as such, was highly compatible with the development policy of then Government.

In the current Fifth Five Year Development Plan (2010-2015), the power sector aims to diversification of energy sources, optimization of power generation, an increase in efficiency of power plants and reduction of energy loss, and simultaneous production of electricity and heat. According to Ministry of Energy, the Government attaches importance to development of renewable energy including hydroelectric power, with a plan to increase the share of hydroelectric power in the total installed

[4] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[5] ③: High, ② Fair, ① Low

capacity of power generation in Iran from 13.7% in 2009 to 18.5% in 2025. The Project remains highly compatible with the present policy.

3.1.2 Relevance with the Development Needs of Iran

Iran suffered from shortage of power supply during 1986 to 1990 as more than 15% of the maximum power demand was in shortage and planned outage was imposed every year. In 1990, maximum power supply was only 8,182MW as against maximum power demand 10,407MW at peak hours. Furthermore, increasing demand for power was expected with reconstruction of the economy after the Iran-Iraq War (1980-1988). As a matter of fact, maximum power demand reached 18,425MW in March 1999. It was an urgent task for the Government to upgrade capacity of supplying power to respond to the rapidly increasing demand for power. As such, the Project was compatible with development needs.

According to the current long term electric power development plan (2000-2025) by Ministry of Energy, the demand is estimated to increase by about 8% annually by average during the period. The development of power generating facilities are planned to meet the increasing demand, with a plan to expand installed capacity of power generation to 13,600MW in 2025 from 58,705MW in March 2011. Because of the continual increase of the demand for power, the Project is highly compatible with development needs.

3.1.3 Relevance with Japan's ODA Policy

While Iran is important for Japan as an oil producing country, Japanese Government basically considers that it is necessary for Iran to adopt realistic and amicable policies and act so as to realize stable relations with neighbouring countries and other countries in view of peace and stability of the Gulf Region. The Japanese Government, at the time of the appraisal, needed to take an approach where Japan’s cooperation would make contribution to recovery of Iran’s devastated economy by providing appropriate support to the efforts for economic reform made by the then government, through which Iran’s foreign relations would be improved and the stability of the Gulf Region would be increased. The Project was implemented in line with this approach. Therefore it was compatible with Japan’s ODA policies toward Iran at the time of the appraisal[6].

As seen above, this Project has been highly relevant with the country’s development plan, 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 would consist of three components; 1) construction of dam, 2) construction of power station and 3) consulting services.
As shown in the table “Comparison between Original Plan and Actual Results” in the last page, every component was completed almost as planned. Although it appears that actual crest length of the dam is 38m shorter than the original plan, this is because the original plan included the spillway in crest length and there is no significant difference between planned and actual output.
Whereas the Masjid-e-Soleiman HEPP has a power station with an installed power generating capacity of 1,000MW (4 units of generators with a capacity of 250MW for each) within the scope of the yen loan Project, Iranian Government, as had been planned from the initial stage, added another 1,000MW (4 units of generators with a capacity of 250MW for each) by its own financial resources at the expansion stage, completing the plant with an installed capacity of 2,000MW (8 units of generators

[6] The description of this section is based on 1993-98 issues of “ODA White Paper” by Ministry of Foreign Affairs of Japan,

with a capacity of 250MW for each) in total[7].

Surrounding area

Dam Lake

Generators

Turbine

3.2.2 Project Inputs

3.2.2.1 Project Cost

The planned project cost at the time of appraisal was approximately 222.7 billion yen (of which yen loan amounts to 151.4 billion) and the actual cost ended up at approximately 130.1 billion yen (of which yen loan amounts to 45.9 billion) which was only 58% of the original budget (Table 2). The main reasons for a significant decrease in project cost despite the fact that outputs were completed as planned are:

- In general, intense international competition brought about the huge difference between the estimated cost and the actual contracted cost[8].
- As a results of negotiation between the implementation agency (Iran Water and Power Resources

[7] As mentioned in 1.1 Background, because the second yen loan for 4 generators, which had been previously planned at the time of the appraisal, was cancelled, the Iranian Government shifted 4 generators for the expansion stage (units 5-8), which had been contracted for procurement with its own fund, to generators for the yen loan Project (units 1-4).

[8] Although the cost for the civil work was estimated assuming that Japanese contractors would be engaged, no Japanese companies made a bid and Daelim Industrial, of South Korea, won the contract. Actually, Daelim formed a joint venture with Sato Kogyo of Japan for the bidding, but the financial portion of Sato Kogyo was only 5%.

Development Company; IWPC) and contractors, the procurement costs for power generation equipment were lowered by concluding contracts as a part of many contractual packages related to other national dam projects. Further, contract prices were reduced by replacing some of foreign-manufactured equipment with local-manufactured equipment with lower manufacturing and transport costs.

Table-2 Planned and Actual Project Costs

	Planned at the Time of Appraisal				Actual		
	Foreign Currency Portion (million yen)	Of which Yen Loan	Local Currency Portion (million IRR)	Total (million yen)	Foreign Currency Portion (million yen)	Local Currency Portion (million IRR)	Total (million yen)
Pre-construction works	8,269	0	23,726	12,065	0	35,884	1,669
Main civil works	89,400	89,400	234,826	126,972	40,614	598,202	68,437
Power generation equipment, etc.	44,420	44,420	19,349	47,516	0	744,248	34,616
Contingency	11,574	11,161	26,116	15,753	0	0	0
Consulting Services	6,462	6,462	27,689	10,892	5,322	349,164	21,562
Tax	0	0	50,036	8,006	0	0	0
Land acquisition	0	0	9,614	1,539	0	81,202	3,777
Total	160,125	151,443	391,356	222,742	45,936	1,808,700	130,062

Note 1: Exchange rate - ¥1=IRR6.25 (September 1992) at the time of appraisal
¥1=IRR21.50 (Weighted average during 1991–2006) at the time of evaluation
Note 2: Refer to footnote for other explanations'[9].

3.2.2.2 Project Period

The actual project period significantly exceeded the original plan. Whereas the original plan was to implement the Project in 92 months from June 1993 to December 2000, the Project was in reality implemented in 140 months from June 1993 to December 2000. The overall project period was 152% of the originally planned period and completion was delayed by 4 years.

The most prominent reason for the delay of completion was the fact that the Project fell in shortage of foreign currency to procure power generators because the second and the third yen loans which were originally planned were suspended. It took time for Iranian Government to make decision to purchase generators by its own financial sources since information was not available on whether and when the suspension of the loans would be lifted. Because of this reason, the Project delayed by approximately two years.

Other reasons for the delay are as follows:

[9] The following should be noted for actual project cost:
- Because the data for project cost by item by year were not available, it was not possible to calculate an exchange rate item-wise. Here, the weighted exchange rate for total project cost (¥1=IRR21.50) was also applied for calculation of project cost of each item in terms of yen, for convenience.
- The foreign currency portion of the actual project cost only refers to yen loan and other foreign currency portion is included in the local currency portion. For example, although the power generators and turbines, which were financed by Iranian Government with financial sources form China because of cancellation of yen loan (second loan), were purchased with foreign currency, they were calculated as local currency portion in the table. While procurement contract of hydraulic steel structures was agreed in terms of local currency, the contractor actually prepared foreign currency necessary for purchase of the equipment. This is also included in the local currency in the table.

- Under the severe competition in international competitive bidding, the contractor proposed dam construction method with low costs. As a result, discussion with regard to appropriateness of the method took a long time before final decision was made, causing the delay.

- Construction of diversion tunnel took time due to difficulty in procurement of materials

- Impounding of dam by the contractor delayed due to floods, which took place twice, and hardness of work because of high temperature in Khuzestan province.

- It was the first experience for IWPC, which was established in 1989, to implement a project with international contractors and consultants. Lack of experience of project management might have been one of causes of the delay.

Although the project cost was within the plan, the project period was exceeded, 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 Effect Indicators

The Masjid-e-Soleiman HEPP has 8 units of power generators with a total installed capacity of 2,000MW (250MW x 8). Four units of generators, which are under the scope of the yen loan Project, started operation one by one from 2002, and another 4 generators, which are outside the scope of the Project started operation one by one from 2007 at the expansion stage. However, as of May 2011, 4 units of the expansion stage were under repair due to technical problems, of which it would take a long period to repair one unit[10]. The 4 units under the scope of the yen loan Project have been being operated without any problems so far.

Operational data of Masjid-e-Soleiman HEPP are shown in Table-3. All 4 units of generators under the scope of the yen loan Project were installed before the end of 2003 and in 2004 all of them started operation from the beginning of the year. Annual average power generation was planned to be 3,700GWh with these original 4 units and this target figure of power generation, 3,700GWh, has remained the same after additional 4 units of generators had installed[11]. In reality, annual average power generation during the years 2004 to 2010 stood at 2,997GWh, or just 81% of the planned figure. This is not because power station facility had any troubles, but because there was a decrease in annual river discharge from 2008. The river discharge decreased because i) the amount of rainfall in the Karun river basin was smaller in 2008 and 2010, ii) cold winter in 2007 caused a significant increase in power demand, hence hydroelectric power plants (Karun 1 Dam and Karun 3 Dam, see Figure-1) of upstream of the river generated much power and decreased the storage of their reservoirs, which resulted in less discharge of water in the following years, and iii) Impounding to newly constructed Karun 4 Dam, located upstream, started in 2010[12]. It is considered that these reasons have only short

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[10] According to IWPC and a consultant responsible for the expansion stage, the repair of one unit would take a long period because of difficulty in procuring some parts with the effect of economic sanction. For other three units, they are under repair due to troubles in turbine. The manufacturer of 4 units of generators of the Project is different from these generators of the expansion stage.

[11] The amount of power generation of a hydro-electric power plant basically depends on river discharge. Because the Masjid-e-Soleiman HEPP is a dam of run-of-river type without a large scale reservoir where water reserve is only for daily adjustment, the excess river discharge which exceeds a capacity of power generation is not used for power generation. The plant increased the capacity of power generation by adding 4 units of generators to 8 units in total, and therefore became capable to utilize a larger amount of river discharge to respond to the increasing demand for power at the peak time.

[12] At the time of appraisal, this new Karun 4 Dam was not planned.

term effects (1 or 2 years), and not for a long period. If the years since 2008, during which period the river discharge was less, are excluded from calculation, annual average power generation is 3,871GWh, exceeding the planned figure.

Table-3 Operational data of Masjid-e-Soleiman HEPP

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
Water used for power generation (m^3)	1,764	7,972	8,818	10,439	12,043	11,698	4,326	4,968	5,383
Installed Capacity of power generation (End of year, MW)	500	1,000	1,000	1,000	1,000	1,750	2,000	2,000	2,000
Total power generated (All 8 units, GWh)	686	2,906	3,136	3,697	4,392	4,259	1,496	1,728	2,272
units 1-4	686	2,907	3,136	3,697	4,392	3,550	1,109	1,074	1,887
units 5-8	0	0	0	0	0	709	387	653	386

Note 1: In this evaluation report, "year" refers to a period from March 21 of the current year to March 20 of the following year, based on Iranian calendar.
Note 2: First 9 months only for the data of water used in 2010.
Source: IWPC

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

At the time of appraisal, the economic internal rate of return (EIRR) and financial internal rate of return (FIRR) of the Project were 17.2% and 7.8% respectively. The calculations were made based on the following assumptions.

EIRR
Project life: 50 years for dam and 25 years for power generation equipment
Costs : Construction cost and cost for operation and maintenance
Benefits: Cost for investment, operation and maintenance and fuels of a thermal power plant of the equivalent scale

FIRR
Project life: 50 years for dam and 25 years for power generation equipment
Costs : Construction cost and cost for operation and maintenance
Benefits: Income from electricity sales

For this ex-post evaluation, the EIRR and FIRR of the Project were recalculated based on the similar assumptions and actual figures available[13]. The results are; 14.35% for EIRR and 14.78% for FIRR[14]. Even though the figure of EIRR is slightly low compared with the figure at the time of appraisal[15], 14.35% is high enough for a public investment project, assuring economic adequacy of the Project.

3.3.2 Qualitative Effects

Quantitative effects include stable supply of power, economic promotion and improvement of living standards, employment creation and saving in hydrocarbon resources. They are regarded as impacts of

[13] Recalculations were conducted by IWPC and examined by the evaluator.
[14] The detailed calculation process of the appraisal is not precisely known, and for the recalculation, some pre-conditions were modified to acquire more realistic figures, such as calculation based on Iranian currency and application of price escalation, although basic assumptions were the same. Therefore, exact comparison is not available
[15] Main reason is that investment cost of the thermal plant, one of benefit factors, was lowered in accordance with real figures available.

the Project and evaluated in the next section "3.4 Impacts".

Based on the above results, the effectiveness of the Project is evaluated as high as the anticipated effects have been mostly achieved as planned.[16]

3.4 Impact

3.4.1 Intended Impacts

The Project was expected to have several impacts, such as 1) steady and increasing power supply nationwide to ease power shortage, 2) economic promotion and improvement in living standards with steady power supply, 3) creation of employment during construction works, and 4) saving of hydrocarbon resources.

1) Steady and increasing power supply

The status of the power sector in Iran has much improved as seen in Table-4. Both nominal capacity for power generation and annual consumption of power have been significantly increasing as the former in 2009 is 2.95 times as much as 1993 while the latter in 2009 is 2.92 times as much as 1993. Power generation by the Project accounts for more than 2% of the total except for years of draught, contributing to the improvement of the power sector as a whole. An installed capacity for power generation in Iran increased by 29,000MW between 2001 and 2009, of which the Project accounts for 6.9%. With steady power supply, shortage in power have been mostly resolved and there have been no planned outage in recent years[17].

Table-4 Profile of Power Sector in Iran

Year	1993	2000	2005	2006	2007	2008	2009
Maximum Power Supply (MW)	13,308	20,609	30,694	32,997	34,583	34,270	37,878
Nominal Capacity (MW)	19,042	27,207	41,044	45,322	49,425	59,972	56,181
Annual Power Consumption (GWh)	58,115	90,366	132,898	144,582	152,329	161,058	169,781
Annual Gross Power Generation (GWh)	69,885	113,032	170,648	184,911	196,080	206,173	221,317
Per Capita Power Generation (KWh/Person)	1,261	1,845	2,566	2,733	2,852	2,956	n.a.

Sources: IWPC and Tavanir (State owned company for power generation, transmission and distribution management)

2) Economic promotion and improvement in living standards

Both households and industries benefit from the improvement of power supply. Power consumption per household increased from 2,265KWh in 1994 to 2,603KWh in 2009. The number of electrified village increased from 32,066 in 1994 to 51,595 in 2009. The share of electrified village reached 93.1% in 2009 as compared to 48.2% in 1994, and the rate of electrified household in villages reached 98.9% in 2009 as compared to 76.0% in 1994.[18]

3) Creation of employment during construction works

During the construction period, a large number of jobs were directly generated at the Project site and surrounding areas. In the cities of Masjid-e-Soleiman, Izeh and Andika, more than 12,000

[16] The rating of effectiveness was judged jointly with evaluation of impacts of the Project.
[17] Based on interviews with Ministry of Energy. Statistical data on outage was not available.
[18] Based on Tavanir, "Statistical Report on 43 Years of Activities of Iran electric Power Industry (1967-2009)",

employments were created in total, contributing to the regional economy[19]. If indirect job creation arising from economic prosperity is taken into consideration, the impact would be even larger. Many employees who worked for the Project found jobs elsewhere after completion of the construction by utilizing their skills acquired with the Project, or worked for the operating company of the Masjid-e-Soleiman HEPP. As such, impacts of the Project remain even now[20].

4) Saving of hydrocarbon resources.
By hydroelectric power generation of the Project, hydrocarbon resources such as oil and natural gas, which are required to generate thermal power of the same scale as the Project, have been saved. According to the calculation by IWPC, 18.1 billion m^3 of natural gas and 6 billion liters of diesel oil[21] are required to generate 24,155GWh, a total power generated by the Project up to December 2010. Therefore it is estimated the Project has had impact of saving this amount of fuels, as well as reducing adverse effects on environment[22].

3.4.2 Other Impacts

1) Benefit for local communities and regions
With implementation of the Project, various auxiliary activities were conducted, including construction of a bridge, construction of the access road to the Project site and other roads, and facilitation of supply of potable water to Masjid-e-Soleiman City. However, except for the construction of the access road, most activities were conducted at the expansion stage, outside of the scope of the yen loan Project. Moreover, with completion of the dam and construction of the roads, there have been an increase in the number of tourists and vitalization of local economy[23].

2) Impacts on the natural environment
Since the Project was started before environmental impact assessment system was introduced in Iran, environmental assessment procedure based on Iranian laws were not conducted. However, it was predicted at the time of appraisal that there would be no effects on ecological system and natural scenery as the Project site is in a desert with little vegetation. Actually no such effects have been reported.
During the construction period, negative impacts on environment such as noises and tremors were not reported. Since the completion of the Project, the operation company has conducted surveys of noises, air pollution and water quality in accordance with relevant laws and regulations, with which no adverse effects have been reported.

3) Resettlement and land acquisition
As the Project site is in a mountainous desert and impounding areas were limited within a glen, no farming areas became under water and the Project required only a small number of relocation of local residents. For the construction of the dam, around 150 persons of 30 households in two villages were required for relocation. Relocation to nearby villages and cities were smoothly conducted with money compensation, without any particular problems. Since many of relocated residents were nomadic people, their current status is not known.
As for land acquisition, there were difficulties in negotiations on compensation in some cases, causing

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[19] Based on estimates by IWPC.
[20] The information is based on interviews with authorities of Andika City, located 5 km north-west of the Project site, as well as IWPC.
[21] More precisely, 3.9 billion liters of Mazot (diesel oil of heavy gravity) and 2.2 billion liters of normal diesel oil.
[22] An emission of CO2 of approximately 53.9 billion kgCO2 has been reduced with the Project, according to the rough calculation based on “Guideline for calculation of greenhouse gas emissions for industries (ver. 1.5)” published by Ministry of Environment of Japan
[23] Based on interviews with authorities of Andika City and IWPC.

higher costs than planned. However, no particular problems were experienced[24].

4) Technology transfer effects
With the Project, it was the first experience for Iran to complete a construction project of a large scale hydroelectric power plant jointly with international experts. Through the Project Iranian side has acquired and improved technologies and techniques, such as design, manufacturing, construction and management of hydroelectric power plant[25]. IWPC claims that the technologies they learned through the Project has been utilized and applied to other projects. The construction projects of Daryan Dam, which is under construction, and Gotvand Dam, which is located downstream of the Karun River, are implemented by only Iranian contractors and consultants, without participation by foreign companies.

5) Power supply to neighboring countries
Since Iran has been increasing its export of electricity to neighboring countries such as Iraq, Turkey and Afghanistan, the Project indirectly contributes to steady power supply in these countries.

Table-5 Exports of Electricity by Iran (GWh)

To Year	2004	2005	2006	2007	2008	2009
Iraq	296	1,003	1,002	1,085	2,416	4,806
Turkey	491	535	576	608	453	508
Afghanistan	20	66	134	206	286	357
Other countries	1,030	1,156	1,062	621	721	483
Total	1,837	2,760	2,774	2,520	3,876	6,154

Source: Tavanir

As mentioned above, the Project has significant positive impacts while no negative impacts are observed.

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspect
Khuzestan Water and Power Authority (hereafter KWPA) is responsible for operation and maintenance of the Project.

Although KWPA was supposed to take over the operation and maintenance of the Project after the completion from IWPC which was responsible for the construction, Ministry of Energy decided in 1998 that IWPC would continue to be engaged in the operation and maintenance even after the completion. Subsequently, for that purpose the Operation Company of Masjid-e-Soleiman HEPP (hereafter Operation Company) was established in 2001 as an affiliated company of IWPC. However, Ministry of Energy, by again changing its policy, decided in 2004 that KWPA should take over the task of operation and maintenance of the Project and Operation Company was transferred as an affiliated company of KWPA in March 2005. There was no monetary transaction in transfer process without any compensation. At present IWPC offers technical support gratuitously to Operation Company as and when requested.

KWPA was established in 1960 as a state owned company under Ministry of Energy. It has two departments; the Power Department is responsible of management of operation of power plants and transmission and distribution of electricity, and the Water Department is responsible of water supply

[24] Based on information by IWPC
[25] Examples of technologies and techniques newly introduced to Iran through the Project include; installation of aerators to prevent negative pressure in spillways, use of crushed ices for concrete placement under the high temperatures, and full-scale application of CAD for designing.

for agriculture, industries and households around Khuzestan Province. Currently KWPA is in charge of operation and maintenance of five hydroelectric power plants[26] in Provinces of Khuzestan, Kohkiloyeh va Boyerahmad.

KWPA, at the time of appraisal, had been a large scale national institution which had exclusively taken responsibility to operate hydroelectric power plants. The Operation Company, affiliated to KWPA, has well organized departments/sections and staffing plan with clear job descriptions. No particular problems are observed in terms of institutional aspect of the Project.

3.5.2 Technical Aspect

KWPA has accumulation of technical know-how in operation and maintenance of hydroelectric power plants with an experience of more than 50 years and highly evaluated by Ministry of Energy. For the operation and maintenance of Masjid-e-Soleiman HEPP, 14 types of manuals are prepared and used for each purpose. The number of staff engaged in operation and Maintenance is 45 in total, which is sufficient, according to KWPA, and no major technical problems have been identified. KWPA has a staff training system where internal training is conducted based on a training program, as well as external training at universities and other research institutions

Overall, because both KWPA and Operating Company have good technical resources and Masjid-e-Soleiman HEPP is well operated without major troubles, their technical standards are judged to be sufficiently high.

3.5.3 Financial Aspect

Expenditure for operation and maintenance of Masjid-e-Soleiman HEPP is shown in Table-6. The budget of Operation Company required for the operation and maintenance are expensed by KWPA. The amount of expense has been increasing because of i) inflation, ii) the fact that up to 2005 when Operation Company is transferred from IWPC to KWPA, part of expenses for operation and maintenance were directly paid by IWPC budget, which is not included in the table, and iii) 4 new generators were added in 2007 at the expansion stage.

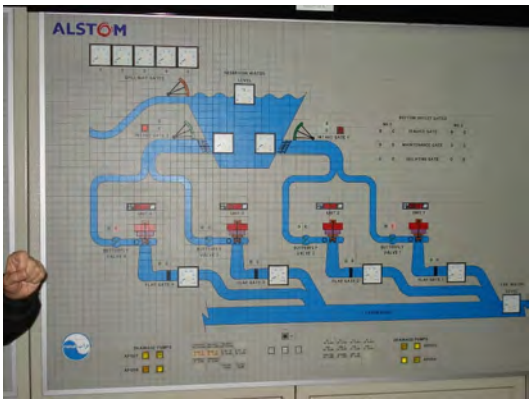
Table-6 Expenditure for Operation and Maintenance

Year	Expenditure (IRR million)
2001	709
2002	3,346
2003	16,389
2004	24,384
2005	31,677
2006	38,970
2007	48,080
2008	58,949
2009	70,000

Source: IWPC

The data on financial conditions of KWPA is not available to the evaluator. However, according to interviews with KWPA and Ministry of Energy, both power and water departments of KWPA have steady revenue and no financial problems are observed. Revenue of power department comes from electricity sales to Iran Grid Management Company[27]. KWPA does not receive any subsidies from the Government.

[26] Besides Masjid-e-Solieman HEPP, other 4 plants are Shahid Abbaspur, Dez, Karkheh and Marun.
[27] One of affiliated companies of Tavanir.



Operation Room in Power Plant

3.5.4 Current Status of Operation and Maintenance

Both the findings of the field survey and explanations given by IWPC and KWPA indicate that all of the facilities of the Project are in good working order, and properly operated and maintained in accordance with the operation and maintenance plan.

On the other hand, 4 generators installed at the expansion stage, which is not included in the scope of the yen loan Project, are under repair and not working for the moment. For the steady power supply of Masjid-e-Soleiman HEPP, full operation of all 8 units is desired to resume as soon as possible.

Based on the above evaluation, no major problems have been observed in the operation and maintenance system, therefore sustainability of the Project effect is high.

4. Conclusions, Recommendations and Lessons Learned

4.1 Conclusions

The Project was planned as one of the measures of electric power development policy of Iran to meet rapidly increasing demand of power. There is still a strong need for a further increase of the generating capacity of the electric power because of the continual increase of the demand. As the Project was compatible with Japan's ODA policies, its relevance is high. The scale of the generating capacity of the constructed Masjid-e-Soleiman Hydroelectric Power Plant is as planned and the overall project cost was within the planned cost. However, the completion of the Project was delayed by 4 years due to the cancellation of part of the yen loan and some other reasons. Accordingly, the efficiency of the Project is judged to be medium. Although the achievement rate of volume of power generation is around 80% of the original plan, it is due to shortage of rainfall and decreases in water discharge of upstream dams. In consideration of the high economic validity (internal rate of return) of the Project, its effectiveness is judged to be high. The Project contributes to steady power supply in Iran as a whole by providing the power through the national grid. The facilities constructed under the Project are in good working condition and Khuzestan Water and Power Authority (KWPA) which operates these facilities is believed to possess an adequate operation and maintenance management system, technical expertise and financial strength. As such, the sustainability of the Project is judged to be high.

In light of the above, the Project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

All the 8 power generators are required to be in a good working condition in order to secure steady power supply of Masjid-e-Solieman HEPP, hence further strengthen effectiveness of the Project. The damaged 4 units of generators, which were installed at the expansion stage, should be repaired at the

earliest possible timing.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

For Iran, The Project was the first project with yen loan after the Islamic Revolution and also the unprecedented project to construct a large-scale hydroelectric power plant with new technologies. Furthermore, for IWPC, an executing agency, it was the first experience to implement a project with an international competitive bidding. Taking all the conditions into consideration, the implementation schedule of a project should be carefully prepared with time allowance, if all the problems in terms of finance, technology and management of the project are not fully anticipated.

Comparison between Original Plan and Actual Results

Item	Original	Actual
1. Outputs	1) Construction of dam (main dam, coffer dam, spillway, etc.) Type: rockfill Height: 170m Crest length: 535m Total reservoir volume: 228 million m^3 2) Construction of power station (power cavern, transformer cavern, etc.) Type: Underground plant Installed capacity: 1,000MW (4 x 250MW) with additional 1,000MW (4 x 250MW) for the extension stage Annual power generation: 3,700GWh 3) Consulting services Assistance to bidding, detailed design, construction management, etc.,	1) Construction of dam (main dam, coffer dam, spillway, etc.) Type: rockfill Height: 177m Crest length: 497m Total reservoir volume: 228 million m^3 2) Construction of power station (power cavern, transformer cavern, etc.) Type: Underground plant Installed capacity: 1,000MW (4 x 250MW) with additional 1,000MW (4 x 250MW) for the extension stage Annual power generation: 3,700GWh 3) Consulting services Assistance to bidding, detailed design, construction management, etc.,
2. Project Period	June 1993 - December 2000 (92 months)	June 1993 - December 2004 (140 months)
3. Project cost Foreign Currency Local Currency Total Of which JICA Loan Exchange Rate	 160,125 million yen 62,617 million yen (IRR391,356 million) 222,742 million yen 151,443 million yen 1yen=6.25 IRR (September 1992)	 45,936 million yen 84,126 million yen (IRR1,808,700 million) 130,062 million yen 45,936 million yen 1 yen = 21.50 IRR (Weighted average during 1991–2006)

Islamic Republic of Pakistan

Secondary Transmission Lines and Substations Project (PK-P43)

External Evaluator: Global Group 21 Japan, Inc.
Kaoru Nishiwaki

0. Summary

This Project was undertaken as a part of the policy to provide stable power supply, which the Government of the Islamic Republic of Pakistan (hereinafter refer to as "Pakistan") is further aiming at for healthy socioeconomic development of the country. This Project has been highly relevant to Pakistan's development plans, development needs, and Japan's ODA policy as it assists economic infrastructure building and contributes to growth and smooth economic activity in Pakistan. Transmission lines and substations were constructed as originally planned. Although construction costs were within budget, services were commenced more than six years behind the original schedule due to delays of implementation and construction work etc. Therefore, the efficiency of this Project is medium. The Project has contributed to reducing power failure/power cut times and curtailing transmission losses in power supply systems, at the same time it has been useful for supplying power and improving high voltage transmission efficiency in the areas where power demand is increasing rapidly. National Transmission and Dispatch Company (NTDC) provides suitable management, organization of operation and maintenance, sufficient technology and financial ability for the Project, and the Project has so far been conducted in good condition. Therefore, it can be said that the evaluation of the Project is very high.

1. Project Description

Location of the Project

Rewet-Islamabad 220kV T/Line

1.1. Background

In 1993, peak power[1] was deficient by 1,117 MW[2] and annual power output by 2,600GWh in Pakistan. At the same time, power supply system losses were recorded at 24.2%, while it was forecast that power demand would increase by about 10% every year. The Water and Power Development Author-

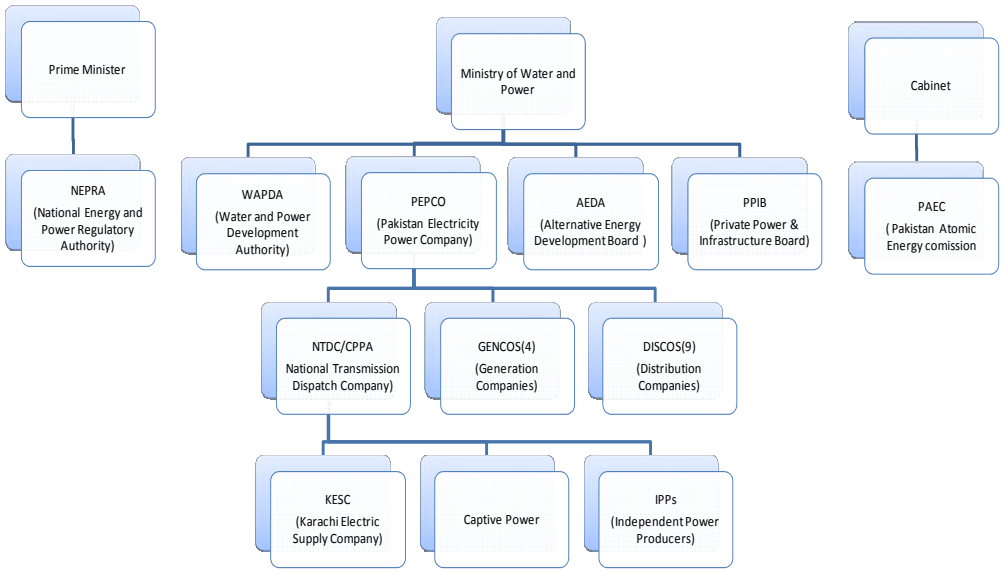
[1] Peak power is the maximum power demand during a certain period. In Pakistan, peak demand occurs at around 21pm of summer when the demand for air conditioning is large.

[2] Electric current of one ampere (A) and one volt (V) has electric energy of one watt (W). One mega-watt (MW) is one million watt, which is equivalent to 25,000 of fluorescent lamps of 40 W.

ity (WAPDA), which had taken over the power supply of Pakistan, responded to the increase in power demand according to the energy policy target of the Government of Pakistan in the 8th 5-year plan.

In these regards, it was necessary to promote the efficient use of power through expanding the secondary transmission line[3] network in order to decrease power supply system losses. Loan agreement was signed for the Project to construct and expand secondary transmission line (220 kV) network and substations in March 1996.

Following the privatization of WAPDA in 1998, the power sector of Pakistan comprises WAPDA, Pakistan Electricity Power Company (PEPCO), four thermal power generation companies (GENCOs), National Transmission and Dispatch Company (NTDC)[4], nine power distribution companies (DISCOs), Pakistan Atomic Energy Commission (PACE), and Karachi Electricity Service Company (KESC)[5]. The organization chart of the Pakistani power sector is shown as follows.



Source：NTDC Planning Division (2011)

Fig-1 Organization Chart of Power Sector in Pakistan

1.2 Outline of the Project

By carrying out reinforcement/expansion/re-powering and the construction of eight secondary transmission lines (220kV) and two substations, the Project aims to improve transmission efficiency by high voltage transmission and stable power supply to high power demand areas. The Project is ex-

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[3] Trunk transmission lines with 500 kV which connect the north and south of the country are primary transmission lines, and transmission lines with 220 kV, 132 kV and 66 kV branched from them and connected to main markets are called secondary transmission lines.

[4] NTDC as a transmission company of PEPCO is in charge of transmission business in Pakistan excluding Karachi region and has a head quarter in Lahore and a central control center in Islamabad. PEPCO is the largest electric company in the country under which four GENCOs and 9 DISCOs are affiliated.

[5] KESC has been working in generation and transmission / distribution business in Karach city and its vicinity since before the privatization of WAPDA. It was privatized in 2005 and has been inter connected with NTDC through 220 and 132 kV transmission lines. KESC's share in the electricity market in the country is around 10%.

pected to contribute to the sound development of Pakistan's socioeconomy through efficient use of energy.

The outline of the loan agreement for the Project is summarized as follows;

Table 1 summary of Loan Agreement

Approved Amount/ Disbursed Amount	12,022 million yen /11,750 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	October 1995/March 1996
Terms and Conditions	Interest Rate: 2.3%, Repayment Period: 30 years (Grace Period: 10 years) Conditions for Procurement: Untied
Borrower / Executing Agency	The President of Islamic Republic of Pakistan/Water and Power Development Authority (WAPDA), (National Transmission and Dispatch Company, NTDC at present)
Final Disbursement Date	July, 2006
Contractors	Siemens AG (Germany), Sichuan Electric Power Import & Export (China), I.C.C.(Pvt.) Limited (Pakistan), CCPG International Economic & Trade Co. Ltd. (China),
Consultant	National Engineering Services Pakistan, Ltd.
Feasibility Study, etc.	Feasibility Study by WAPDA
Related Projects	JICA was carrying out the syndicated loan with the World Bank and the Asian Development Bank, etc. for Ghazi/Barotha hydropower project of WAPDA.

2. Outline of The Evaluation Study

2.1 External Evaluator

K.NISHIWAKI (Global Group 21, Japan)

2.2 Duration of Evaluation Study

The ex-post evaluation was carried out as follows;

Study Period: November 2010 to September 2011

Field Survey: 1st Visit 17th January, 2011 to 5th February,2011

2nd Visit 19th to 26th April, 2011

2.3 Constraints during the Evaluation Study

In this evaluation, the hearing of details, particulars and circumstances of the Project implementation were carried out in WAPDA, PEPCO and NTDC, which are involved in this Project, and those related data were collected. Simultaneously, the hearing about the present conditions and issues of the power sector was conducted at the National Energy and Power Regulating Authority (NEPRA), which is the competent authority of the power sector. Since the Project sites are dispersed over 10 locations and the

security in northwestern part of Pakistan was not good, the field survey was carried out at the sites of three transmission lines and one substation. The external evaluator has interviewed the engineers and the personnel of the sites about the actual progress of construction work and/or the actual condition of operation and maintenance after commencement of the Project.

3. Results of the Evaluation (Rating: A)

3.1 Relevance (Rating：③)

3.1.1 Relevance with the Development Policies of Pakistan

From the Project appraisal through to ex-post evaluation, the target in energy medium-to-long term plans in the development policy of the Government of Pakistan has been putting an emphasis on healthy socioeconomic development based on stable power supply, and it has continually strived to improve energy supply capacity in line with this. Specifically, the main policy has been the development of large-sized hydropower and coal-fired thermal power stations, while transmission lines have been constructed in line with this. Accordingly, this Project has had high relevance with the development policy of Pakistan.

3.1.2 Relevance with the Development Needs of Pakistan

As described in the background, the Project was implemented to respond to the growing demand for power, reduce power system losses and improve power efficiency through building high voltage transmission lines. It was considered an easier way than developing new power sources in order to achieve the energy policy targets of the Government of Pakistan in the 8th 5-year plan.

As of the ex-post evaluation stage, against the backdrop of rapidly growing power demand, power shortages are becoming worse rather than improving, and the efficient use of energy and stable power supply by high voltage transmission lines are very important issues still now. Therefore, the Project is highly relevant to the development needs of the Government of Pakistan.

3.1.3 Relevance with Japan’s ODA Policy

Japan’s ODA policy for Pakistan aims at assisting construction and development of a sustainable society, viewing construction of a "moderate and modernistic Muslim state" as essential for the peaceful and stable growth of Pakistan and peace and stability of South Asia in general. Accordingly, the Project supports power sector development plans as part of the policy for economic infrastructure development geared to the promotion of sound market economy, diversification of industrial structure and vitalization of the market economy, and it contributes to smooth economic activities through stabilizing the power supply system.

It is concluded that this project has been highly relevant with the country’s development plan, development needs, as well as Japan’s ODA policy, therefore its relevance is high.

3.2 Efficiency (Rating: ②)

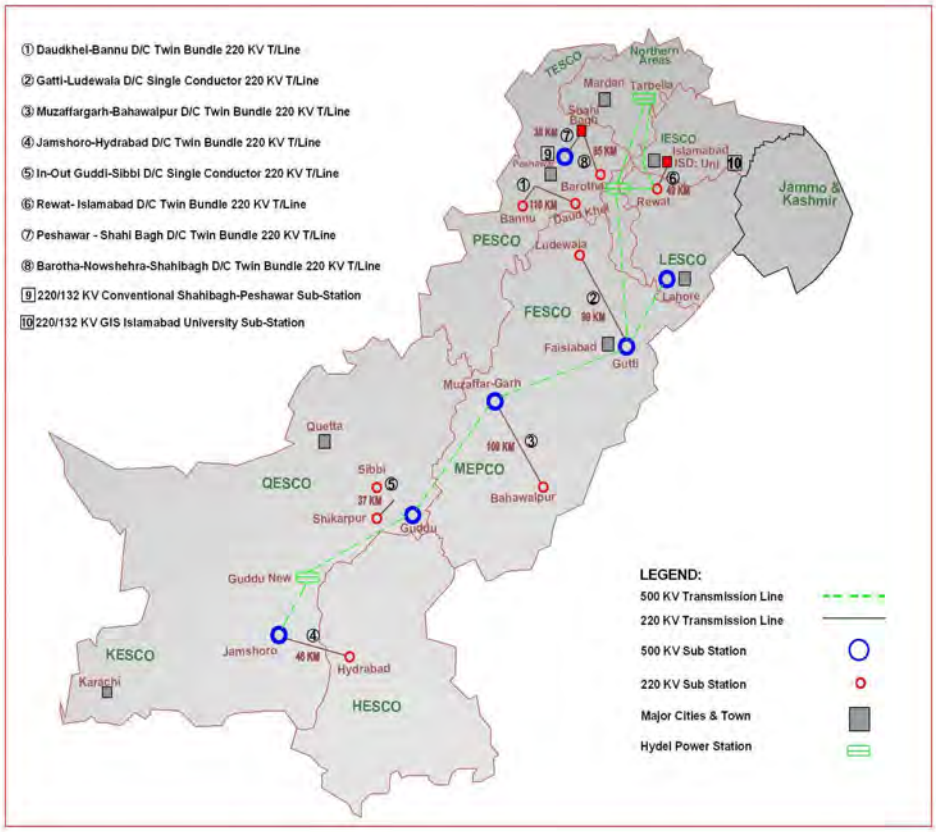
3.2.1 Project Outputs

At the time of appraisal, the Project was designed with three main components as shown below:

1) Eight 220 kV transmission lines with total length of 492 km
2) Two substations with capacity of 220 kV/132 kV, and

3) Procurement of consulting services for management and supervision

Out of the eight substations to be linked by these transmission lines six substations were scheduled for construction utilizing loans from the World Bank, Germany, Spain and Switzerland, and it was planned to finish these to coincide with completion of the Project. Figure-2 shows the location map of the Project and Table-2 summarizes the Project outputs.



Source: Prepared by the External Evaluator (2011)

Fig-2 Location Map of the Project

Peshawar-Mardan line was replaced by Barotha-Nowshera-Shahibarg line, along which there is remarkable growth in demand, because the importance of Peshawar-Mardan line declined due to the Project delay; moreover, it became possible for the newly constructed Ghazi/Barotha hydropower station to supply power to the Peshawar area.

There were changes of alignment/route and length from the original design due to right of way (ROW) issues and route examination. For example, Jamhsore-Hyderabad line became more than one and half times longer because it was found to hinder air traffic routes in the implementation stage. In Shahibarg substation, the number of transformers was changed because of re-examination of power demand due to the Project delay. Many of these changes/modifications were originated due to the delay of the Project and they were judged to be appropriate to cope with the changes in the situations.

Table-2 The Project Output

Description	Original	Actual
220kV Transmission lines		
Daudkhel-Bannu D/C twin bundle 220KV T/Line	L=100km	L=110km
Gatti-Ludewala D/C single conductor 220KV T/Line	L=100km	L= 99km
Muzaffargarh-Bahawalpur D/C twin bundle 220KV T/Line	L= 90km	L=109km
Jamhsoro-Hyderabad D/C twin bundle 220KV T/Line	L= 30km	L= 46km
In-Out Guddi-Sibbi 220KV T/Line at Shikapur(D/C single conductor)	L= 60km	L= 37km
Rewat-Islamabad D/C twin bundle 220KV T/Line	L= 35km	L= 49km
Peshawar-Shahibagh D/C twin bundle 220KV T/Line	L= 21km	L= 38km
Peshawar-Mardan D/C single conductor 220KV T/Line	L= 56km	-
Barotha-Nowshehra-Shahibagh D/C twin bundle 220KV T/Line	-	L= 85km
Sub-stations(220/132kV)		
Conventional Sub-station at Shahibagh Peshawar	-2×220/132KV, 160MVA Autotransformer	-4×220/132KV, 160MVA Autotransformer
GIS Islamabad University Sub-station	-2×220/132KV, 160MVA Autotransformer	-2×220/132KV, 160MVA Autotransformer
Consulting Services	Assistance for management and supervision	Assistance for management and supervision

Source：External Evaluator made(2011)

Gatti-Ludewala D/C single conductor T/Line

Jamhsoro-Hyderabad D/C twin bundle T/Line

Jamhsoro-Hyderabad T/Line, Foundation work

Islamabad University Substation Transformer

Islamabad University Substation, Bus Bar

Islamabad University Substation, Control Room

3.2.2 Project Inputs

3.2.2.1 Project Cost

The Project has been completed by spending about 88% (15.5 billion yen including yen loan of 11.7 billion yen) of the estimated budget (17.7 billion yen, including yen loan of 12 billion yen) made at the appraisal. Although the Project cost was impacted by changed work quantities due to revised scope (replacement of transmission sections), lengthening of transmission lines and changes to substation specifications, as well as additional payments arising from works delays, higher consultant fees and major inflation in steel and aluminum prices, the eventual Project cost was lower than budget thanks to appreciation of the yen and depreciation of the rupee.

Table-3 Project Cost

	Original			Actual		
	F.C (Mil. ¥)	D.C (Mil. Rs.)	Total (Mil. ¥)	F.C (Mil. ¥)	D.C (Mil. Rs.)	Total (Mil. ¥)
220kV T/L	5,759	550	7,513.5	6,066	1,926	10,188
220/132kV Grid ST.	3,562	552	5,322.9	3,000	626	4,269
Physical Con.	712	529	2,399			
Contingency	1,003	163	1,524	-	-	-
Consultant fee	128	49	284		159	370
IDC	702	0	702	674		674
Project Cost	11,866	1,843	17,746	9,7939	2,711	15,501

Note: Exchange Rates (Plan) 1Rs.=3.19¥
(Actual) 1Rs.=2.13

Source: Prepared by the External Evaluator based on NTDC data (2011)

3.2.2.2 Project Period

It was scheduled to start all Project works by the end of August 1997, but in reality the contract of consulting services was made in October 1998, the construction work was contracted between October 2001 and June 2002, and long delays occurred before the work could actually start. The period necessary for completion of transmission lines was 55 months (original was 31 months), and the period necessary for substations was 44 months (original was 27 months). Finally, the total period became 126 months compared to the original plan of 49 months, and the Project was completed in December 2006, more than six years behind the original plan. According to NTDC, reasons for the delay in completion were the change in management policy brought about by privatization of WAPDA at the start of the Project, inadequacy of clerical processing capability in NTDC, NTDC's inexperience in dealing with the procedures of the Yen loan system, and compensation issues under transmission and distribution lines.
According to hearings conducted at NTDC, the major reasons for delays in each implementation phase were as follows.

1) Delays arising from consultant procurement

NTDC launched the procurement procedure for the external consultant to conduct design and construction supervision, however, upon examining this policy in review of its management principles in line with privatization, in June 1997 it applied to JICA to not utilize an external consultant but perform the work with its own engineers due to financial restrictions. However, because the Yen loan agreement was predicated of recruitment of an external consultant and the JICA side gave priority to this in consideration of past lessons, the JICA side initially refused this application. After that, NTDC conducted review and in February 1998 offered to recruit an external consultant upon reducing the contract amount. JICA accepted this and the consultant agreement was signed in October 1998. According to the plan, it was assumed that eight months would be needed until consultant procurement, however, in reality it took 31 months due to the said review and adjustments.

2) Delays in Packages 1~4 (common) (prior to the start of works)

Due to NTDC's inexperience with the necessary procedures, major delays arose in the procedures before the start of construction work; for example, the review of tender documents took 8~14 months (compared to the scheduled 1~2 months), JICA consent and approval of agreements took 2~12 months (compared to the scheduled 1 month), contract negotiations took 3.5~7 months (com-

pared to the scheduled 2 months), and establishment of the letter of credit (L/C) took 6~8 months (compared to the scheduled 1 month). Moreover, Packages 2 and 3 took 11 months and 6 months respectively due to the additional tender process including design review arising from the revision of scope.

3) Delays in Packages 1~4 (common) (after the start of works)

Time was used in revising transmission line routes and layout of substations and approving equipment specifications. Delays in payments to contractors due to paperwork deficiencies also caused delays in the works. The frequent turnover of NTDC employees also impeded construction supervision guidance on the NTDC side and slowed procedures with JICA, thus causing further delays in the works. In Package 4, the outbreak of SARS (Severe Acute Respiratory Syndrome) in 2003 caused delay of inspections at the manufacturing plant in China, and this too delayed the works. Moreover, in Packages 1 and 2 (transmission line works), holdups surrounding the right of way (RoW) [6] below lines were a further cause of delays.

Although the project cost was lower than planned, the project period was significantly longer than planned, therefore efficiency of the project is fair.

Table-4 Project Period

Package	Original Period (Month)	Start	Completion	Actual Period (Month)
(1)Transmission Lines	21	2002/01	2006/07	55
(2)Transmission Lines	24	2002/06	2006/12	55
(3)Substation	24	2002/07	2006/02	44
(4)Substation	20	2001/10	2003/12	27
Consultant Procurement	70	1998/10	2006/07	94

Source：External Evaluator made based on NTDC data(2011)

3.3 Effectiveness (Rating: ③)

3.3.1 Quantitative Effects

The primary objective of the Project was to realize stable supply of power and greater efficiency of power transmission in areas where the demand for electricity is increasing. The transmission lines and substations of this Project are secondary transmission lines and substations making up about 3% of the whole system and are connected to primary transmission lines and substations extended from various power plants. Moreover, since these secondary transmission lines and substations are linked to other transmission lines and power distribution companies not included in the Project, it is difficult to evaluate and check the above-mentioned effect individually. Accordingly, it was decided to evaluate effectiveness by analyzing the contribution of the Project based on changes in the operation effect index of the overall power system.

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[6] NTDC conducted RoW negotiations according to compensation criteria in Pakistan with a view to finishing by the start of construction work, however, it failed to reach agreement with landowners, leading to the prolonging of negotiations and even court cases, thereby delaying the start of works in many cases. According to hearings with NTDC staff and in site surveys, one of the reasons for the lack of progress in compensation negotiations was the different tenancy system adopted between landowners and farmers. Since negotiations often had to be conducted with absent landowners, it was necessary to travel long distances to meet them and time was taken up adjusting to the landowners' schedules and so on. Moreover, some landowners made exorbitant demands (claiming additional compensation because they intended to open a restaurant under lines and so on), while protective orders issued by law courts caused further delays. The NTDC side did not have a sufficient setup to deal with so many difficulties.

3.3.1.1 Results from Operation Effect Indicators

1) Utilization of the facilities

The present operating situation of transmission lines and substations is shown in Table-5.

Table-5 Facilities Operating Status

Distribution Areas	Facilities	Conrtibute to Peak Power	Conrtibute to Power Consumption
PESCO	Three transmission lines One grid station	○	—
IESCO	One transmission lines One grid station	—	○
FESCO	One transmission line	○	○
MEPCO	One transmission line	○	—
HESCO	One transmission line	○	○
QESCO	One transmission line	○	—

Source：Prepared by the External Evaluator based on NTDC data (2011)

Note: "—" shows areas where increases in peak power demand and power consumption are not recognized

These facilities are utilized to help increase supply of peak power and electric energy in various power consuming areas. The effect has shown up in reduction of power failure/power cut time over the whole power system. Power marketing data issued by NEPRA shows that the number of power consumers is increasing everywhere with an annual increase of about 5.6% as of 2009. It is more than the 4.9% anticipated at the planning stage of the Project. Thus, the effect of this Project has manifested as response to the increase of consumers.

2) Reduction of power failure / cut

The effect of the Project has shown up in shortening of power failure/power cut time. According to the data of NEPRA, power failure/power cut time of 399.4 hours was recorded in 2006 at the commissioning of the Project, but power failure/power cut time was reduced by half in the next year (2007). After that, work was continued on shortening power failure/power cut time and it was improved to 89.7 hours in 2009, about one fifth of the figure at the time of commissioning of the Project. Shortening of the power failure/power cut time of transmission lines contributes to better reliability of the whole power system, stable power supply and improvement of customer services.

3) Reduction of transmission loss

As for transmission loss, this was reduced to 3.58% in 2009 compared with 7.26% in 2006 at the time of commissioning of the Project. Although sufficient data has not been obtained on transmission loss on the Project transmission lines, according to the data collected in the field survey, Jamhsoro-Hyderabad line shows maximum transmission loss of 2.73%, which is lower than the loss over the whole transmission network. Therefore, it may be said that this Project has contributed to improvement of transmission loss.

Table-6 Reliability Indices

	2006	2009
Generation Loss (%)	2.21	1.98
Transmission Loss (%)	7.26	3.58
Distribution Loss (%)	15.12	17.48
System Loss in total (%)	24.59	23.04
Number of Power Failures/Power Cuts (/annual)	1,177	1,188
Hours of Power Failures/Power Cuts (hrs/annual)	399.4	89.7

Source：External Evaluator made based on NTDC data (2011)

4) Conclusion

Reductions of power failure/power cut time and transmission loss are seen over the whole power system, and this Project has actively contributed to supplying power to an area where power demand is increasing rapidly. It can be said that this Project has manifested the anticipated effects such as stable power supply and improvement of transmission efficiency based on high voltage transmission for an area of rapidly growing power demand.

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

At the appraisal of the Project, the Financial Internal Rate of Return (FIRR) was estimated as 12%. FIRR was re-estimated assuming the Project benefits on the basis of 10% of revenue from power transmission business activity over the Project life (30 years), operation and maintenance cost of 1% of initial investment and the discount ratio as 12%. The result was an FIRR of 16%[7]. The FIRR exceeded the average interest rate of subleased cost (weighed average cost rate of capital); therefore this Project has not led to aggravation of the financial condition of NTDC. However, if the present market interest rate of about 15% is taken into consideration, the FIRR value is not sufficient to cover the exchange risk (calculated to be about 3%).
Economic Internal Rate of Return (EIRR) was not estimated in the appraisal of the Project. The Project cost was adjusted by multiplying with the Standard Conversion Factor (SCF) to arrive at true economic value of the investment made under the Project[8]. As a result, EIRR was 17.3%. Sensitivity analysis was conducted based on the following four scenarios: i) 20% increase of maintenance/operation cost; ii) 20% decrease of selling power; iii) simultaneous occurrence of i) and ii), and iv) shortening of equipment life by five years. Calculated results were 17.2%, 15.8%, 15.7% and 17.1% respectively. Sensitivity analysis proved the EIRR to be robust as it remained above the thresh-

[7] The Project residual value was set at 10%. The benefit was set at 10% of power sales revenue prorated according to the scale of transmission lines. Actual revenue was used up to 2009, while forecast values were used for 2010 onwards. Concerning transmission loss, it was assumed that the 3.5% as of 2010 will continue, while insurance premiums (0.35%) during operation were added. The rate of increase in power charges was assumed to be 5% per annum, while maintenance costs were assumed to increase at 10% per annum. Also, the inflation in consumer prices was set at 2% per annum. Incidentally, since the technique used to calculate costs at the time of review was unknown, no comparison was carried out with the new calculations.

[8] Adjustment for disparity between domestic and foreign prices (0.95)=(M+T)/((M+Tm)+(X-Tx)), where M: total value of imports, Tm: import tariff, X: total value of exports, Tx: export tariffs

old value of 15%. As sensitivity analysis proved the EIRR robust, it may be concluded that the Project is economically viable and can withstand all kinds of risks.

3.3.2 Qualitative Effects

According to demand forecast of WAPDA and NEPRA report, power shortages will continue for some time due to the remarkable growth in power demand in Pakistan. Power sources have been developed and power supply systems improved every year, and the effects of improvement are seen in reliability of power supply and reinforcement of transmission/distribution lines and substations. Some power distribution companies said that the Project's high voltage transmission system has led to stable power supply, improvement of customer services and increase in revenue to some extent, as well as contributing to sustainable and stable company operation.

This Project has largely achieved its objectives; therefore its effectiveness is high.

3.4 Impact

3.4.1 Intended Impacts

It was expected that this Project would contribute to efficient exploitation of energy and healthy socioeconomic development of Pakistan. Since fossil fuel resources such as oil, coal and natural gases are restricted, successive 5-year plans have called for reduction of energy losses through development of hydropower and construction of transmission and distribution lines, thereby contributing to reduction of fuel imports.

Development of high voltage transmission lines has been executed since the commissioning of the Project as shown in Table-7, and the improvement of transmission efficiency based on high voltage network system is still in progress.

Reduction of losses by energy saving effect and shortening of power failure/power cut time based on high voltage transmission have been seen in NTDC systems, and the Project has been effective in improving power supply reliability in areas of remarkable growth in power demand, which was one of the targets of this Project.

Since the energy saving effect enabled by the Project based on high voltage transmission system is minor, there is still a long way to go to resolve power shortages, and there are still rolling planned power cuts[9]. Therefore, it is necessary to drive forward development of power and provision/expansion of transmission systems and bring stable power supply and effective use of energy in order to respond to the rapidly growing power demand.

[9] According to the experience gained during the site surveys, rolling blackouts regularly occur even in the main cities such as Islamabad, Lahore and Karachi, and traffic signals do not operate at these times. There are also problems regarding the quality of electricity; for example, lighting suddenly goes off and back on again in restaurants. During the site survey of transmission lines, since there have been cases of power company employees being attacked by people unhappy with the power cuts, access to some sites was restricted.

Table-7 Development of Transmission Facilities

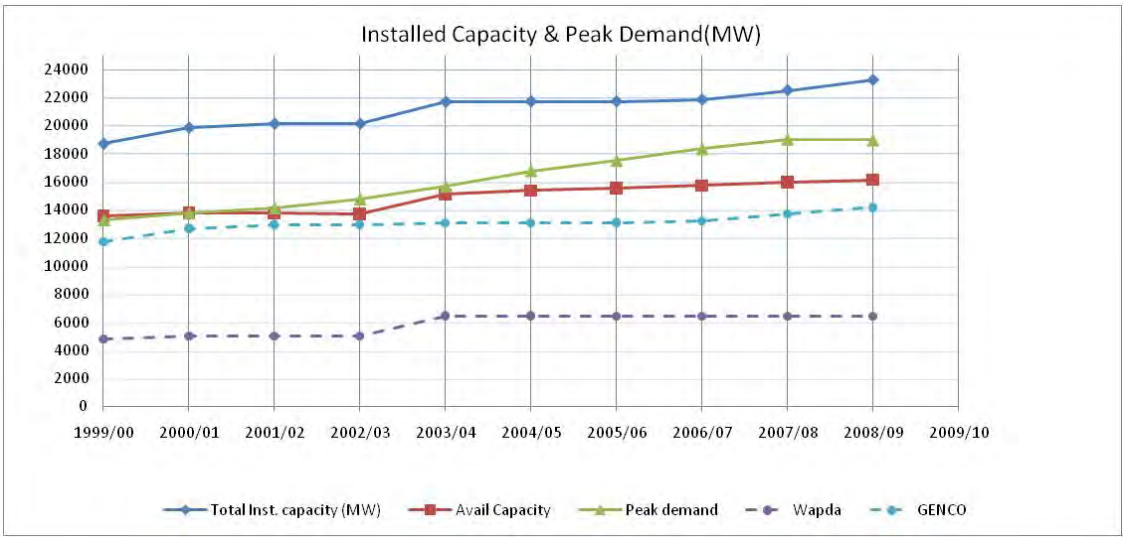
	Transmission Line(km)			Grid Station				
				500KV		220KV		Total Grid Station
	500KV	220KV	Total (km)	Grid Station	Capacity (MVA)	Grid Station	Capacity (MVA)	
2006	4,453	6,993	11,446	10	8,874	27	9,688	37
2007	4,712	7,318	12,030	10	11,400	26	10,403	36
2008	4,748	7,318	12,066	11	12,000	26	11,190	37
2009	5,078	7,325	12,403	12	13,800	26	14,829	38
2010	5,108	7,337	12,445	12	14,850	27	15,744	39

Source：External Evaluator made based on NTDC data(2011)

(1) Improvement of Demand/Supply Balance

It was predicted that power demand-and-supply balance would get worse at the time of Project review, and since demand for power has increased faster than predicted, the supply and demand balance has deteriorated in reality.

WAPDA forecasts that the power demand will grow at an annual rate of about 7~8% in line with the improvement of living standards. The maximum demand occurs in summer due to air conditioning demand. As is shown in Fig-3, peak demand has continued to grow in excess of possible generation output since 200010.



Source：External Evaluator made based on NTDC data (2011)

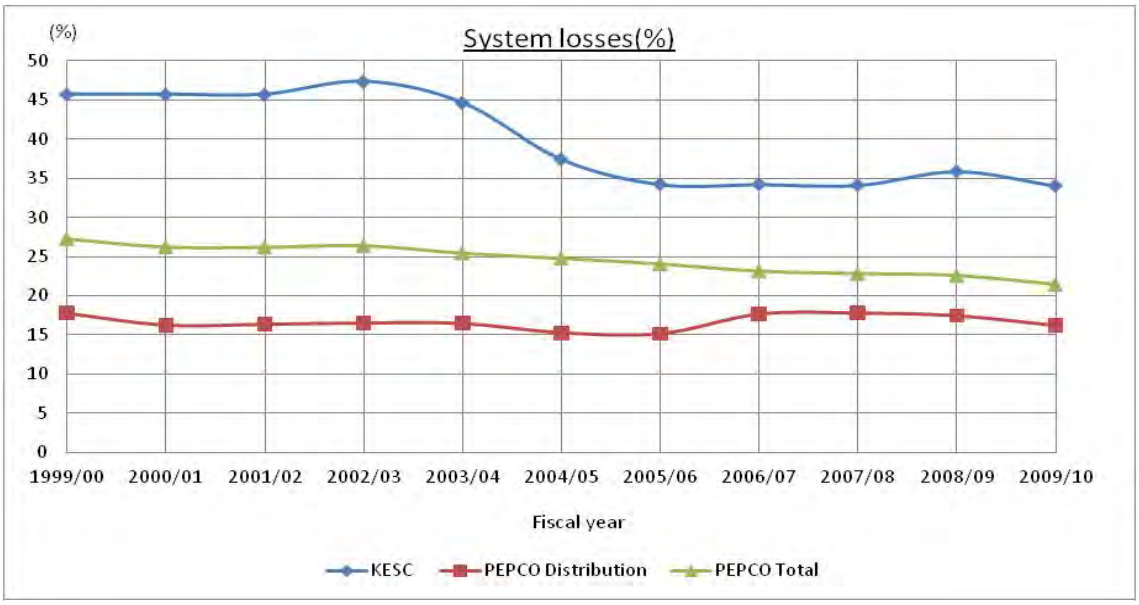
Fig-3 Power Capacity and Peak Demand

[10] Plant output of WAPDA facilities as of June 2010 is 21,665 MW (hydropower 6,555 MW, thermal power 14,576 MW, nuclear power 463 MW, other 71 MW). The annual total amount of generated electrical energy in future is planned as 99,450 GWh (hydropower 28,228 GWh, thermal power 68,228 GWh, nuclear power 2,667 GWh, other 327 GWh). NTDC transmits approximately 90% of this electricity.

According to NEPRA, the greatest concern for commerce and industry is the continuation of power cuts due to inadequate supply capacity. Therefore, it must be said that consumer awareness of the contribution to power supply reliability arising from the Project is limited.

(2) Reduction of System Losses (Operation loss, Technical loss and Commercial loss)

NTDC assumed the total system losses at the original commissioning of the Project (2000) were 26%. In reality, these system losses remained until 2003. From 2004, the loss rate decreased and reached 22.8% as of 2010 as shown in Fig-4 following commissioning of the Project (2006). On the other hand, distribution loss has been increasing from 2006, and it implies that a part of the reduction of transmission loss has been offset to distribution loss.
The official target for system loss improvement over the entire power sector was set as 14.5% by 2017 at the time of the ex-post evaluation, and efforts are being continued with a view to achieving this. In addition, NTDC is striving to reduce commercial loss, and there was almost no commercial loss in NTDC at the time of the ex-post-valuation survey.



Note：Difference between PEPCO Total and PEPCO Distribution indicates transmission losses.

Source：Prepared by the External Evaluator based on NTDC data (2011)

Fig-4 Change of System Losses

3) Electrification Rate

The average electrification rate of the country was about 72.3% as of 2005 according to JICA data, and there are still rural areas not served by power supply. The rural electrification rate in the vicinity of the Project areas is rising except for the area managed by MEPCO[11]. It must be said that this Project has contributed to expansion of the power supply area.

[11] Looking at the rate of change in the rural electrification rate, according to NEPRA data, the Peshawar system has remained the same at 72%, the Islamabad system increased from 93% in 2006 to 95% in 2009, the Faisalabad system rose from 80% in 2006 to 91% in 2009, the Multan system changed from 79% in 2006 to 70% in 2009, the Hyderabad system rose from 43% in 2008 to 58% in 2009, and the Quetta system rose from 39% in 2006 to 67% in 2009.

3.4.2 Other Impacts

1) Impacts on the natural environment

At the time of review, it was concluded that the Project is not in a sector that is liable to impact the natural environment and that it doesn't target a vulnerable area. Therefore, it was guessed that there is little negative impact/influence on the natural environment. In the field survey and from NTDC, it was confirmed that there has been no large-scale reclamation, land development/cleaning, nor large-scale deforestation in and around the Project area, and that the Project doesn't contain national parks, protected areas, swamp areas, residential areas for ethnic minorities and indigenous peoples, cultural heritage areas, and so on.

NTDC had conducted the local consultation hearings/meetings and social/natural environmental impact assessments prior to the Project implementation in order to deepen understanding of the Project to the persons concerned.

According to the monitoring during construction by the external consultant, "noise caused by unloading work at nighttime", "leaving of unsuitable excavated materials", and "delay of payment for compensation of vegetation etc." were pointed out as environmental problems during the construction period. Since immediate correspondences and measures by NTDC and contractors were made, these did not develop into the serious problems such as delay of construction.

After commissioning, the department of social and natural environmental assessment in NTDC is in charge and is continuing such monitoring.

According to the report of NTDC, at the ex-post-valuation stage, conditions having a bad influence on social/natural environment are not seen, and there are no complaints about the natural environment from locals, etc. Therefore, the influence on the natural environment by the Project is at a minimum. In the field survey too, conditions having a bad influence on social/natural environment have not been seen.

2) Land Acquisition and Resettlement

No resettlement was done, and land acquisition for substations was conducted prior to the Project implementation. On the other hand, trouble/conflict over compensation of transmission line routes occurred along the transmission route (so-called ROW problems) and led to suspension of works and major delays in progress. Some of these compensation disputes have gone to court and are still ongoing.

3) Social Impact in the vicinity of the Project

On average 85 persons per day were employed as daily wage workers during the construction period. Moreover, 45 persons continued to be employed as NTDC local personnel after commissioning. NTDC says that there has been no female participation in construction work and there have been no gender problems. Also, there has been no racial or religious discrimination of workers or labor disputes, etc.

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

After privatization of the power sector in 1998, NTDC is developing its business in its role as power system operator (same as transporter of power). Its main duties are purchasing power from generating companies, conveying power through its transmission line network and selling power to distribution companies. Purchasing power is managed/administrated by the Central Power Purchasing Agency established in December 2008 (CPPA). Moreover, NTDC conducts transmission line projects in line with progress of power development by generating companies. Current status of operation/maintenance of transmission lines and substations is performed smoothly for 24 hours by three teams working in four shifts. The number of staff is about 100 persons in total at 220 kV substations and 200 persons at 500 kV substations, respectively. Inspection of transmission facilities is carried out once per month according to a standard, and data are recorded and used for improvement.

3.5.2 Technical Aspects of Operation and Maintenance

NTDC provides sufficient structures for operation/maintenance of its facilities such as quality of staff assignment, engineer level and organization. Especially, its staffs are the former WAPDA personnel, who soundly perform management of daily operation/maintenance and recording of measuring/controlling data. Therefore, in the field survey by the evaluator, it can be said that they had sufficient technology on the operation and maintenance. For example, since power failures/forced power cuts tend to occur more frequently on foggy days, conventional insulator supports are being replaced with fog-countering ones and hotline maintenance for shortening of power failure time of maintenance work, etc. is performed actively[12].

Training/skill improvement of operation/maintenance technology for staffs is carried out at appropriate intervals at WAPDA training center. This center is equipped with repair kits for transmission lines/substations and a substation operation simulator[13], and it accepts more than 1,000 trainees per year. Moreover, the personnel who obtain basic skills at the training center are also aiming to brush up skills by on-the-job training using actual sized imitation facilities at each job site.

Therefore, it was recognized that NTDC is fully equipped with technology for operation and maintenance.

3.5.3 Financial Aspects of Operation and Maintenance

The income of NTDC is composed both of capacity charges (constant cost for peak demand) and energy charges (valuable cost for transmitted power). All power tariffs are collected to an escrow account and the share of NTDC is paid from the escrow account through NERPA. Moreover, stable income is secured with charges set at an appropriate tariff level by NEPRA[14]. This means that NTDC is guaranteed its operating cost by the government for healthy operation and maintenance of power sys-

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[12] Hotline maintenance is the technique whereby insulation supports (glass), etc. are washed in water while lines remain electrically charged.

[13] The simulator was granted by GTZ (Deutsche Gesellschaft Technische Zusammenarbiet) in Germany.

[14] Transmission charge is set at the price that constitutes necessary costs plus appropriate profit.

tems and avoids negative impacts on operation and maintenance due to problems in its financial affairs[15].

In the past, NTDC conducted direct power transactions with power companies but its revenue declined due to non-collection and non-payment of charges so it calculated profit and losses combining power transactions with the transmission utility. However, following establishment of NEPRA, financial statements have been compiled for the transmission utility alone from 2009 onwards. According to financial indicators from 2009, figures were good with profitability (net profit / net fixed assets) at 18%, financial soundness (equity capital ratio = capital / (borrowing + capital)) at 33%, cash management (own fund ratio = own funds / new financial investment) at 200% and debt ratio (debt ratio = own funds / debt repayments) at 103%. This shows that NTDC has sufficient own funds to appropriately carry out operation and maintenance.

3.5.4 Current Status of Operation and Maintenance

According to NTDC, there have been no large-scale accidents or operation mistakes/troubles in transmission lines and substations of the Project since commissioning of commercial operation.

Preventive maintenance actions, such as early exchange of insulators and adoption of maintenance techniques for shortening power failure times, have been taken, and technical transfer and training have been carried out. Therefore, it must be said that NTDC provides sufficient operation and maintenance technique and management/organization.

On the other hand, the present facilities have had almost no spare capacity in the several years after commissioning of commercial operation, and the future issue will be how to carry on the reinforcement/re-powering/updating of facilities in line with the rapidly increasing power demand. According to NTDC, although countermeasures are being planned and designed, the major stumbling block is the lack of funds to invest in new equipment.

To sum up, no major problems have been observed in the operation and maintenance system, therefore sustainability of the project is high.

4. Conclusion, Recommendations and Lessons Learned

4.1 Conclusion

This Project was undertaken as a part of the policy to provide stable power supply, which the Government of the Islamic Republic of Pakistan (hereinafter refer to as "Pakistan") is further aiming at for healthy socioeconomic development of the country. This Project has been highly relevant to Pakistan's development plans, development needs, and Japan's ODA policy as it assists economic infrastructure building and contributes to growth and smooth economic activity in Pakistan. Transmission lines and substations were constructed as originally planned. Although construction costs were within budget, services were commenced more than six years behind the original schedule due to delays of implementation and construction work etc. Therefore, the efficiency of this Project is medium. The Project has contributed to reducing power failure/power cut times and curtailing transmission losses in power supply systems, at the same time it has been useful for supplying power and improving high voltage transmission efficiency in the areas where power demand is increasing rapidly. National Transmission and Dispatch Company (NTDC) provides suitable management, organization of operation and main-

[15] In order to realize full privatization (public stock release) of the entire electric power sector including NTDC, which is the basic policy objective of the Government of Pakistan, it is necessary to raise the value of stock.

tenance, sufficient technology and financial ability for the Project, and the Project has so far been conducted in good condition. Therefore, it can be said that the evaluation of the Project is very high.

4.2 Recommendations

4.2.1 Recommendations to NTDC

It is necessary to take the following points into consideration which are based on experience of the delay of six years to completion due to problems in consultant procurement and ROW.

1) Concerning reconsideration of the EPC (Engineering, Procurement and Construction) contract, NTDC is recommended to dispatch its engineers to the Project sites at an early stage for the execution of field investigation, survey, planning and detailed design and make its own efforts to detect problems in field. This will mitigate the friction with locals and lead to smooth instruction to contractors, quality control, and justin-time completion.
2) Decisions concerning whether to revise design or conduct new tender should be made upon considering the level of cost increase and losses arising from delay in the commissioning of Project activity.
3) Assignments delegated to the staff need consideration and should not disturb the consistency of performance of the Project.
4) In order to avoid prolonged compensation negotiations, examine measures such as enhancing the local liaison and adjustment setup and locally procuring human resources and materials for works, and prepare fully for negotiations.

4.2.2 Recommendations to JICA

None in particular

4.3 Lessons Learned

In order to minimize delays in implementation of project such as that caused by preparation and procurement of an external consultancy services, it is important for both JICA and concerned organizations to share the recognition about the necessity of the consultancy services. Especially in those projects where employment of an external consultancy service is crutial, both sides are required to perform sufficient exchange of opinions in advance and form common views on it. Moreover, such a common view should be clearly shown in agreed documents such as M/D.

Comparison of the Original and Actual Scope of the Project

Item	Original	Actual
1. Project Outputs	(Package-1) 1)Daudkhel-Bannu D/C twin bundle 220KV T/Line（L= 100km） 2) Gatti-Ludewala D/C single conductor 220KV T/Line（L= 100km） 3) Muzaffargarh-Bahawalpur D/C twin bundle 220KV T/Line（L=90km） 4) Jamhsoro-Hyderabad D/C twin bundle 220KV T/Line（L=30km） 5) In-Out Guddi-Sibbi 220KV T/Line at Shikapur(D/C single conductor)（L=60km） (Package-2) 6) Rewat-Islamabad D/C twin bundle 220KV T/Line(L=35km) 7) Peshawar-Shahibagh D/C twin bundle 220KV T/Line（L=21km） 8) Peshawar-Mardan D/C single conductor 220KV T/Line（L=56km） (Package-3) 220/132KV Conventional Sub-station at Shahibagh Peshawar（2units） (Package-4) 220/132KV GIS Islamabad University Sub-station（2units）	(Package-1) 1)Daudkhel-Bannu D/C twin bundle 220KV T/Line（L= 110km） 2) Gatti-Ludewala D/C single conductor 220KV T/Line（L= 99km） 3) Muzaffargarh-Bahawalpur D/C twin bundle 220KV T/Line（L=109km） 4) Jamhsoro-Hyderabad D/C twin bundle 220KV T/Line（L=46km） 5) In-Out Guddi-Sibbi 220KV T/Line at Shikapur(D/C single conductor)（L=37km） (Package-2) 6) Rewat-Islamabad D/C twin bundle 220KV T/Line(L=49km) 7) Peshawar-Shahibagh D/C twin bundle 220KV T/Line（L=38） 8) Peshawar-Mardan D/C single conductor 220KV T/Line（L=85） (Package-3) 220/132KV Conventional Sub-station at Shahibagh Peshawar（4 units） (Package-4) 220/132KV GIS Islamabad University Sub-station（2 units）
2. Project Period	March,1996 – March,2000 (49 months)	October,2001 – December,2006 (63 months)
3. Project Cost **Foreign currency** **Local currency** **Total** **Loan portion** **Exchange rate**	 11,886 million yen 5,879 million yen （Local currency 1,843Mil. Rs.） 17,746 million yen 12,022 million yen 1Rs.＝3.19yen （May, 1995）	 9,740 million yen 5,761 million yen （Local currency 2,711Mil. Rs.） 15,501 million yen 11,739 million yen 1Rs.＝2.13yen （Oct. 2001～June. 2002）

Republic of Peru

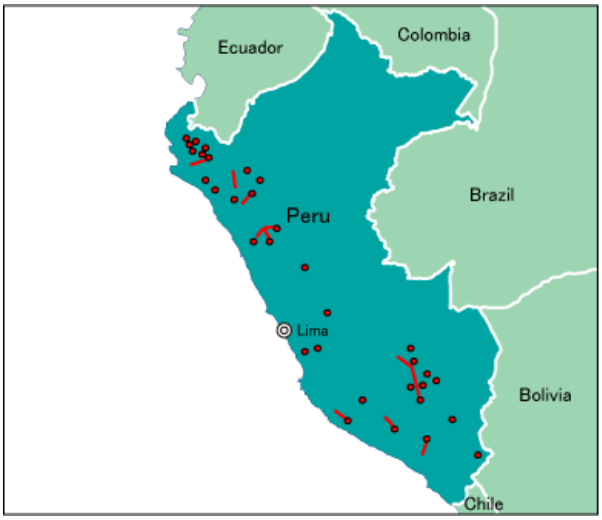
Ex-Post Evaluation of Japanese ODA Loan Project
"Electric Frontier Expansion Project Phases I & II"

External Evaluator : Global Group 21 Japan, Inc.
Hajime Sonoda

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