Republic of Paraguay

Ex-Post Evaluation of Japanese ODA Loan

Asuncion Power Transmission and Distribution Network Improvement Project

External Evaluator: Hajime Sonoda
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## 0. Summary

This project was implemented for the purpose of achieving a stable power supply by means of improving the transformation, transmission, distribution facilities, distribution control system and telecommunication facility for power supply maintenance in the Asuncion Metropolitan Area which was experiencing a rapid increase of the power demand. As this purpose was consistent not only with the development policies and needs of Paraguay but also with the ODA policy of Japan, the relevance of the project is high. With the implementation of this project, a stable power supply to the Metropolitan Area was secured as the capacity to receive power from the trunk transmission line and the capacity for transforming were increased. Moreover, the insulation of the distribution network and introduction of a distribution control system had a positive effect on the reduction of interruptions. In the Metropolitan Area, the increase of the power consumption per household in recent years is believed to have contributed to improvements in standard of living and the project is contributed to such improvement. As such, the effectiveness / impact of the project is judged to be high. Meanwhile, although the final project cost was within the planned cost, the project period was two times of the originally planned period, therefore efficiency of the project is judged to be fair. Some substation sites experienced strong opposition from local residents who feared damage to their health by electromagnetic field. In the face of such opposition, Administracion Nacional de Electrididad (ANDE) now places more emphasis on the aspect of social consideration in its work involving transmission and transformation. The sustainability of the project is judged to be fair as there are minor problems with the institutional and technical aspects of the maintenance of the distribution control system. Based on the above, this project is evaluated to be satisfactory.

## 1. Project Description


Project Location

Republicano Substation

### 1.1 Background

The long-term power generating capacity in Paraguay was secured from the late 1980's when the Itaipu Power Station, one of the world's largest hydropower stations, was commissioned with joint operation with Brazil. However, the transmission and distribution capacity in the Metropolitan Area which accounted for 60% of the country's power demand was predicted to suffer from a significant

shortage by 2000 when the power demand was forecasted to grow to 2,141 GWh with a rapid population increase. To make matters worse, the Metropolitan Area was experiencing frequent interruptions caused by damage to uninsulated power lines by fallen trees, etc. The long wait for the restoration of power supply due to the weak maintenance regime had a considerable negative impact on industrial activities and civic life. In 1988, the Government of Paraguay made a request to the Government of Japan for the provision of technical cooperation to achieve a stable power supply in the Metropolitan Area. In 1990, a master plan was formulated based on the findings of the Feasibility Study on Power Distribution System Improvement Project in the Metropolitan Area of the Republic of Paraguay. To implement this master plan, the Government of Paraguay made a request for Japanese ODA Loan to the Government of Japan which subsequently decided in 1994 to implement the Asuncion Power Transmission and Distribution Network Improvement Project (target project of the present ex-post evaluation; hereinafter referred to as "the Project"). The ODA Loan for the Project was disbursed from 1994 to 2005 and the work continued thereafter until 2007 with funding by the Paraguay side.

### 1.2 Project Outline

The project aimed at achieving a stable power supply in the Metropolitan Area, which was experiencing a rapid increase of the power demand, by means of improving the transmission lines, substations, distribution network, distribution control system and telecommunication equipment for power supply maintenance, thereby contributing to the improvement of the basic living environment for residents of Asuncion.

| | |
|---|---|
| Loan Approved Amount/ Disbursed Amount | ¥8,100 million yen / ¥5,636 million yen |
| Exchange of Notes Date / Loan Agreement Signing Date | November, 1994 / November, 1994 |
| Terms and Conditions | Interest Rate: 3.0%<br>Repayment Period: 30 years(Grace Period: 10 years)<br>Procurement type: General untied |
| Borrower/Executing Agency | Administracion Nacional de Electricidad (ANDE: National Electricity Administration), Republic of Paraguay |
| Final Disbursement Date | November, 2005 |
| Main Contractors | Schneider Electric SA France (France) / Alstom T & D SA (France) / SAINCO (Spain) |
| Main Consultant | Electric Power Development Co., Ltd. (Japan) |
| Feasibility Studies, etc. | Feasibility Study on Power Distribution System Improvement Project in the Metropolitan Area of the Republic of Paraguay |
| Related Projects | ・Transmission and Distribution Network Improvement Project (L/A in 1985)<br>・Yguazu Hydropower Station Construction Project (L/A in 2008) |

## 2. Outline of the Evaluation Study

### 2.1 External Evaluator

Hajime Sonoda (Global Group 21 Japan, Inc.)

### 2.2 Duration of Evaluation Study

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

Duration of Study : September, 2012 - July, 2013
Duration of Field Study : November 3 - December 9, 2012
March 24 - March 31, 2013

## 3. Results of the Evaluation (Overall Rating: B[1])

### 3.1 Relevance (Rating: ③[2])

#### 3.1.1 Relevance to the Development Plan of Paraguay

Around the time of appraisal, the Office of the President of Paraguay published a white paper on the power sector in 1993, stressing the importance of this sector in view of the correlation between economic development and the power demand. Following this white paper, the Power Development Plan (to 2000) of ANDE adopted such goals as power supply to all, sufficient power supply to industries and socioeconomic development as well as improvement of the living standard through power supply.

At the time of ex-post evaluation, the Strategic Socioeconomic Plan (2008 – 2013) of the Government of Paraguay stipulates eight development policies, including the promotion of infrastructure development. The power sector heads the priority order for infrastructure development. As the problem was Paraguay's inability to undertake sufficient power supply for the power demand due to an insufficient transmission and distribution capacity despite a sufficient generating capacity, the priority issues were extension of the high voltage transmission network, reduction of the power loss of the existing transmission network and extension of the distribution networks in rural areas.

As outlined above, the electricity sector has always been a priority sector of Paraguay's development policy since the time of appraisal to the time of ex-post evaluation.

#### 3.1.2 Relevance to the Development Needs of Paraguay

As described in 1.1 Background, the improvement/development of the transmission and distribution networks was urgently required to provide a stable power supply for the Metropolitan Area.

As the improvement of the transmission and distribution networks in the Metropolitan Area was largely achieved by a series of projects, including the present project, the current priority is said to be the improvement of the high voltage transmission network linking the power generating area to consumption areas. As the existing transmission network does not meet the N-1 standard[3], it is important to construct a highly reliable transmission network. In addition, given the 6.2% annual increase of the power consumption in the Metropolitan Area (2006 – 2011), the continual expansion of the transmission and distribution facilities is required. Meanwhile, the needs for insulation of distribution network is high, due to the fact that frequent interruptions still occur in areas without insulated distribution lines as only 10% of the distribution network is currently insulated.

In short, even though the project has helped the Metropolitan Area to avoid a significant capacity shortage in terms of transmission and distribution, there is still a strong need for the further improvement of the transmission and distribution networks in view of the likely rapid increase of the power demand.

#### 3.1.3 Relevance to Japan's ODA Policy

At the second consultation meeting between Japan and Paraguay in July, 1992, an agreement was reached that the important areas for Japan's ODA were the promotion of agriculture, development of

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

2 ③: High , ② Fair ,①: Low

3 The N-1 standard means that a transmission network has reserve capacity to continue to supply power in a stable manner even if an incident such as a failure on one transmission line occurs with the power system.

economic infrastructure, development of the social sector and environmental conservation among others. The project fell in the category of the development of economic infrastructure.

Based on the above observation, 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.

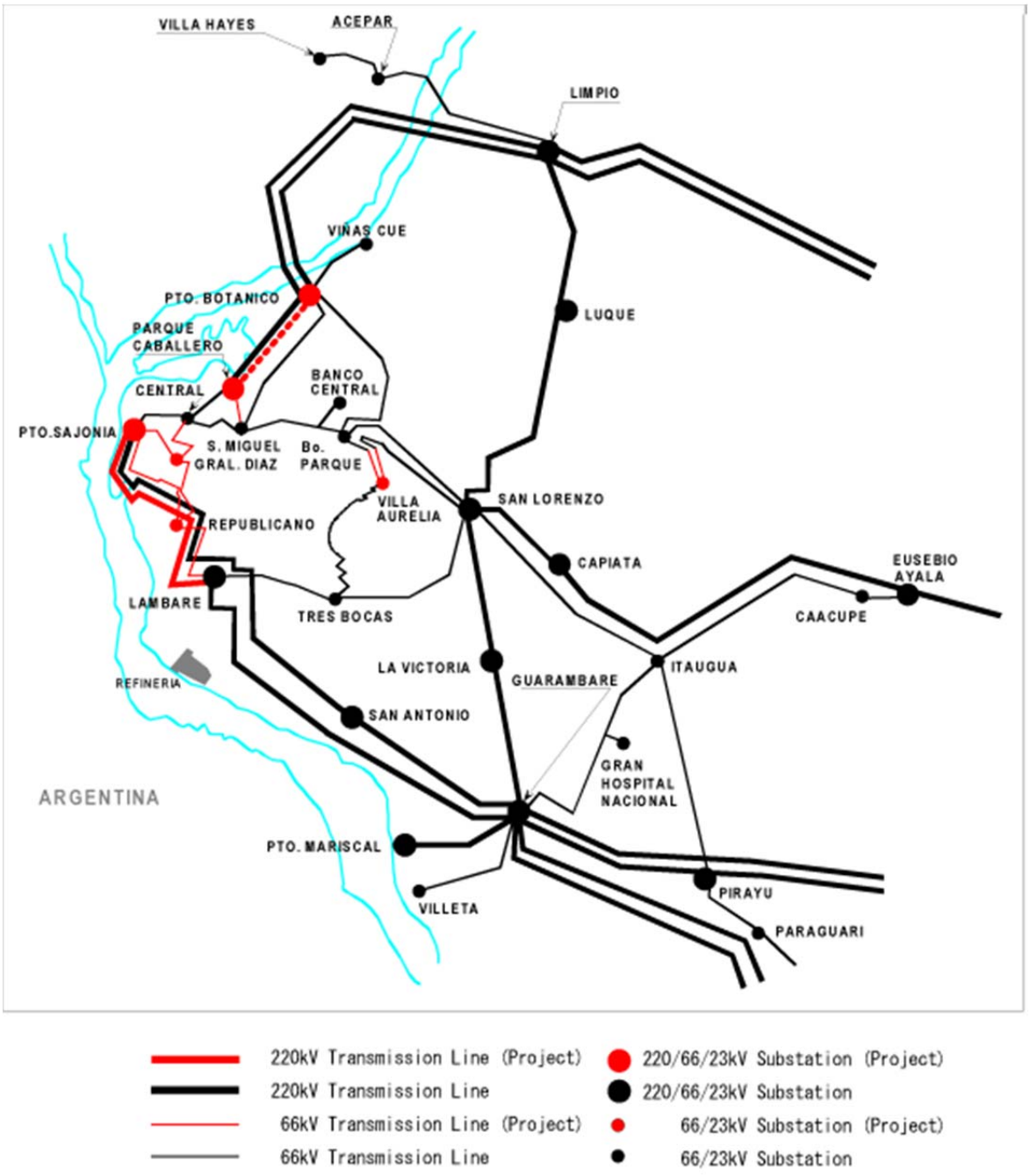


Figure 1 Power transmission facilities constructed by the Project (in red)

### 3.2 Effectiveness[4] (Rating: ③)

#### 3.2.1 Quantitative Effects (Operation and Effect Indicators)

The project aimed at achieving a stable power supply in the Metropolitan Area by means of constructing transmission lines and substations, extending and insulating distribution lines and introducing a distribution control system. The degree of achievement and the contribution of the project are quantitatively analysed next from several viewpoints[5].

(1) Increase of the Capacity to Receive Electricity from the Trunk Transmission Lines

The trunk transmission lines from the Itaipu Power Station and other power sources to the Metropolitan Area consist of four 220 kV lines and one 500 kV line with a second 500 kV line under construction as of March, 2013. The three substations included in the project receive power from these trunk transmission lines (Substations Puerto Botanico, Puerto Sajonia, Parque Caballero). The increased capacity to transform 220 kV in the Metropolitan Area as a result of the project is 360MVA and accounts for 20% of the capacity of the power system in the Metropolitan Area (1,800 MVA in 2011). However, at the Parque Caballero Substation, an overhead 220 kV transmission line has not been constructed nor connected at the time of ex-post evaluation because of an opposition among local residents who worry over health damage by magnetic field and a disagreement by the land owner (local authority) on its use. Therefore, even though the additional transformation facility of 120 MVA installed is in operation, the additional capacity is not fully utilized as the substation has sufficient capacity[6]. Similarly, the 220 kV switchgear installed at the Puerto Botanico Substation is not in operation as it has not yet been connected to the transmission line.

(2) Increased Substation Capacity in the Metropolitan Area

Under the Project, 23 kV transforming facilities with a total capacity of 380 MVA (against the planned capacity of 360 MVA) were installed at five substations and were connected to the distribution networks (Substations Parque Caballero, Puerto Sajonia, Republicano, Villa Aurelia, and General Diaz).[7] This capacity was equivalent to 21% of the entire capacity of the power system in the Metropolitan Area (1,824 MVA in 2011).[8]

The power consumption in the Metropolitan Area increased by 2.5 times from 1994 to 2011 and the annual peak power demand reached 1,146 MW in 2011. In January, 2006 (peak power demand month due to the use of electricity for heating), before the commencement of the operation of the substations constructed or expanded under the Project, the utilisation ratio (maximum load / [installed capacity x power factor]) of the 26 substations in the Metropolitan Area was an average of 77% with the ratio exceeding 90% at 14 substations (more than 100% at seven substations), indicating that the transforming capacity limit was exceeded in some areas.

The increased transforming capacity as a result of the Project reduced the average utilization ratio of the substations to 65% in 2008 with only four out of 29 substations recording the utilization ratio of more than 90% and no substations recording the utilization ratio of more than 100%.

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4 Sub-rating for the Effectiveness is to be put with consideration of Impact.

5 Although target values were shown as for electrification rate of the Metropolitan Area at the time of appraisal, no indicators or target values were specified as for an attainment of reliable power supply. In the ex-post evaluation, analyses were made based on such indicators as transmission and transformation capacity, utilization ratio of substations, frequency and duration of interruptions, while no analysis was made on electrification rate as the Project did not affect it (refer to the section of "Efficiency").

6 The additional facility was used as a back-up facility for the existing substation at the time of field visit.

7 Excluding the Puerto Botanic Substation where only switchgear was installed.

8 In addition to the project, ANDE has continually expanded the transmission and transforming facilities in the Metropolitan Area. From 2005 to 2012, it added capacity of some 300 MVA outside the scope of the Project.

In January, 2012, the utilization of the five substations newly constructed or expanded under the Project was between 36% and 90%. Meanwhile, the utilization ratio of the Villa Aurelia Substation distributing power to an area with a rapid power demand increase exceeded 90%.[9] Without the Project, it is reasonable to assume that the power demand in some parts of the Metropolitan Area would have significantly exceeded the transforming capacity, causing severe disruption to the power supply, including a series of planned outages. In other words, the Project made it possible to avoid the emergence of a serious problem in power supply.[10]

Table 1 Transitions of Utilization Rate of Substations in the Metropolitan Area

| | January, 2006 | January, 2008 | January, 2012 |
|---|---|---|---|
| Average utilization ratio (%) | 77% | 65% | 75% |
| Number of substations with a utilization ratio of 90% or lower | 15 | 25 | 23 |
| Number of substations with the utilization ratio of between 90 % and 100% | 14 | 4 | 10 |
| Number of substations with the utilization ratio of 100% or higher | 7 | 0 | 0 |

Source: Prepared by the evaluator using ANDE data

Puerto Sajonia Substation (left; switch yard, right; control room)

Parque Caballero Substation (the facility not yet connected)

66kV transmission line

[9] As the power demand in the area is very high, this substation is scheduled for upgrading to a 220 kV substation by 2019.

[10] The delayed implementation of the Project temporarily caused a situation where the transforming capacity fell short of the increasing power demand in some areas, including Villa Aurelia.

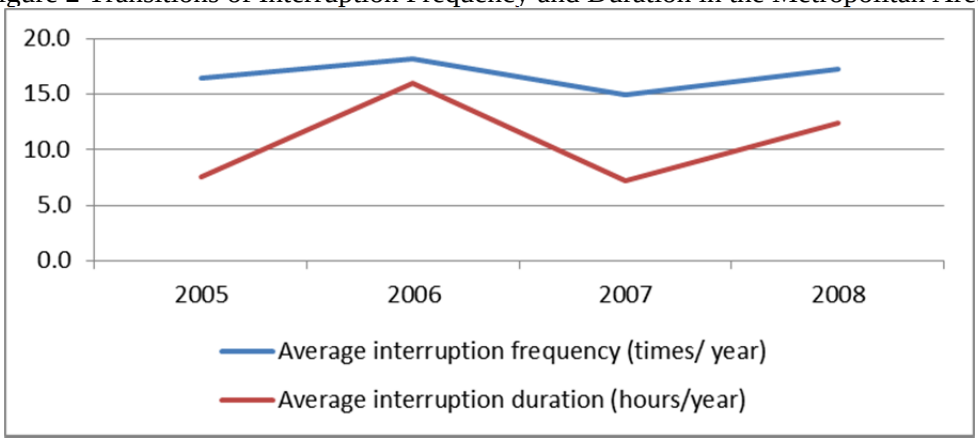
(3) Decrease of Interruption due to Newly Insulated Distribution Network

Under the Project, 23 kV distribution lines and 380 V distribution lines were constructed for 256 km and 351 km respectively. These figures correspond to 4.4% and 6.9% of the total length of 23 kV distribution lines and 380 V distribution lines respectively in the Metropolitan Area in 2012. The beneficiaries of the distribution network improved by the Project are estimated to be some 38,000 households and 4,500 commercial or industrial facilities. As the improvement of the distribution network under the Project entirely consisted of the renewal or upgrading (insulation) of the existing distribution network without extension, the Project made no contribution to the improvement of the electrification rate.[11]

Insulation of distribution lines is known to be effective for reducing interruptions due to contacts with trees in severe weather conditions and small animals. Using insulted distribution lines, trimming of trees will be unnecessary and more flexibility in routes of installation can be acquired. (Figure 2) According to ANDE, the number of interruptions was dropped by one-third to a quarter after the insulation of the distribution network.[12]

According to Figure 1, the frequency and duration of interruptions with the 23 kV distribution network in the Metropolitan Area did not show any tangible decrease in the period from 2005 to 2008.[13] Because the insulation work under the Project covered less than 10% of the distribution network in the Metropolitan Area, its effects are not visible in the results those indicators. However, ANDE has been implementing further insulation work with its own funds for the purpose of enhancing the reliability of power supply and increasing the degree of freedom of the work to install new distribution lines.

Figure 2 Transitions of Interruption Frequency and Duration in the Metropolitan Area




Source: ANDE

[11] The Project initially planned to improve the electrification rate by means of extending the distribution network. Refer to the section on "Efficiency" for the reasons for the non-extension of the distribution network. The electrification rate in the Metropolitan Area reached 99.7% in 2011.

[12] In one distribution section, for example, the number of interruptions fell from some 40 times a year in 2004 and 2005 to less than 10 times a year from 2010 onwards.

[13] The work under the Project was completed in September, 2007. The data calculation method was refined in 2009 to make new data reflect the occurrences of interruptions more accurately. Accordingly, the data for 2009 onwards cannot be compared with the data shown in Fig. 1.

Fig.3 Relationship between a tree and distribution line
(left; un-insulated lines, right; insulated lines) (provided by ANDE)

23kV distribution lines

On-pole switch

(4) Power Distribution Control System and Communication Equipment

With the introduction of a distribution control system and telecommunication facilities, it became possible to remotely monitor and operate more than 200 switches for the 23 kV distribution network in the Metropolitan Area and to make the response to interruptions much faster. Prior to the Project, a repair team was only dispatched after a visual or other confirmation of an incident of interruption at the site concerned upon reporting by a user(s). With the new system, a repair team is dispatched almost immediately after the occurrence of an interruption.

In short, the Project increased the capacity to receive power from the trunk transmission lines as well as the transforming capacity in the Metropolitan Area. The actual increase of these capacities exceeded the planned increase. The new facilities have been fully utilized, contributing to a stable power supply in the Metropolitan Area. Moreover, the improvement (insulation and introduction of the distribution control system) of the distribution network under the Project has reduced the frequency of interruptions to some extent, thereby contributing to a stable power supply. The Project has, therefore, made an important contribution to achieving a stable power supply in the Metropolitan Area and its effectiveness is high.

### 3.2.2 Qualitative Effects

Improvement of the living environment in the Metropolitan Area is considered to constitute a qualitative effect of the Project and is analysed in this report as part of the Impact.

### 3.3 Impact

#### 3.3.1 Intended Impacts

The project was expected to contribute to the improvement of the basic living conditions of local residents by means of achieving a stable power supply to match the power demand in the Metropolitan Area.

The power consumption in the Metropolitan Area increased by 52% in the seven years from 2005 to 2011 (Figure 4). In the same period, the total number of users increased by 17% (Table 3). General users (residential) account for 45% of the total power consumption in the Metropolitan Area while commercial users and industrial users account for 21% each in 2011 (Figure 5).

It was considered that the living standard improved in this period of a substantial increase of the power consumption per residential user. The power consumption by commercial users also increased, suggesting a possible improvement of their services. In the case of industrial users, the level of power consumption did not increase as much as the number of such users, suggesting a possible increase of the ratio of small business users among industrial users. The project is judged to have made these changes possible through preventing destabilization of power supply due to an increase of demand.

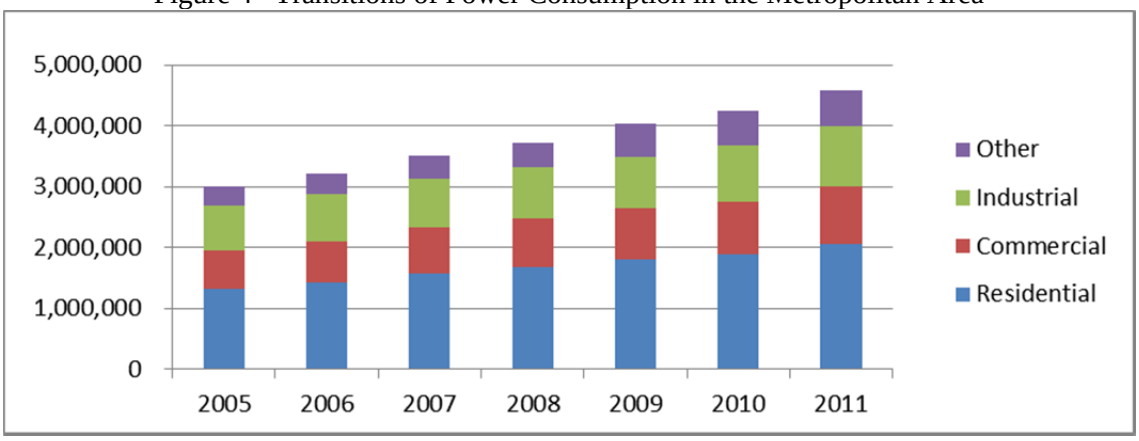
On the other hand, the findings from the interviews with business operators and ordinary households in the Metropolitan Area appear to suggest a decline of the number of interruptions in areas where the distribution network was improved under the Project. However, interruptions have not been completely eradicated and many business operators possess their own generator in case of an interruption.

Table 3 Transitions of Power Consumption in the Metropolitan Area (2005-2011)

| | Increase of the Number of Users | Increase of Power Consumption | Increase of Power Consumption per User |
|---|---|---|---|
| Residential | 17% | 57% | 34% |
| Commercial | 12% | 48% | 32% |
| Industrial | 51% | 34% | -11% |
| Other | 29% | 81% | 41% |

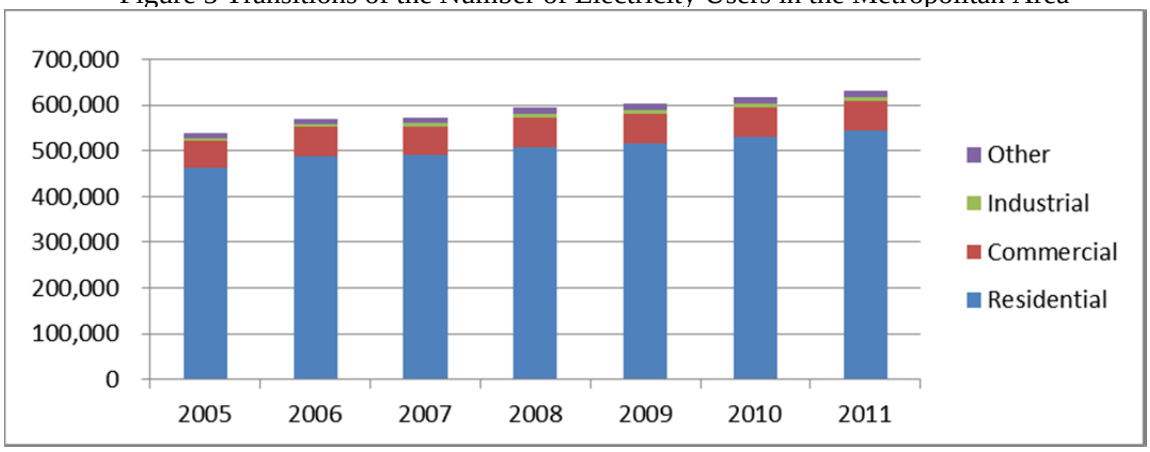
Source: ANDE

Figure 4 Transitions of Power Consumption in the Metropolitan Area




Source: ANDE

Figure 5 Transitions of the Number of Electricity Users in the Metropolitan Area




Source: ANDE

### 3.3.2 Other Impacts

(1) Environmental and Social Impacts

At the time of appraisal, it was possible to obtain an environmental permit for the transmission and transformation facilities included in the Project by means of simply submitting an environmental management plan. However, revision of an environment-related law after the commencement of the Project made an environmental impact assessment (EIA) a compulsory requirement for transmission and transforming facilities with a capacity of less than 100 kV. Following this revision, an EIA was conducted for the Project. The environmental permit requires renewal every two years after its original issue. ANDE is regularly reporting on the maintenance work, training and impacts on the surrounding environment (in terms of noise, odor and electromagnetic field) regarding each of the new substations, and the environmental authority monitors the measures taken by ANDE.

The necessary environmental permit for the Project was obtained prior to the signing of the construction contract. However, strong opposition by local residents concerned about possible health damage due to electromagnetic field emerged at three substation sites at the time of the renewal of the said permit after signing of the construction contract for Substations of Republicano, General Diaz and Pinoza. As politicians became involved in this dispute, the issue acquired political and social dimensions. ANDE patiently negotiated with the opposing local residents at a forum involving residents' groups, municipal offices, competent environmental office and environmental experts. In the case of two substations, an agreement to allow the construction of a substation was reached with conditions which included the construction of a high perimeter wall around the substation and the construction of neighbourhood parks, and such facilities were constructed as agreed. In the case of Pinoza Substation, however, the construction work had to be abandoned because of the failure to reach agreement with the residents and find an alternative site. The construction of part of the planned 220 kV transmission line (overhead) was also abandoned because of opposition by local residents or the difficulty of using the earmarked land (the use of the municipal land in question for another purpose was prioritised by the municipal authority).

(2) Other Impacts

As ANDE had never experienced opposition by local residents on the grounds of electromagnetic field, it implemented several measures as listed below to build up the understanding of local residents[14]. As a result, similar incidents have become rare.

[14] In those days there were no environmental standards on electromagnetic field, and there was no awareness on

- An international conference was held to which experts from the World Health Organization, Pan American Health Organization and others were invited to share an international understanding of and information on health damage by electromagnetic field.

- Based on the achievements of the above conference, the competent environmental office set forth electromagnetic field protection standards in 2007 and every EIA today must reflect these standards.

- A consultation meeting with local residents is now held prior to construction work. All relevant government offices, etc. participate in this meeting.

- The environmental management section of ANDE has been upgraded.

The experience of opposition by local residents to the construction of some of the facilities planned under the Project had the effect of making ANDE focus on the social consideration aspect of its transmission and transformation projects. As it was difficult to predict such opposition by local residents in advance, and ANDE's construction plan for the project followed the administrative procedures required at the time, its preparations for the project cannot be said to have been inappropriate.

Based on such observation results confirming the achievement of certain positive effects of the project, the effectiveness/impacts of the Project is high.

### 3.4 Efficiency (Rating:②)

#### 3.4.1 Project Outputs

The planned and actual outputs of the Project are shown below.

Table 4 Planned and Actual Project Outputs

| | Planned | Actual |
|---|---|---|
| Substation 220/66/23kV<br>66/23kV | 3 locations<br>3 locations | 3 locations<br>3 locations |
| Transmission line 220kV<br>66kV | 2 sections, 15.5 km<br>7 sections, 19.2 km | 1 section, 9.1 km<br>8 sections, 10.7 km |
| Distribution line 23kV extension<br>23kV insulation<br>380/220V extension<br>380/220V insulation | 790 km<br>57 km<br>1,087 km<br>83 km | 0 km<br>256 km<br>0 km<br>351 km |
| • Distribution control system<br>• Telecommunication system for distribution maintenance | • Substation monitoring system | • Independently controlled automatic distribution system |
| Road lighting | (Not planned) | Street lights: Approx.14,000 |

Source: ANDE

The locations of some substations and transmission lines were changed or their construction was cancelled because of the reasons described below. In addition, some of the planned overhead transmission lines were buried underground instead. As a result, the increase of the transformation capacity by the new substations was 360 MVA (100% of the planned capacity) for 220 kV facility and 380 MVA (112% of the planned capacity) instead of the planned 340 MVA for 23 kV facility.

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its possible health damage neither in ANDE nor in general public.

- After the feasibility study in 1990, the master plan of ANDE was revised to take the rapid increase of the power demand and the ageing nature of the original master plan into consideration. With the subsequent planning of multiple high voltage transmission lines, the routes of the planned high voltage transmission lines under the Project were altered.

- Apart from the cancellation of the construction of some transmission and transforming facilities due to the difficulty of land acquisition or opposition by local residents who were concerned in regard to possible health damage by electromagnetic field, it was necessary to make some changes to the plan, including the change of location and the laying of the transmission lines underground (refer to the section for "Impact".)

While the procurement of the consultant for this Project was delayed due to the delay in approval of loan agreement by the parliament as mentioned below, ANDE extended the distribution network using its own funds (partly paid by local residents) under a "self-implementation scheme" against the background of a rapidly increasing power demand.[15] The enforcement of a new municipal regulation (restriction on the felling of trees) in 1994 made it impossible to install un-insulated power cables while felling lines of trees. This new situation increased the necessity for insulation work and the focus of the Project was placed on the renewal and insulation of existing distribution lines instead of extending them. In the end, the total length of the distribution network construction of the Project was reduced to approximately one-third of the planned length at the time of appraisal.

In the case of the distribution control system, the originally planned "substation monitoring system" was changed to an "independently controlled automatic distribution system" capable of reducing interrupted sections as well as the duration of each interruption with a smaller manpower requirement for system maintenance as requested by ANDE against the background of falling system prices due to technological innovation. However, the specifications of the system introduced under the Project were determined in 2000 and have already become obsolete. All of the above changes are judged to be appropriate as they correspond to changing needs and technologies.

As part of the environmental as well as social consideration, the procurement and installation of street lights was added as a crime prevention measure. This change was approved as a better social and environmental consideration measure to meet the request by local residents living in the vicinity of some substations and was made possible because of the leeway for Japanese ODA Loan. The completion of this additional work was delayed until 2013 as the necessary coordination with the related administrative organizations proved to be a lengthy process at some sites.

### 3.4.2 Project Inputs

#### 3.4.2.1 Project Cost

Under the Project, Japanese ODA Loan was used to procure material for the transmission, transforming and distribution facilities while the counterpart fund was used to carry out the civil engineering work. The final construction cost of these facilities fell significantly below the planned cost because of the reduced length of the transmission and distribution lines caused by changes of the plan, the reduced yen equivalent local currency amount to cover the cost of the construction work conducted by the Paraguayan side due to changes of the exchange rate and the reduction of the cost due to a competitive tender.[16] The resulting total project cost of ¥6,848 million was 64% of the

[15] From 1994 to 1997, ANDE constructed 1,577 km of 23 kV distribution lines and 1,902 km of 380/220 V distribution lines.

[16] In regard to the construction of distribution lines, the cost per unit length was higher than planned as the total length of the insulation work (including the laying of power cables underground) increased with the extension of the existing distribution lines being removed from the scope of the Project.

planned cost (¥10,801 million) and the disbursed loan amount of ¥5,636 million was 70% of the planned amount. [17]

Although simple comparison is difficult because of the much changed outputs, the Project cost was within the planned cost, therefore the efficiency of the project is evaluated to be high.

Table 5 Planned and Actual Project Costs

(Unit: ¥ million)

| | ODA Loan | Plan Paraguay | Total | ODA Loan | Actual Paraguay | Total |
|---|---|---|---|---|---|---|
| Construction of transmission lines | 923 | 488 | 1,411 | 2,572 | 377 | 2,949 |
| Construction of substations | 2,615 | 696 | 3,311 | | | |
| Construction of distribution lines | 2,587 | 376 | 2,963 | 1,238 | 506 | 1,743 |
| Distribution control system | 333 | 0 | 333 | 990 | 329 | 1,319 |
| Telecommunication equipment | 347 | 0 | 347 | | | |
| Consulting services | 547 | 0 | 547 | 831 | 0 | 831 |
| Land expropriation | 0 | 154 | 154 | Unknown | Unknown | Unknown |
| Taxes | 0 | 898 | 898 | Included in the construction cost | | |
| Contingency | 680 | 157 | 837 | 0 | 6 | 6 |
| Total | 8,100 | 2,701 | 10,801 | 5,636 | 1,211 | 6,848 |

Source: Prepared by the present evaluator using ANDE data

(Exchange rate) At the time of appraisal: 1 US$=1,797 Gs = 113.5 Yen

Actual: 1 US$ = 113.0 Yen (average for 2005-07)

1 Yen = 49.7 Gs (average for 2002-07)

#### 3.4.2.2 Project Period

The Project was originally planned to take 74 months to complete from November, 1994 to December, 2000. In reality, it took 155 months from November, 1994 to September, 2007 when the work for the distribution lines was completed. Therefore, the actual project period was 209% of the plan, massively over-running the originally planned period.[18]

The expiring date for loan disbursement was also extended for three years from November, 2002 to November, 2005. A lump sum advanced disbursement was made so that the necessary equipment and materials could be procured before this extended expiring date. Meanwhile, construction work using Paraguay's own funds continued beyond the time limit for loan disbursement.

There are several reasons for the prolonged implementation of the Project as described below.

- Approval of the loan agreement by the parliament of Paraguay was delayed for approximately one year.

- More than three years were required to review the feasibility study to reflect the revised master plan of ANDE and to modify the plan as necessitated by the problem with local residents regarding land acquisition and other problems. [19]

[17] Land acquisition cost is not included in the actual total project cost as no information is available.

[18] Street lighting work is still taking place in some sections as of March, 2013 following the relevant field survey as the necessary agreement with the local public bodies involved could not be reached by the project completion date of September, 2007. However, as street lighting is not directly related to the purpose of the project, the work is not considered to be part of the Project.

[19] As land acquisition was difficult for the Substations in the down town of Bario Obrero and Catedral, the Substations of Republicano and General Diaz were constructed in other locations.

- It took almost four years to conclude the contract because of unsuccessful bidding, restructuring of the work package, rebidding and re-rebidding[20].

- It took almost eight years from the procurement of materials, etc. to the completion of the transmission and transforming facilities because of modification of the plan and suspension of the work necessitated by the opposition among local residents, the difficulty of land acquisition and other reasons.

- In the case of the distribution control system, it took a long time to modify the scope to reflect technological advancement, to answer technical questions posed by the bidding companies (as ANDE had no previous experience of the type of system to be procured) and to evaluate the actual bids. Consequently, the procurement of equipment and materials was considerably delayed and it took six years since the bidding preparation (including examination of specification) by consultant to contract agreement.

### 3.4.3 Results of Calculations of Internal Rates of Return (IRR)

The economic internal rate of return was not calculated at the time of appraisal. No calculation is made in the ex-post evaluation because of the lack of sufficient data from ANDE.

Although the project cost was within the plan, the project period was exceeded the plan, therefore efficiency of the project is fair.

## 3.5 Sustainability (Rating:②)

### 3.5.1 Institutional Aspect of Operation and Maintenance

ANDE is a public body which is responsible for the operation of the power system in general, ranging from generation to distribution, in Paraguay and operates all of the facilities introduced under the Project. At the end of 1992, ANDE had 2,533 employees. This increased to 3,755 in 2011. While the manpower strength increased by 50% in this period, the number of users and the power consumption in Paraguay per ANDE employee increased by 1.7 times and 2.2 times respectively. As the standard of service was maintained through the period without a significant increase in interruptions, these figures indicate an improvement of the labor productivity.

At the time of ex-post evaluation, the operation and maintenance of the transmission and transforming facilities are conducted by the Operation Division and the Transmission Maintenance Division of the Technical Department while the operation and maintenance of the distribution network and distribution control system are conducted by the Metropolitan Area Distribution Operation Division and the Distribution Maintenance Division of the Distribution Department. The maintenance of the distribution network in the Metropolitan Area is conducted by six teams with five members each for the 23 kV network and six teams with five members each for the low voltage distribution lines. Those on the front line believe that an additional three teams or so are necessary for each of the 23 kV network and the low voltage distribution lines to achieve their proper maintenance.

The personnel affairs of ANDE are prone to political influence and the frequent reorganization, personnel reshuffles and large numbers of non-technical employees are believed to have damaged the organizational efficiency of ANDE.[21] In addition, there appears to be room for improvement in regard to the administrative capacity of ANDE in view of problems associated with the operation and

[20] The first bidding for material of distribution line was not successful due to non-existence of qualified bidder. Rebidding was carried out after dividing into four lots, among which two lots needed re-rebidding as there were no bidders technically qualified.

[21] In the last seven years, ANDE has seen the successive appointment of 10 presidents.

maintenance of the distribution control system and also its failure to provide sufficient internal information for the ex-post evaluation.

### 3.5.2 Technical Aspect of Operation and Maintenance

In 2012, ANDE received an international quality award as a result of a consumer satisfaction survey conducted by the CIER with 1,300 power distribution companies in Central America, South America and the Caribbean Region.[22] The Human Resources Training Division of ANDE implemented some 200 training courses in 2011 and 1,795 staff members attended these courses for a total of 55,000 hours or some 15 hours per staff member.

The general technical capability in regard to transmission, transforming and distribution on the part of the staff members of ANDE is believed to be sufficient. For the operation and maintenance of the distribution control system, training was provided by the manufacturer to transfer the necessary skills and technical knowledge to some staff members of ANDE. However, some of these staff members have since been transferred to other positions. As such, there appears to be no firm build-up of skills to operate and maintenance the distribution control system in the competent division of ANDE.

### 3.5.3 Financial Aspect of Operation and Maintenance

In recent years, ANDE has maintained a high level of profitability and sound financial health as outlined below.

- From 1997 to 2002, ANDE recorded a deficit in such accounting items as the ordinary profit and profit before tax. These went into the black in 2003 and thereafter. The contributory factors for its positive performance are an increase of the power tariff by some 30% in 2003, beneficial changes of the purchase contract for power from the Itaipu Hydropower Station and changes of the exchange rate for the purchase of power.

- The rate of return (ordinary profit/working capital) went into positive in 2003 and has since been in the range of 4–8%. Although not entirely sufficient, it has maintained a generally adequate level (the government criteria for public entity is 8%).

- The EBITDA margin (EBITDA/turnover) has been in the range of 25–33% for the last five years, maintaining a high level of profitability.[23]

- The current ratio has exceeded 200% in the last five years and is, therefore, sufficiently high. The equity to liability rate of 48.3% in 2007 was fairly adequate and has since improved to 30.2% (2011).

Interviews with those responsible for the operation and maintenance of the facilities provided under the Project found no incidence of an insufficient budget significantly hindering maintenance except in the case of the distribution control system as described next.

[22] Regional Electric Integration Commission (La Comisión de Integración Eléctrica Regional：CIER) is NGO established in 1964 aiming at a regional integration of power systems, having its headquarter in Uruguay and participation of more than 200 electric companies, regulating bodies and relevant ministries from 16 countries in Latin America and Caribbean Region.

[23] EBITDA margin is an indicator of corporate profitability. It is given by dividing EBITDA (Earnings Before Interest, Tax, Depreciatiion and Amotization) by sales.

Table 6 Financial Results of ANDE

(Unit: million Grs.)

| | 2009 | 2010 | 2011 |
|---|---|---|---|
| Current assets | 2,406 | 2,529 | 2,508 |
| Fixed assets | 6,677 | 7,321 | 7,760 |
| Total assets | 9,083 | 9,849 | 10,268 |
| Current liabilities | 967 | 1,106 | 926 |
| Fixed liabilities | 1,531 | 1,628 | 1,454 |
| Net assets | 6,585 | 7,115 | 7,888 |
| Operating income | 315 | 283 | 387 |
| Income before income taxes | 477 | 357 | 595 |
| Current net income | 451 | 330 | 540 |

Source: ANDE

The delay of the official handing over of the distribution control system by its supplier until November, 2012 meant that ANDE did not allocate a maintenance budget for the system until then, causing some operational problems. Trial operation of the system began in February, 2007 and the provisional handing over took place in March, 2008 to continue operation. The delay in question was caused by slow procedural progress within ANDE, in turn caused by the lack of a proper succession of the work whenever the person in charge was replaced.

### 3.5.4 Current Status of Operation and Maintenance

(1) Transmission and Transforming Facilities

The substations and transmission lines constructed under the Project have been maintained based on the relevant ANDE standards. Because of the adoption of preventive maintenance, the adequate conditions and functions of the facilities have been maintained, suggesting no problems in regard to operation and maintenance.

(2) Distribution Facilities

The 23 kV distribution lines are subject to annual preventive maintenance which includes thermographic inspection. Any disconnection is promptly repaired. ANDE possess the technical capability to repair live lines. The insulated distribution lines appear to have undergone frequent repairs as the original insulation work was less than satisfactory because of the unfamiliar nature of the work for the local contractor. In regard to the low voltage distribution lines, preventive maintenance is not practiced and repair work is conducted on receipt of a report of disconnection or interruption.

(3) Distribution Control System

Of the 350 pole switches procured under the Project, 325 were installed. However, some of the installed switches were later removed due to changes of the distribution routes, reducing the number of operating switches to 289 at present. These switches are linked to the distribution control room by radio. The actual number of switches linked to the control room stands at 220 at present (overall availability ratio of 76%) as some have lost their link due to tilting of the highly directional antenna or have broken down because of the incursion of rainwater to the transmitter. As for some of the operating switches which register less reliable information on the state of opening/closing, on-site checking is essential. The person responsible for the system believes that it is necessary to recruit a full-time telecommunications engineer(s). However, according to an ANDE engineer involved in the installation of the distribution control system (the same person who was responsible for the installation work under the Project), the positional adjustment of the antenna of the pole switches and protection of the transmitter from rainwater are not difficult and are within the present capability of ANDE.

The control room has three large display units. However, these units are not used because of their broken-down lamps and an old manual display unit is used. The front view of this manual display unit is hindered by the new large display units which cannot be removed until their final handing over. These new units have been out of action because of the high cost of replacement lamps.[24] It must be mentioned that large display units with older specifications were procured. ANDE side believed that a series of problems starting from the lamp out did not be posed if liquid crystal displays were procured. While the procurement of the distribution control system was experiencing substantial delays, JICA side did not accept the proposal to change the specification of the display in the course of procurement procedures, considering the possibility of further delay.

ANDE is currently examining a development of an information system that allows integrated management of operation, quality and loss of power, investment, maintenance, protection and planning of transmission and distribution system. It is not yet clear how the distribution control system of the Project will be considered in this system.

Distribution Control Room (left; large display units not in use, right; manual display unit)

### 3.5.5 Sustainability Summary

Based on the above observations, some problems have been observed in terms of technical and financial aspects, therefore sustainability of the project effect is fair.

## 4. Conclusion, Recommendations and Lessons Learned

### 4.1 Conclusion

This project was implemented for the purpose of achieving a stable power supply by means of improving the transformation, transmission, distribution facilities, distribution control system and telecommunication facility for power supply maintenance in the Asuncion Metropolitan Area which was experiencing a rapid increase of the power demand. As this purpose was consistent not only with the development policies and needs of Paraguay but also with the ODA policy of Japan, the overall relevance of the project is high. With the implementation of the project, a stable power supply to the Metropolitan Area was secured as the capacity to receive power from the trunk transmission line and the capacity for transforming were increased. Moreover, the insulation of the distribution network and

[24] After the provisional handing over of the SCADA system in 2008, the official handing over took place in November, 2012. During this period, ANDE did not allocate the necessary budget and manpower to maintain the system on the grounds that the system had not been officially handed over. ANDE took the stance that it could not touch the system until the official handing over. As the guarantee period in the contract was two years from the provisional handing over, any necessary repair or adjustment during this period was the responsibility of the supplier.

introduction of a distribution control system had a positive effect on the reduction of interruptions. In the Metropolitan Area, the increase of the power consumption per household in recent years is believed to have contributed to an improved standard of living and the Project is partly responsible for such improvement. As such, the effectiveness / impact of the Project is judged to be high. Meanwhile, although the final project cost was within the planned cost, the project period was two times of the originally planned period, therefore efficiency of the Project is judged to be fair. Some substation sites experienced strong opposition from local residents who feared damage to their health by electromagnetic field. In the face of such opposition, ANDE now places more emphasis on the aspect of social consideration in its work involving transmission and transformation. The sustainability of the Project is judged to be fair as there are minor problems with the institutional and technical aspects of the maintenance of the distribution control system. Based on the above, this project is evaluated to be satisfactory.

## 4.2 Recommendations

### 4.2.1 Recommendations for ANDE

- Utilization of the distribution control system: It is necessary to examine a range of required work to improve the availability ratio of pole switches and the use or renewal of the large display units. ANDE should then implement such work with appropriate funding so that the distribution control system can be better utilized. For this purpose, the existing internal technical resources of ANDE must be effectively utilized and the necessary engineers should be deployed. In connection with new technologies, ANDE must be aware of the need to avoid the excessive transfer of engineers once trained with such technologies. The work recommended here should conform to an integrated information management system for transmission and distribution which is currently being examined by ANDE.

- Continual expansion of the transmission and transforming facilities in the Metropolitan Area: It is necessary to continually expand the transmission and transforming facilities to ensure a sufficient and stable power supply to meet the ever increasing power demand in the Metropolitan Area. Possible solutions, including the laying of power cables underground for the entire section, should be sought to re-start the suspended construction of a 220 kV transmission line between the Parque Caballero Substation and the Puerto Botanico Substation. It is hoped that this section will be completed at an appropriate time utilising the facilities constructed under the Project.

- Information management of the completed project: It is desirable for ANDE to sort and store various types of information relating to the operation of the completed facilities under every completed project so that the follow-up and ex-post evaluation activities for the projects can be efficiently conducted.

### 4.2.2 Recommendations for the JICA

None

## 4.3 Lessons Learned

- Importance of social consideration for a project to construct transmission and transforming facilities in an urban area: When a project to construct transmission and/or transforming facilities in a densely population area is planned, careful consideration should be given to the following matters with a view to preventing misunderstanding and anxiety among local residents to the project and to reduce possibility of unnecessary opposition by them.

    - Explanations on the influence of magnetic field based on scientific knowledge.

- Information sharing and consensus building with local residents as well as other stakeholders through continual dialogue.

- A highly professional expertise in the above regards of the project implementing body.

➢ Important points for the introduction of new technologies in the field of rapid technological innovation: When technologies in the field of rapid technological innovation are newly introduced, careful consideration should be given to the following matters with a view to preventing (i) inadequate operation and maintenance due to insufficient technical capability and (ii) the current new technologies soon becoming obsolete.

- The time from the decision on equipment specifications to the commissioning of equipment should be made as short as possible.

- In relation to the above, the aid organization should ensure its own flexibility to accommodate the modification of the specifications.

- Careful considerations to personnel transfer so that technical expertise can be firmly built up, such as avoiding excessive transfer of personnel with high technical expertise.

- Follow-up should be provided by means of technical cooperation, etc.

Comparison Between the Original Plan and the Actual Results

| Item | Components | Original Plan | Actual Results |
|---|---|---|---|
| Outputs | • Substation<br>• Transmission line<br>• Distribution line<br>• Substation monitoring system<br>• Telecommunication system for distribution maintenance<br>• Consulting service | 220/66/23kV 3 stations<br>66/23kV 3 stations<br>22 kV 2 sections 15.5km<br>66kV 7 sections 19.2km<br>Extension of 23kV line<br>790km<br>Insulation of 23kV line<br>57km<br>Extension of 380/220V line<br>1,087km<br>Insulation of 380/220V line<br>83km | 220/66/23kV 3 stations<br>66/23kV 3 stations<br>22 kV 2 sections 9.1km<br>66kV 8 sections 10.7km<br>Extension of 23kV line<br>0km<br>Insulation of 23kV line<br>256km<br>Extension of 380/220V line<br>0km<br>Insulation of 380/220V line<br>351km<br>• SCADA(Supervisory Control And Data Acquisition)<br>• Telecommunication system for distribution maintenance<br>• Consulting service |
| Project Period | | November,1994 to December, 2000 (74 months) | November, 1994 to September, 2007 (155 months) |
| Project Cost | • Japanese ODA Loan Portion<br>• Executing Agency<br>• Total<br>Exchange Rate | ¥8,100 million<br>¥2,701 million<br>¥10,801 million<br>US$ 1= ¥113.5<br>(as of January, 1994) | ¥5,636 million<br>¥1,211 million<br>¥6,848 million<br>US$ 1 = ¥113.0<br>(weighted average between 2005 to 2007) |