

**1. Project Profile and Japan's ODA Loan**



Site Map: Asunción to Alto Paraná Region



Site Photo: Limpio Substation

**1.1 Background**

For the ten years following the late 1970's, Paraguay's power demand increased at annual rate of 14% on an average and had reached 228MW at the time this project was proposed in late 1984. Nevertheless, only about 40% of households had electrical service as of that year, making the potential demand very large, and further yearly increases rate of 10% were predicted.

Meanwhile, at the end of 1984 Paraguay's power-generation capacity was 274MW, and the world's largest hydroelectric power plant, the Itaipu Plant<sup>1</sup>, was then under construction. The operation of generator units 1 and 2 (1,400 MW) were scheduled to begin in 1985, and by 1989, full-scale operation of 9 generator units was to begin. Paraguay was expecting a 6,300 MW jump in generation capacity. In the late 1983, electric power was transmitted from the Itaipu Plant to the capital of Asunción by three high-voltage transmission lines (total transmission capacity of 390MW max.).

Generally, high-voltage transmission lines are not operated to its full capacity, for the case in that one line (circuit) fails, another line of transmission is available (stable transmission method).

With the full-scale completion of the Itaipu Plant and the predicted 10% annual increase in power demand at that time, it was forecasted that the three transmission lines will reach their full capacity by 1986, and by 1989 the transmission power will surpass the line capacity.. These conditions made the construction of a fourth high voltage transmission line in that area an urgent issue.

**1.2 Objectives**

The purpose of this project was to supply power from the Itaipu Plant to the metropolitan area surrounding Asunción. At the same time, it also sought to expand the construction of transmission lines, substations, and distribution network in order to accelerate the provision of electricity to Alto Paraná region on the right bank of the Paraná River. Through these means, the project aimed at an improvement in Paraguay's electric service.

**1.3 Project Scope**

- A. Additional construction of a fourth high voltage transmission line between the Itaipu Plant

<sup>1</sup> The Itaipu Hydroelectric Power Plant, co-constructed by Paraguay and Brazil, produces an ultimate capacity of 12,600MW. Of that, power transmitted to Paraguay is 6,300MW from generator units 1-9.

and the capital of Asunción

1. construction of a transmission line between Itaipu and Limpio (220KV)
  2. construction of Limpio Substation (220/66KV)
  3. construction of a transmission line between Limpio and J. Botanico (220KV)
  4. construction of J. Botanico Substation (220/66KV)
  5. up-grading of the San Lorenzo Substation and Itaipu Substation
  6. construction of Itaquyry Substation (220/66KV)
- B. Expansion of the distribution network in the Alto Paraná Region
1. construction of Parananpu Substation (220/23KV)
  2. construction of Edelira (later renamed as Natalio) Substation (220/23KV)

Consulting Services

#### 1.4 Borrower / Executing Agency

Government of Paraguay / Administracion Nacional de Electricidad (ANDE)

#### 1.5 Outline of Loan Agreement

Loan Amount	8,800 million yen
Loan Disbursed Amount	8.7 million yen
Date of Exchange of Notes	November 1985 / November 1985
Date of Loan Agreement	
Teams and Conditions	
Interest Rate	Interest rate: 4.75%
Repayment Period (Grace Period)	Loan Duration: 25 years (grace period 7 years)
Procurement	Partially untied
Final Disbursement Date	November 1990

## 2. Results and Evaluation

### 2.1 Relevance

Electricity is one of the most basic infrastructures for economic and social development. At the time of project appraisal, Paraguay's National Power Company (Administracion Nacional de Electricidad: ANDE) had drawn up a Five-Year Electrification Plan (1986-1990) based on the National Economic and Social Development Plan, inextricably linking Paraguay's economic development to the effective use of electricity from the Itaipu Plant along with existing resources. The Electrification Plan gave high priority to the development of transmission lines and the expansion of a power distribution network under this project, saying that they were necessary projects in order to promote the effective use of the power supply from the Itaipu Plant and to improve power transmission service. The project was deemed to be of extreme importance to the development of the Paraguayan economy and society. In particular, the construction of a fourth high-voltage transmission line under this project was urgently needed in order to equalize the imbalance between the supply and demand of transmission capacity.

Following completion of the project, power supply and demand both grew at roughly the same pace as was expected at the time of the appraisal<sup>2</sup>. Despite the low growth of the Paraguayan economy in the first half of the 1990's and the flagging economy of the latter half, electric consumption continued to grow. Furthermore, following that, the project led to the implementation of additional projects such as the self-financed construction of transmission lines and expansion of the power grid. Therefore, this project was also deemed to be appropriate at the time of this evaluation.

<sup>2</sup> Power demand in Paraguay increased at annual rate of 8.1% on an average during 1993 and 1998.

## **2.2 Efficiency**

### **2.2.1 Project Scope**

This project comprises a high voltage transmission line construction and distribution network expansion. Of these, the two major changes from the initial plan were 1) a transmission line from Itaipu to Limpio was extended from the original planned 305km to 321km, and 2) a power line carrier (PLC) in the communication system was added.

The transmission line was extended for the concerns that the ILS (Instrument Landing System) then under construction for Este Airport would be obstructed by the project's transmission lines, and was therefore diverted. With respect to the additional power line carrier (PLC) added to the communication system, it was needed to be installed at a substation in Asunción in order to enable communication between the Paranambu Substation and the Natalio (Edelira) Substation via the Carlos Lopez Substation.

### **2.2.2 Implementation Schedule**

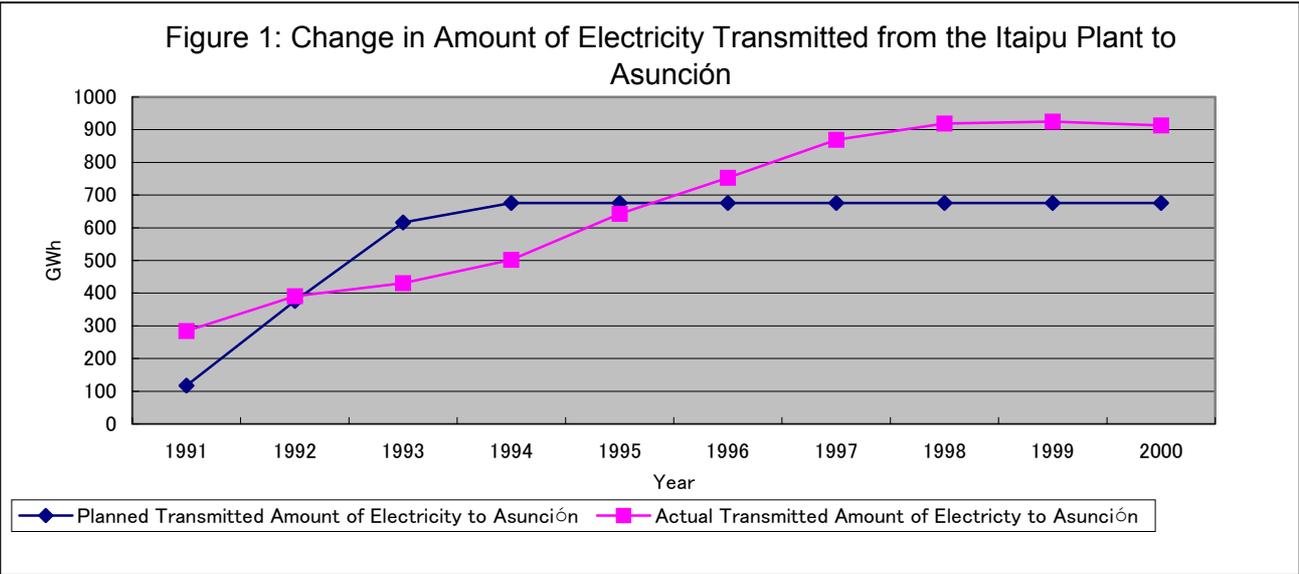
An estimated 40 months were initially planned for the whole implementation process, from the hiring of consultants and the preparation of bids to the inaugurating the facilities. However, it actually took 50 months from bid preparation in August 1986 to the time when the lines were first in use in June 1990. A delay of from one to three months occurred at each stage including the preparation of bids, the bidding, contract negotiation, manufacturing and shipping, and actual construction, and as a result, the entire project took ten months more than initially planned.

### **2.2.3 Project Cost**

The planned total cost for the project was ¥10.8 billion, and actual costs were ¥10.1 billion. As a result of the bidding, the foreign currency amount slightly exceeded the original estimate of ¥6.1 billion at the time of appraisal, and was actually ¥6.6 billion. Meanwhile, the sudden appreciation of the yen after the Plaza Accord in September 1985<sup>3</sup> and the decline in the value of the domestic currency during the project construction period resulted in a fivefold increase in cost over the time of appraisal in guaraní terms (23 billion guaraní vs. 4.3 billion guaraní), but costs were held to approximately seventy percent of the amount at the time of appraisal in yen terms (¥3.5 billion vs. ¥4.7 billion).

---

<sup>3</sup> At the time of appraisal the exchange rate was \$1=¥240, when the consultants were hired in August 1986 it was \$1=¥154.0, and when construction began in April 1988 the rate was ¥124.9.



**2.3 Effectiveness**

**2.3.1 Amount of Transmitted Electricity**

The amount of transmitted electricity from the Itaipu Plant to the capital of Asunción as a result of the construction of a fourth trunk transmission line under the project was expected to be 117GWh in the year following completion of the project (1991) and 676GWh in the fifth year following that.

As shown in Figure 1, in 1995, the fifth year following the completion of the project, the actual amount of transmitted electricity was 643GWh. In 1996 another transmission lines was constructed by ANDE's own funding, which further increased the actual amount of electricity transmitted. In 2000 913GWh was transmitted. The fourth transmission line constructed under the project, is therefore, delivering the transmission amount according to plan, and are contributing to the stable supply of electricity to Asunción.

Meanwhile, looking at the total amount of electricity transmitted to the Alto Paraná Region, the amount that was only 0.13GWh in 1985 increased to 8.6GWh in 1991, two years after completion of the project, and the actual total amount of electricity transmitted further increased by 9.5 times to 81.9GWh in 2000. During this ten-year period, the annual rate of increase in the amount of transmitted electricity was 28.5%,. This is considered to be due not only to the new construction of a substation under the project, but also largely to the expansion of distribution networkin the same region with the support of InterAmerican Development Bank (IDB).

**2.3.2 Rate of utilization of substations**

According to project data on the utilization rates of substations, the substation utilization remains at above 70%, and thought to be a good rate of utilization.

Table 1: Substation Utilization Rate (%): 2000

	Botanico (23kV)	Limpio (23kV)	Natalio (Edelira) (23kV)	Paranambu (23kV)	Itaquyry (66kV)	Itaquyry (23kV)
Substation Utilization Rate (Avg.)	69.8	86.0	72.2	74.6	112.0	66.8

Source: ANDE

**2.3.3 Improvement of Electric Service (transmission system failure and/or loss of transmission)**

Electric supply to the metropolitan area, accounting for roughly half of Paraguay's electric consumption, comes from the Itaipu Hydroelectric Power Plant and the Acaray Hydroelectric Plant. Before the project, power was transmitted from the Itaipu Plant to Asunción over three high voltage transmission lines (maximum transmission capacity of 390MW). Upon completion of the project, a fourth transmission line was constructed, making possible the total transmission of 600MW.

The number of power interruptions in the entire transmission system was a record of 32 times p.a. in 1990, the year prior to completion of the project. However, in 1991, the year following completion of the project, the number of power interruptions had decreased (see Table 2). Following that, the number of interruptions again rose due to an increase in electricity load, but after 1996 and the completion of the self-financed fifth high voltage transmission line, an improving trend continues to be seen. Although the number of power interruptions has fluctuated according to transmission volume, there were around ten times in the latter half of the 1990's. A 12% loss of transmission between Itaipu and Asunción was forecasted at the time of appraisal, but an acceptably low level of less than 10% has been maintained.

Table 2: Change in Overall Transmission System Power Interruptions and Transmission Loss Between Itaipu and Asunción

	1985	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00
Power Interruptions	21	17	12	21	20	32	26	16	17	23	28	7	5	14	8	11
Transmission Loss (%)	5.4	5.8	5.2	4.9	5.1	5.4	5.2	5.9	5.9	6.5	7.4	7.6	9.1	8.4	9.3	8.9

Source: ANDE

### 2.3.4 Financial Internal Rate of Return (FIRR)

FIRR was estimated to be 25.9% at the time of appraisal, however, due to the fact that related data from ANDE could not be obtained the actual figure could not be calculated.

## 2.4 Impact

### 2.4.1 Electrification Rates / Electricity Consumption

This project was expected to contribute to an increase in the electrification rate of the target regions. While regional electrification rate for the Asunción and Alto Paraná regions was unavailable, the nationwide electrification rate increased from 40% at the time of appraisal (1985) to 83% in 1999. Per capita electric consumption increased.

Table 3: Change in Electrification Rates and Amount of Electricity Consumed

	1985	1991	1992	1993	1994	1995	1996	1997	1998	1999
Electrification Rate (%)	40	50	52	57	63	70	75	79	82	83
Consumption (kWh/person)	468	468	525	592	644	712	732	759	761	808

Source: ANDE Annual Report

### 2.4.2 Regional Economic Development

While the progress in electrification as a result of project was expected to contribute to the economic development of the regions, no regional indices existed at the start of the project, and therefore quantitative analysis cannot be performed.

However, the Alto Paraná region, the area assisted by the project, boasts the most fertile soil in Paraguay, and 90% of the country's production of soybeans (Paraguay's principal export), and wheat (the staple food of Paraguayans) comes from this region. In light of the fact that this region's electrification was lagging far behind prior to the project, we can surmise that this project contributed a certain amount in supporting the regional economy and also in improving the quality of life of the area's residents.

### 2.4.3 Environmental Impact

When new transmission lines built under the project began operating, power transmission from the Itaipu Plant to the metropolitan area became possible, resulting in discontinuation of operation of the gas turbine thermal power station (total capacity of 42MW) at the existing Power Plant in the metropolitan area. As the plant was located in a residential area, we can surmise that the environment of those living there has been improved by the discontinuance of operations at the plant. Concerns about such problems as oil spills during the fuel unloading and transport have been eliminated and noise in neighboring areas has abated.

## **2.5 Sustainability**

### **2.5.1 Operation and Maintenance**

The Administration of Paraguay's National Power Company (ANDE) comprises nine departments under the President, and the management structure is roughly the same as it was at the time of appraisal. Operations and Maintenance Management are within the scope of the Technical Department, and handled by that department's Maintenance Division. The Maintenance Division comprises four sections, the Transmission Line Maintenance Section, the Transmission Equipment Maintenance Section, the Maintenance Policy Section, and the Technical Maintenance Section.

### **2.5.2 Technical Capacity**

The Maintenance Division conducts maintenance control with a total of approximately 130 staff, including ten engineers, approximately 100 operators, and other staff. The personnel in charge of repair and maintenance are very experienced and are provided funds and tools necessary to perform their functions. At present, the project notes no obstacles such as lack of funding or decrease in the level of maintenance workers, and operations are conducted with no decrease in capacity of existing equipment.

In general, substation equipment is inspected once yearly, and inspection of the compressor of the power switch, inspection of the compressor for switching operations, and silica gel replacement are performed once every four months. High voltage lines are examined three times a year, including examination of the power lines and the protective cable. The disconnecting switch and its ancillary parts are examined three times a year, and the ground resistance measurement on the steel towers is examined once every two years.

### **2.5.3 Financial Status**

While revenues from electric sales exceed operating expenses, the sales cost ratio that was approximately 75% in 1998 increased to approximately 83% in 1999. Operating loss in 1999 therefore grew to about three times the 1998 figure. This was partly due to the fact that the purchase price for electricity from the Itaipu Plant, accounting for the greater part of the operating expenses, are paid in US\$ terms. The tariff structure does not allow the cost to be passed along to consumers through conversion of the dollar-based purchase price to guaraní terms. Therefore, if we take into consideration the fixed assets depreciation burden, gross operating expenses far exceed gross operating revenue.

If we look at non-operating expenses and revenue, we can see a substantial impact resulting from the decline in currency value. In particular, interest payments on the foreign currency denominated debt and loss on foreign exchange substantially increased between 1988 and 1999 (97% and 31% respectively), resulting in an worsening in the balance of non-operating expenses and revenue. Accordingly, the net loss for 1999 increased approximately 2.4 times over 1998.

These conditions have prompted ANDE to request government permission to revise the current electric tariff. In order to revise electric rates, ANDE must receive permission from the Ministry of Public Works and Communications (MOPC)<sup>4</sup>. The Government is also aware of the need for an increase in

---

<sup>4</sup> The Ministry of Public Works and Communications (MOPC) is the administrative point of contact for ANDE. ANDE reports to

electric tariff, but the reality is that exchange rates continue to fluctuate greatly, and forecasts for electric tariff cannot be made. The Minister of MOPC has said, however, that a 58% electric tariff increase is necessary (2001). As opposition to a rate increase from residents is expected, simply raising rates is not so easy. This situation has resulted a persistent deficit over the past few years. In addition, ANDE operates under self-financing system, receiving no financial assistance from the Government. ANDE has a relatively sizable amount of net worth, so while there isn't much likelihood of a capital deficit in the near future, improvement in the balance of operating revenue and expenses is remains an important issue.

In evaluating the sustainability of the project, the project found no particular issues with technical ability or personnel. However, as the financial situation is vulnerable and needs to be strengthened in order to improve the project's sustainability and self-development.

Table 4: ANDE Financial Data (Profit and Loss Statement) (Unit: million guarani)

	1998	1999
<b>Operating Expenses and Revenue</b>		
Electricity Sales Revenue	595,749	654,808
Other Operating Revenue	11,224	10,841
Total Operating Revenue	606,973	665,649
Operating Expenses	449,639	543,051
Supplies Expenses	32,335	36,973
Overhead Expenses	65,725	67,549
Depreciation	84,521	106,802
Total Operating Expenses	632,220	754,375
Operating Expenses	-25,247	-88,726
<b>Non-Operating Expenses and Revenue</b>		
Non-Operating Revenue	91,553	104,134
Non-Operating Expenses	151,282	221,803
Interest	20,345	40,112
Loss on Foreign Exchange	108,414	142,072
Non-Operating Expenses and Revenue	-59,729	-117,669
Pre-Tax Current Net Earnings	-84,976	-206,395

Source: ANDE Annual Report

---

MOPC on long term plans (major improvement plans), submits electric supply and demand status reports (monthly, yearly), and requests from and must obtain permission for electric rate revisions from MOPC.

### Comparison of Original Plan and Actual Scope

Item	Plan	Actual
<b>(1) Project Scope</b>		
1. Itaipu Substation Lead Facility [translators note: unsure of correct translation]	220kV	Same
2. Construction of transmission line from Itaipu to Limpio	220kV TL 305km	220kV TL 321km
3. Construction of Limpio Substation	40MVA(220/66kV), 20MVA(66/23kV)	37.5MVA(220/66kV) Same
4. Construction of transmission line from Limpio to Jardin Botanico	220kV TL 28km	Same
5. Construction of Jardin Botanico Substation	120MVA(220/66/23kV)	Same
6. Addition of San Lorenzo Substation Lead Line	220kV	Same
7. Construction of Itaquiry Substation	25MVA(220/66/23kV)	Same
8. Construction of Paranampu [translators note: unsure of spelling] Substation	10MVA(220/23kV)	Same
9. Construction of Edelira (Natalio)Substation	10MVA(220/23kV)	Same
10. Power line carrier (PLC) at Carlos Lopez Substation		Additional power line carrier (PLC)
11. Consulting services	Bidding to contract, process control advice	Same
<b>(2) Implementation Schedule</b>		
1. Consulting services	May 1986 – Sept 1989	Aug 1986 – May 1990
2. Bidding / Evaluation	Jan 1987 – July 1987	June 1987 – Jan 1988
3. Construction	Aug 1987 – Sept 1989	Apr 1988 – May 1990
<b>(3) Project Cost</b>		
Foreign Currency	6,200 million yen	6,600 million yen
Local Currency	4,700 million yen (PG 4,300 million guarani)	3,500 million yen (PG 23,000 million guarani)
Total	10,800 million yen	10,100 million yen
ODA Loan Portion	8,800 million yen	8,700 million yen
Exchange rate	1 guaraní = 1.075 yen (June 1985)	1 guaraní = 0.1508 yen (Weighted average during implementation)

# Organizational Chart of Paraguay's Electricity Authority (ANDE) (April 2001)

