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INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

OPERATIONS EVALUATION REPORT: ELECTRIC POWER

CASE STUDY: FURNAS, BRAZIL

*[Faint, illegible text]*

March 24, 1972

Programming and Budgeting Department  
Operations Evaluation Division

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INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

REPORT OF THE BOARD OF DIRECTORS

FOR THE YEAR 1970

CURRENCY EQUIVALENTS  
(Average annual market  
exchange rates)

	<u>US\$1 =</u> <u>NCr\$</u>	<u>NCr\$1 =</u> <u>US\$</u>
1958	0.13	7.75
1959	0.16	6.37
1960	0.19	5.26
1961	0.28	3.61
1962	0.39	2.57
1963	0.59	1.70
1964	1.27	0.78
1965	1.90	0.53
1966	2.22	0.45
1967	2.67	0.38
1968	3.41	0.28
1969	4.08	0.24
1970	4.60	0.22

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT  
WASHINGTON, D.C. 20540

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## I. INTRODUCTION

1.01 Furnas-Centraís Eletricas S.A., (Furnas) was formed in February 1957 and granted in July 1957 a 30-year concession to utilize hydraulic power from the Rio Grande at Furnas Rapids. It is an autonomous Government corporation and the largest subsidiary of Centrais Eletricas Brasileiras, S.A. (Eletrobras), a Federal Government holding company created in 1961 to carry out a national electrification plan and implement the Federal Government's policy in the electric power sector. More than 95% of Furnas' common and preferred stock is presently owned by Eletrobras.

1.02 The name of the company derives from its first plant built at Furnas Rapids and partly commissioned in 1963 with an initial generating capacity of 300 MW. The installed capacity of the company was about 2,300 MW by the end of 1970, of which about 200 MW were thermal and 1,600 MW were partly financed by Bank loans. The transmission system of Furnas consists of about 2,700 km of transmission lines in operation, most of them at 345 kv; about 1,300 km of existing transmission lines were financed by the Bank. The annual peak demand on Furnas' system grew from 290 MW in 1963 to 2,070 MW in 1970, i.e. by an average of 32% p.a.

1.03 All power generated by Furnas has been sold in bulk under contract to other utilities for resale to the ultimate consumers. These utilities are located in the South-Central region of Brazil; the principal generating companies in the region are:

Furnas-Centraís Eletricas S.A. (Furnas);

Centrais Eletricas de Sao Paulo, S.A. (CESP), state-owned company;

Centrais Eletricas de Minas Gerais, S.A. (CEMIG), state-owned company; and

Light Servicos de Eletricidade, S.A. (Light), a subsidiary of a foreign company.

These companies are interconnected by a transmission system and up until now the major exchange of power has been from Furnas to Light. CESP, which received three loans from the Bank, will supply a large part of the Sao Paulo market; CEMIG received also three Bank loans and supplies the state of Minas Gerais. Furnas is presently the principal supplier of the Rio de Janeiro area where Light will continue to be the principal distributor. The transmission

grid makes it possible for these utilities to obtain substantial advantages from coordinated operation; Furnas assisted by Eletrobras has taken the lead in organizing recently a Committee for the Coordination of Integrated Operation which includes the companies operating in the South-Central region. This Committee which meets regularly on technical matters is expected to achieve for the region a high quality of service at low cost.

1.04 The South-Central region is the industrial heart of the country; it contains 45% of the country's population, accounts for 40% of its agricultural production and 70% of its industrial production, and consumed in 1970 about 29 billion kwh of electricity or about 78% of the country's total consumption. Commercial and industrial sales of electricity have amounted to nearly 60% of total sales in the region. A study made under a UNDP grant and updated in 1968 by a market study undertaken by Eletrobras yielded a program for the region's power development through 1980 when total consumption is expected to reach at least 75 billion kwh. The development program is predominantly hydroelectric since there are many such sites that can be developed at low unit costs, whereas the known indigenous fossil fuels are either scarce or of poor quality and remote from the region. All the companies have adhered to the program for their ongoing investments and were expected to continue doing so; some companies, however, are now thinking of building small thermal plants. The program is being updated by Eletrobras to take account of the most recent developments in demand.

II. THE ASSOCIATION BETWEEN THE BANK AND FURNAS

2.01 The Furnas Company received over the period 1958-1970 five loans from the Bank as follows:

Loan No.	Date of Loan Agreement	Effective Date	Closing Date	Amounts (\$ mln)		Interest	Period (years)	
				Committed	Disbursed <sup>a/</sup>		Grace	Term
211-BR	10/58	2/59	1/66 <sup>b/</sup>	73.0	73.0	5-3/4%	5	25
403/ 474-BR: Tranche I	2/65	7/65	4/72 <sup>c/</sup>	57.0	55.7	5-1/2%	6	25
Tranche II	12/66	6/67	6/74 <sup>c/</sup>	39.0	13.9	6,6-1/4%	5	25
565-BR	10/68	2/69	3/75	22.3	4.2	6-1/2%	6	25
677-BR	5/70	9/70	8/77	<u>80.0</u>	<u>8.9</u>	7%	7	30
Total				<u>271.3</u>	<u>155.7</u>			

a/ As of December 31, 1971.

b/ Extended three times from September 1963 to January 1966.

c/ Extended once.

2.02 Most of Brazil's industry has been situated in the South-Central region. The demand for electricity in the area had been growing rapidly before 1957 and it was expected to continue to do so. Generating resources of the eight utilities supplying the area with power were barely sufficient to meet the demand. Power plant development promoted by individual utilities was largely parochial and there was no coordinated long-term plan; the power deficit in the area was expected to grow from 11 MW in 1958 to 1010 MW in 1964 and increase faster afterwards. Official Brazilian agencies entered into a joint venture with private foreign-owned power companies to establish and finance Furnas; three of the four entities entering the venture were already directly or indirectly IBRD borrowers. The capital of Furnas was agreed to be 50% common and 50% preferred stock and subscriptions were to be



made to a total of Cr. 6 billion for the first stage of the Furnas plant with a final capacity of 1100 MW. The electricity produced by the Furnas Company was to be sold only to the shareholders, with 50% of the output assured for supply in the State of Sao Paulo and 50% for supply in the State of Minas Gerais. The Government-controlled National Economic Development Bank (BNDE) was to subscribe 51% of the common stock. Moreover, long-term loans from BNDE and the Federal Electrification Fund were to be made to Furnas to cover the local expenditures of the Furnas plant.

2.03 The Bank made loan 211-BR to cover the foreign exchange required for the project consisting of the 460 MWs first stage of the Furnas plant and associated transmission facilities to be commissioned by mid-1963. Assurances were obtained before the loan became effective that:

- a) the capital and long-term loans be available as required for the expeditious construction of the project;
- b) the Company seek to obtain the maximum revenues permitted under the relevant regulations;
- c) enactment of a bill then before the Brazilian Congress, permitting the periodic revaluation of assets to make public utilities attractive for investment despite the rapid depreciation of the cruzeiro, be pressed through as quickly as possible by the Government.

The Government also agreed to discuss with the Bank the question of setting up a joint planning board in which all major utilities in South-Central Brazil would cooperate in jointly planning the future generation and transmission expansion in order to assure a sound development, both technically and economically.

2.04 Under a UNDP grant administered by the Bank, a consortium of consulting engineers (Canambra) made during 1963-1966 a survey of the requirements and resources of power in the South-Central region and recommended that a group of hydroelectric plants be built to supply the anticipated market. Many of these were to be located on the Rio Grande with transmission systems to connect the cities of Sao Paulo, Rio de Janeiro and Belo Horizonte. The highest priority in this power program was given to the Estreito plant downstream from the Furnas plant and associated transmission, the construction of which was assigned to the Furnas company by the Federal Government. The Bank made the loan 403/474-BR in two steps:

- a) Loan 403-BR of US\$57 million of February 1965 was to finance the Estreito plant with a planned capacity of 533 MW and the minimum transmission facilities needed to connect the plant to the existing transmission system. The plant was to be completed early in 1971.
- b) A supplementary loan 474-BR of US\$39 million was made at the end of 1966 to finance the extension of existing transmission system by about 950 km of 345 kv lines to be completed early in 1971.

The reasons given for this were that, at the time of the first loan, no decision had been made as to the voltage of the additional transmission facilities needed to carry the full output of Estreito and there was no need to start construction of these lines at the same time as construction of the plant was started; the Bank also preferred to stretch its commitments over two years because its funds were not ample at that time.

2.05 The Bank obtained during negotiations for 403/474-BR assurances that:

- a) Furnas would revalue its assets at least once a year and apply for adjusted tariffs to produce revenues resulting in at least a 10% return on its average net revalued fixed plant in operation (before taxes);
- b) Eletrobras would convert into equity such amounts of outstanding long-term debt as to allow debt not to exceed two-thirds of the total net revalued fixed assets;
- c) the Government would take all necessary action for coordination of operation of facilities of the integrated system which would use Furnas' power, and also take effective action in regard to the expansion of the distribution facilities in the Rio de Janeiro and Sao Paulo areas where many of the distribution systems were at the saturation point because the principal distributing companies had not been allowed to earn sufficient income to expand the systems.

Also, because it was finally agreed by the Bank that Brazilian manufacturers would compete with a 15% maximum protection in the international bidding for

the contracts covering materials and equipment to be financed by the proposed loans, a supplementary letter detailed the basis and method for comparing bids of Brazilian and foreign manufacturers.

2.06           Until September 1966, when it began bulk deliveries to CEMIG, Furnas' sole customer was Brazilian Light S.A. for its own market in Sao Paulo. According to arrangements agreed by the Government and the companies involved in the supply of power in the South-Central region, Furnas was committed for 1968 and subsequent years to supply power in bulk to other utilities (Light Rio, CEMIG and Companhia Paulista de Forca e Luz-CPFL); these commitments were covered by power contracts made on conventional lines as required by the Loan Agreement 403/474-BR (1965-1966). In order to provide adequate capacity to meet the contract commitments, Furnas had in 1968 an expansion program for 1969-1974 which included the completion of the Funil and Estreito hydroelectric plants, the extension by 400 MW of the Santa Cruz thermal plant with the help of a U.S. AID loan (see paragraph 7.02) and the Porto Colombia hydroelectric project downstream from the Furnas and Estreito hydroelectric stations. The Bank made in 1968 the loan 565-BR of US\$22.3 million to cover the estimated cost of equipment to be purchased after international competitive bidding, including contracts won by Brazilian suppliers, for a project to be completed in Spring 1974 consisting of the 360 MW Porto Colombia plant, the construction of a 345 kv transmission line to connect the plant to the terminus of the Furnas system at Estreito and 138 kv transmission facilities for connection to the Paulista system. Loan Agreement covenants and supplementary letters were the same as in the previous Loan Agreement 403/474-BR (1965-1966).

2.07           Among the projects which had been under study by Furnas since 1967 was the Marimbondo hydroelectric project with a 1,400 MW installed capacity. The updating review of the Canambra demand-projection made in 1968 by Eletrobras projected an annual rate of expansion of demand by 9% over 1969-1980 and indicated a small shortage of energy in the South-Central region by 1974-1975, so that, to avoid substantial shortages in reserve capacity starting then, it was necessary to add the final two units to the Furnas plant by 1973-1974 and to put the Marimbondo plant in operation in early 1975. The Bank made in 1970 the loan 677-BR to partially finance a project consisting of the construction of the Marimbondo plant, associated transmission at 500 kv between the plant and Rio de Janeiro, and 300 MW generator capacity in the existing Furnas plant. The project was estimated to cost US\$287 million, of which US\$57.7 million in foreign exchange; the external financing was arranged to be US\$106 million, of which US\$80 million to be provided by the Bank loan and US\$26 million by supplier credits from industrialized countries under joint financing arrangements. On the basis of past experience, Brazilian

manufacturers were expected to secure a substantial part of the equipment orders, and these would be financed entirely by the Bank; financing for other equipment would be provided on a 50/50 basis by the Bank and the countries in which contracts were placed. In addition to the covenants adopted in the previous Loan Agreements, Furnas agreed to make its best efforts to obtain joint loans.

III. THE POWER SECTOR IN THE SOUTH-CENTRAL REGION OF BRAZIL

Coordination

3.01 Some ten public utilities have been supplying electric power in the South-Central region. The Federal Government sector, which accounts for more than half of the total capacity in the area, is headed by Eletrobras, a majority stockholder in its subsidiary (Federal) companies. Eletrobras administers public funds to expand the Federal power systems and makes loans to state utilities. Eight of these utilities, including the four major ones (paragraph 1.03) have received over the period 1949-1970 twenty loans from the Bank totalling US\$597 million, of which US\$424.2 million were disbursed by the end of 1971. Prior to the 1964 tariff regulation revisions, the private capital companies which are the principal distributors had not been allowed to earn sufficient income to expand their distribution systems so that they were by then at the saturation point, with frequent load shedding and substantial repressed demand as a result. As required in the 403-BR Loan Agreement, the Government took effective action to develop the distribution systems in the area commensurately with the expansion of generation and transmission facilities. Four Bank loans (475-BR, 476-BR, 477-BR and 478-BR of December 1966) totalling US\$61.6 million (of which US\$44.3 million were disbursed by the end of 1971) have been helping the rehabilitation and expansion of four distribution systems in the area; a U.S. AID loan of US\$40 million to Light helped finance a program of distribution improvements in Rio de Janeiro and Sao Paulo; and other companies in the region, with the improved earnings based on revalued assets permitted since 1964, have been engaged in similar programs. The Rio Light system which was the only one by 1960 operating at 50 cycles was gradually converted to 60 cycles in order to facilitate exchanges of energy; conversion was completed early in 1971.

3.02 The urging of the foreign and international lending agencies has also been important with respect to coordination of the planning and operations of electric power facilities in the area (Covenants to Loan Agreements 211-BR and 403/474-BR). The priority list of power development sites provided in the Canambra study made in 1963-1966 under a UNDP grant (paragraph 2.04) was followed by the main utilities concerned (Furnas, CESP, CEMIG) and by the lending agencies in orienting their assistance. Despite the reluctance of some utilities, a system interconnection committee which had been recommended by the Bank since 1958 (paragraph 2.03) was eventually established in 1968 and has met regularly since under Furnas' lead to coordinate operations. There still do not exist, however, inter-utility load dispatch centers, but the first one is expected to be established in Furnas by 1972. An important step toward the orderly marketing of power in the

region was the signature of marketing and pooling agreements in 1968, concretized by regular long-term power contracts between Furnas and its present customer companies and by the agreement that Furnas would market energy from the 250 MW expansion of the Peixoto plant owned by the CPFL.

### Tariffs

3.03 Prior to 1964, tariffs were based on historic value of investments and became unrealistic as inflation developed, causing many utilities to incur losses. The 1964 decrees, which had been expected to be passed shortly after the loan 211-BR was made in 1958 (paragraph 2.03), allowed utilities to revalue their investment, and the 1966 legislation made yearly revaluation of assets mandatory. Under the decrees tariffs were allowed to yield revenues covering: (a) operating costs and income taxes; (b) provisions for depreciation and "amortization"<sup>1/</sup> up to a maximum of 5% of gross fixed assets for each; and (c) a return of 10% (after taxes) on the estimated net plant in service at the end of the year plus some allowance for working capital. Applications for tariff adjustments, which have to be approved by the Ministry of Mines and Energy, are thus based on analyses of anticipated operating costs during the year in which the tariffs will apply and anticipated net plant in service at the end of that year, with allowances for expected interim inflation on both items. In the accounts of the utilities, by contrast, assets actually in existence at the end of each year are revalued by the official price correction factor applying to the previous year -- simply for reasons of timing in the issuance of the official price correction factors. Tariff adjustments are also permitted to recover shortfalls in achieving the 10% return, and these may be made at two year intervals.

3.04 The implementation of the revaluation and tariff adjustment provisions were not satisfactory during the initial years after 1964, because many of the provisions were at first permissive rather than obligatory and some utilities hesitated to adopt them wholly or partly. The Bank was concerned that different tariff policies might be followed by interconnected utilities, leading to the use of conflicting principles in calculating the cost of power blocks and resulting in economic decisions based on erroneous assumptions. During negotiations for Loan 477-BR, the Government objected to the Bank's proposed tariff covenants, and negotiations were suspended until legislation was changed by measures alleviating much of the Bank's concerns. Furnas took immediate and full advantage of the new regulations and, after revaluing its 1963 and 1964 assets, obtained corresponding tariff increases in early and mid-1965. As a result of this

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<sup>1/</sup> This provision for "amortization" is not based on actual debt repayments but is intended to pay off the whole investment over the concession period.

and the maximum permitted 5% rates taken by Furnas for both depreciation and amortization, tariffs introduced in mid-1965 were four times the 1964 tariffs. CEMIG, which had the right to purchase Furnas' power, did not do so in 1965, although Furnas had both the capacity and energy available due to a good water year; hence, Furnas did not market all of its power in that year. This was due to the substantially higher level of Furnas' wholesale tariff in comparison with both alternative sources and the retail tariffs of CEMIG which had revalued its assets only for 1963 and charged depreciation at 3% only. Expert assistance was needed in 1967 to reach agreement upon the power contract. During negotiations for Loan 474-BR (1966) and 565-BR (1968), Furnas indicated to the Bank that, when CEMIG would purchase large amounts of power starting in 1968, it would lower its 5% depreciation rate to a normal rate (estimated at 2.5%) based on the lives of its assets, and eliminate its provision for amortization, which had been reduced to 3% according to changes in regulations. At first Furnas did not reduce its provisions for depreciation and amortization, but the Government in 1969 restricted the depreciation rate to a maximum of 3%. Furnas' inability to market part of its power resulted also from its tariff structure. The demand charge which accounts for 90% of Furnas' revenues not only reflects the high depreciation charges but also allocates total capital cost to actual sales rather than to available capacity. There has been in addition a "ratchet" provision by which the highest demand registered in a given month establishes the charge for the year, regardless of subsequent demands. If Furnas had marketed all its available power, instead of spilling water, its charges could have been lower and its net revenues greater.

3.05           The average price per kwh sold by Furnas grew from US¢0.5 in 1964 to US¢1.4 in 1966, and US¢1.6 in 1970 (including indirect taxes paid by ultimate consumers which amount to about 30% of the base tariff). The increase of US¢0.66 which occurred in 1965 reflects the triple impact of the foregone revenue due to the non-marketed Furnas power (US¢0.2), the first revaluation of Furnas' assets and the increases in depreciation costs. The guaranteed rate of return in Furnas' concession might endanger the efficiency of Furnas since increases in operating costs due to labor pressure or operational inefficiency as well as decreases in sales (due to inability to sell the power as in 1965, or as in 1970) would be compensated for, when power from other sources is not available, by tariff increases borne by the consumers.

IV. LOAD FORECASTING AND INVESTMENT PLANNING

4.01 The construction of the Furnas plant and the establishment of the company was originally based on the projections made in 1958 for the power market in the South-Central region (paragraph 2.02). The demand in the area was expected to grow at 10.8% p.a. over 1958-1970 from 2600 MW to 8800 MW and, with the then existing investment programs of the utilities supplying the area, the power deficit would grow from 122 MW in 1962 to about 4400 MW in 1970 (see following table, item 4); the Furnas plant with its final capacity of 1100 MW was expected to reduce the deficit temporarily and further new projects totalling some 3000 MW by 1970 would have to be built between 1965 and 1970. The output of the first stage of Furnas was expected to be fully absorbed as it was built, and the output of the complete plant by 1965.

4.02 Although the full 3000 MW deficit projected was never made up, installed capacity in the South-Central region was in fact substantially higher after 1968 than originally forecast, mainly due to the greater capacity of the Furnas Company itself, as illustrated by the following table (summary of Table II-A.1):

	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>
<u>Forecasts (MW)</u>						
1. Installed capacity in South-Central region	5208	5328	5388	5448	5448	5448
2. Installed capacity of Furnas	1104	1104	1104	1104	1104	1104
3. Deficit with Furnas	363	752	1283	1858	2547	3315
4. Deficit without Furnas (2 + 3)	1467	1856	2387	2962	3651	4419
<u>Actual (MW)</u>						
5. Installed capacity in South-Central region	4910	5058	5267	5485	6451	6803
6. Installed capacity of Furnas	900	900	980	1260	2154	2294
<u>Difference Between Forecast and Actual Capacity</u>						
7. In the South-Central region (1 - 5)	298	270	121	(37)	(1003)	(1355)
8. Of Furnas (2 - 6)	204	204	124	(156)	(1050)	(1190)



The expected power deficit turned out actually to be a gross reserve capacity exceeding 1000 MW in 1964-1966, and peaking at 1350 MW in 1969 with the increase of capacity which took place between 1968 and 1969, or about 25% of demand in 1969. This was due mainly to a lower level of demand, which grew only by 8.3% p.a. over 1958-1970 and reached 5830 MW in 1970 as against 8760 MW forecast. The slower growth of demand was due primarily to the economic slowdown which took place in 1963-1967 but also to the deficiencies in the distribution systems of electricity in the area which could not carry the whole demand through to the generation level (paragraph 3.01).

4.03 The output from Furnas was fully absorbed in 1963-1964 and after 1967, but part of Furnas' capacity was not marketed in 1964 to 1967 because of a lower demand from its shareholders and clients (economic slowdown and insufficient substation capacity) and because of Furnas' high tariffs (paragraph 3.04). For these reasons, and also because Furnas' installed capacity up to 1968 was lower than forecast, revenues and operating income during 1963-1967 were substantially lower than expected in the first appraisal report. The financial return on net fixed assets, however, reached satisfactory levels after 1964 when legislation for tariff increases was changed to yield satisfactory returns.

4.04 Forecasts made in the second appraisal report (1965) for the period 1965-1970 substantially underestimated Furnas' expansion, sales and income during this period. Installed capacity was expected to increase from 900 MW in 1965-1969 to 1430 MW in 1970. Sales and income were expected to increase by about 15% p.a. on average between 1965 and 1970. The larger capacity installed in the Estreito plant and the acquisition by Furnas of the Chevap properties and Peixoto plant facilities (paragraphs 3.02 and 7.02) led to an installed capacity in 1970 outgrowing by far the forecasts; sales, revenues and incomes were actually substantially larger than expected. The financial return (after taxes) was higher, except in 1969, than the expected 9% (Table II-A.2).

4.05 The records on the effective-peak spare capacity indicate that the large investments made by Furnas have been necessary to meet the demand. Small load shedding occurred in 1963 and 1964. Spare capacity at the effective peak was between 30 MW and 80 MW in 1965-1967 (paragraph 4.02) but decreased to less than 10 MW in 1968-1969. Furnas was severely affected in 1970 by drought, which reduced its capacity to meet demand and caused energy sales to fall 7% from 1969.

V. PROJECT IMPLEMENTATION AND COSTS

5.01 Two plants out of the four financed by Bank loans to Furnas have been partly completed, i.e., the Furnas and Estreito plants aggregating 1600 MW. An extensive transmission network partly financed by Bank loans has also been completed.

5.02 The first stage of the Furnas hydroelectric plant financed by Loan 211-BR (1958) had been originally planned to consist of five 92 MW or four 110 MW generating sets, the size depending on the weights to be transported over the Brazilian railroads. The capacity was to be expanded ultimately to about 1100 MW in a second stage expected to follow quickly on the first stage, scheduled for completion in June 1963. Subsequent investigation showed the desirability of installing four 150 MW units in the first stage, and a corresponding change in the description of the project in the Loan Agreement was approved in June 1959. In view of the low prices obtained for the electrical equipment, the project was again increased with Bank consent to six 150 MW units which did not increase the foreign cost but did affect the local cost.

5.03 Construction of the first stage of the Furnas plant began in June 1958. The first unit was commissioned in September 1963 and the fourth in September 1964, that is with a 15-month delay behind schedule due to the large amount of excavation in excess of that originally estimated. The last unit was commissioned in May 1965. Transmission lines were originally designed to connect the plant to Sao Paulo and to Lafaiete and were actually built between the plant and Sao Paulo and Belo Horizonte. The first line to Sao Paulo started operating in September 1963; the line to Belo Horizonte had been completed in September 1960. Total cost of the 900 MW plant was US\$130 million, and about US\$27 million for the transmission lines and substations (Table III). The total foreign exchange cost of US\$58 million (excluding US\$14.4 million interest during construction) did not exceed the appraisal estimates; the local cost for generation and transmission together was 36% higher than expected. Due to the doubling of installed capacity, the unit cost has been US\$145 per kw installed against US\$236 estimate. Most of the equipment was supplied by foreign manufacturers after international competitive bidding, and the civil works contract was won by a British firm in association with a Brazilian firm.

5.04 Substantial savings were made also on the equipment cost of the Estreito hydroelectric plant financed by the Loan 403/474-BR (1965-1966) and originally designed to receive four 133 MW units. Because of very good

foundation conditions, work progressed satisfactorily and the first four 175 MW units were commissioned between March and November 1969, more than one year ahead of schedule. Due to the good prices obtained for equipment, the Bank agreed in 1968 to permit use of loan savings to add to the plant two more 175 MW units, expected to be in operation in 1972, and to extend the project transmission lines from 1060 km to 1560 km. By the end of 1970, 560 km had been erected and the US\$57 million Loan 403-BR was nearly fully disbursed. The US\$39 million Loan 474-BR will be used to finance the two additional units in the plant and the remaining transmission lines amounting to about 1000 km. Total cost of the 700 MW first stage of Estreito and its associated minimum 160 km transmission lines has been US\$96 million, of which US\$22 million for foreign exchange, leading to a unit cost of US\$137 per kw installed against US\$153 forecast. The 400 km of transmission lines already completed cost US\$23 million, of which US\$9.6 million for foreign components. Out of the US\$44.2 million disbursed from the Loan 403-BR for purchases of materials and equipment, US\$12.8 million were used to finance equipment from Brazilian manufacturers who won, with the 15% protection, about 30% of the orders.

## VI. FINANCING OF THE INVESTMENT PROGRAMS

6.01 Although there were in 1958 no definite plans for the financing of the second stage of the Furnas plant, the Furnas Company was planning to invest US\$303 million over 1958-1965 for the construction of the 1,100 MW Furnas plant, of which US\$209 million for the first stage of the plant and its associated transmission (Table II-B). Foreign borrowing was expected to contribute US\$127 million (42% of total), of which US\$54 million for the second stage from unspecified sources. The expected US\$156 million (51% of total) domestic contribution was to come mainly from loans from the BNDE and the Federal Electrification Fund, with share capital from the shareholders representing US\$52 million, equivalent to 17% of total required funds. Net internal cash generation was expected to contribute US\$20 million after 1963 to the cost of the second stage.

6.02 Actual investments amounted to US\$227 million during 1958-1965; this was the result of the low cost of the first phase of Furnas (paragraph 5.03), of the non-implementation of the second phase and of additional transmission investments (transmission line from Furnas to Rio) financed with the help of a US\$17.6 million U.S. AID loan after 1964. Foreign borrowing amounted to about US\$74 million representing 32% of total required funds, of which US\$1 million from the first disbursements from the U.S. AID loan. Total domestic contribution was US\$147 million (63% of total), most of it in the form of loans from the public sector; share capital was only US\$24 million because the shareholders did not have sufficient funds before 1964 as a result of the inflation and the lack of adequate tariff legislation. Furnas' own resources contributed only US\$10 million, due to the delay in the commissioning of the plant with resulting reduced earnings in 1963 (paragraph 5.03).

6.03 The investment program for the period 1964-1970, as forecast in the second appraisal report (1965), was to comprise the completion of the Furnas plant's first stage with its six units and associated transmission, and the two stages of the Estreito project to be covered by loans 403/474-BR. The cost of this investment program was estimated at US\$217 million. Furnas' own resources were expected to cover one third of total required funds, loans from the public sector (Eletrobras) 20%, and foreign borrowing was projected to amount to US\$111 million of which US\$17.6 million from U.S. AID for the additional transmission line from Furnas to Rio. Actual investments were more than twice the expected amount. Investments on Furnas and Estreito plants and transmission facilities amounted to US\$230 million, the acquisition of Chevap's properties in 1967 cost US\$81 million (see paragraph 7.02) and investments in the acquired Funil and Santa Cruz plants were US\$111 million;

initial work on the new projects of Porto Colombia (Loan 565-BR) and Marimbondo (Loan 677-BR) took US\$35 million investments. Furnas was still able to finance 30% of required funds from its own resources; the public sector had to increase substantially its contribution to US\$239 million (48% of total), primarily in the form of share capital and loans. Foreign borrowing contributed only 22% to total required funds, amounting to US\$112 million of which US\$60 million only from the Bank (paragraph 5.04) and US\$52 million from U.S. AID which transferred to Furnas its first loan of US\$15.5 million to Chevap for the Santa Cruz plant (paragraph 7.02) and also made in 1967 a second loan of US\$41.2 million for the extension of this plant.

VII. INSTITUTIONAL DEVELOPMENT

7.01 The management of the Furnas Company in 1958 was drawn from the electricity supply industry in Brazil and composed of a group of competent executives with extensive experience in this field. The organization of Furnas has developed well, due to this aggressive and competent management and to the technical and financial assistance furnished by the Bank and other lenders. All Bank loans have included funds for personnel training, and some 100 employees have been sent since 1960 to the United States and European countries for graduate study and training in technical and financial matters. Some buildings at the Furnas Dam were converted into a training school for operation and maintenance technicians drawn from all utilities in Brazil. Furnas' financial statements have been audited since 1958 by the Brazilian branch of Arthur Andersen and Company; as required by the Loan Agreement 403/474-BR (1965-1966), Furnas, when converting to an operating company, contracted with Arthur Andersen Company to reorganize the accounting department, train accounting personnel and supervise the installation of a computerized accounting system. The contract was satisfactorily completed in 1966-1967. Furnas has employed consulting engineers and contractors when necessary to complement its own forces for the design and construction of its large investment program. Planning for the Marimbondo transmission system (Loan 677-BR of 1970) at 500 kv, a voltage which is relatively new, has been assisted by consultant firms specializing in this field. Relations of Furnas with its consultants and services rendered by the latter have been satisfactory.

7.02 Over 1963-1970, total revalued net fixed assets of Furnas increased from NCr192 million to NCr2,634 million. This large increase consisted of three elements: (1) the large construction program, (2) revaluation of assets, and (3) the acquisition in 1967 of the assets of the Companhia Hidroeletrica do Vale do Paraiba (Chevap). Chevap had under construction since 1963 two generating stations intended to supply the Rio market: the 160 MW Santa Cruz thermal plant (near Rio) scheduled to be in service by 1967 and the 210 MW Funil hydroelectric plant scheduled for 1969. Construction had been financed by loans from Eletrobras and U.S. AID. The Government, in view of Chevap's unsatisfactory organization, rescinded in 1965 the concession granted to Chevap, which was taken over by Eletrobras. In 1967, the Government transferred the former Chevap concessions and assets to Furnas who obtained the Bank's consent.

7.03 Financing for Furnas' large assets originally came from borrowing from Eletrobras and others, and the debt/equity ratio in 1964 was 82/18. In 1964 and 1965, Eletrobras converted substantial parts of its long-term loans to Furnas into share capital, which is presently almost entirely owned by Eletrobras. This and the systematic reinvestment into equity of the dividends paid to the shareholders brought the debt/equity ratio under the 67/33 debt limitation (provided in the Loan Agreements) for 1965 and the following years.

7.04 Other management indicators reflect the sound financial situation of Furnas due to the automatic adjustments of tariffs. The financial rate of return of Furnas has been steadily over 9%, except in 1964 before the tariff increases and in 1965 when Furnas did not market all its capacity (paragraph 3.04). Dividend payments on share capital have increased from 4% in 1965 to more than 12% in 1970. Furnas has been able since 1964 to finance 30% of its investments from its own resources, this proportion being about 50% in 1970.

7.05 The average cost per kwh sold, however, increased from USç0.2 in 1963-1964 to USç0.4 in 1965 and USç0.6 in 1970. Depreciation and amortization provisions share in cost increased from 67% in 1964 to 90% in 1965 and 1966 and decreased after 1967 to about 60%, amortization being responsible for about half of this, as shown in the following table:

	<u>Average Cost/kwh Sold (USç)</u>						
	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>
1. Depreciation	0.10	0.21	0.24	0.22	0.12	0.14	0.17
2. Amortization	<u>0.07</u>	<u>0.15</u>	<u>0.16</u>	<u>0.16</u>	<u>0.15</u>	<u>0.14</u>	<u>0.18</u>
3. Sub-total	0.17	0.36	0.40	0.38	0.27	0.28	0.35
4. Fuel	-	-	-	0.01	0.07	0.06	0.03
5. Energy Purchases	-	-	-	-	0.11	0.14	0.12
6. Administration	0.02	0.01	0.01	0.02	0.02	0.01	0.02
7. Others	<u>0.01</u>	<u>0.02</u>	<u>0.03</u>	<u>0.04</u>	<u>0.04</u>	<u>0.04</u>	<u>0.06</u>
8. Sub-total	<u>0.03</u>	<u>0.03</u>	<u>0.04</u>	<u>0.07</u>	<u>0.24</u>	<u>0.25</u>	<u>0.23</u>
9. Total Unit Cost	<u>0.20</u>	<u>0.39</u>	<u>0.44</u>	<u>0.45</u>	<u>0.51</u>	<u>0.53</u>	<u>0.58</u>

The average operating cost/kwh sold (excluding depreciation and amortization), shown in line 8, doubled between 1964 and 1967, due principally to labor pressure. The large increase in the average operating cost experienced since 1968 was due for the most part to the operation of the thermal plants (line 4) and to the rents paid for the Peixoto hydro plant (line 5); also the other average operating costs increased, indicating a continuing labor pressure (line 7) and increasing administrative responsibilities (line 6) handed over to Furnas by Government agencies (Eletrobras, Ministry of Mines and Energy). The average cost of thermal and purchased energy (about US\$1.0) was higher than the average cost in the company's hydroelectric plants (US\$0.4).

7.06            The average revenue per kwh sold (excluding indirect taxes) increased from US\$0.4 in 1963-1964 to US\$0.9 in 1965 due to the first re-valuation of assets, and from US\$1.1 in 1969 to US\$1.3 in 1970 due to the decrease in sales caused by the 1970 drought. Transmission losses (about 5% of the energy sent out) and the amount of capacity out of service for maintenance and failures of equipment have been kept at satisfactory levels.



### VIII. CONCLUSION

8.01 The development of Furnas over the 1963-1970 period has been impressive and the Bank's contribution to this achievement substantial; the cooperative and positive attitude of the Federal Government has been an essential factor. Due to its effective management Furnas has been able to build its large plants with substantial savings in costs and in time over original forecasts. It has grown in its short life to service satisfactorily nearly one-third of the total power demand in the large market of the South-Central region of Brazil. Recognition of the Company's capabilities by the Government authorities is indicated by the responsibilities assigned to it to take over Chevap's plants, to build the first nuclear power plant in Brazil, and to lead the committee for coordinating operation and expansion of the power systems in its region. The Bank also appears to have played a useful role in helping to set the financial situation of the Brazilian power sector on a sounder footing, enabling it to keep up with growth of demand more satisfactorily than in the 1950s. However the steady upward trend in Furnas' real unit costs, due principally to changes in the legislation on depreciation before 1967 and to thermal and purchased energy afterwards but also to a continuous labor pressure -- does raise a question as to whether the existing regulatory structure of the industry provides sufficient incentive to efficiency in operations. Moreover, the tariff structure of Furnas may have introduced some distortion in the power investments for the whole region, since the high revenues it earned have allowed it to expand its capacity and has led CEMIG to build hydroelectric plants in order to reduce its dependence on the relatively expensive energy supply from Furnas; when CEMIG completes its Sao Simao 1,500 MW hydro plant and has sufficient power, Furnas may face some difficulty in selling its energy. To assess the real extent of these problems, if any, would require a more intensive study than has been possible here.

8.02 According to Furnas and the Canambra study, the electric power system in the South-Central region which has been supplied primarily by hydroelectric plants needs to be complemented by thermal plants. Because of the lack of adequate fossil fuels in Brazil, the Government has decided to construct a nuclear plant, the responsibility for which has been given to Furnas in view of its past performance. The nuclear plant of about 500 MW is expected to be constructed during 1972-1978 in order to meet market requirements. It will be necessary also to build other plants in the 1970s and Furnas' present plan, beyond the ongoing projects, is to build the Itumbiara hydroelectric plant (about 1,000 MW) on the Paranaiba River during 1974-1978. The internal capital market is still insufficient and bond issues by Furnas on the foreign market would probably meet Government

opposition. Financing of future investments, therefore, is expected by Furnas to come partly from its own resources, and partly from Eletrobras and Bank loans; the atomic plant would be financed partly by tied supplier credits.

8.03           The Bank loans are still considered by Furnas as a very good source of financing, because of the substantial help received from the Bank in technical and financial matters and because of the low prices obtained from foreign or Brazilian suppliers by international bidding. Equipment has been substantially more expensive when purchased with U.S. AID loans than with Bank loans. However, the arrangements made in connection with Bank loans could become more complicated in the future as a result of pressure from the Brazilian industries to supply a major part of the equipment in the projects irrespective of international competitive bidding. Furnas would also prefer not to receive joint financing for its future projects, in view of the substantial administrative costs and complexity involved in arranging such an operation as it experienced in the last Loan 677-BR (1970).

CHAPTER III - FURNAS - BRAZIL

I. Introduction

1.01 ~~The~~ Centrais Eletricas de Furnas S.A., (FURNAS) was formed in February 1957 and granted in July 1957 a 30-year concession to utilize hydraulic power from the Rio Grande at Furnas Rapids. It is an autonomous Government corporation and the largest subsidiary of Centrais Eletricas Brasileiras, S.A. (ELETROBRAS), a Federal Government holding company created in 1961 to carry out a national electrification plan and implement the Federal Government policy in the electric power sector. More than 95% of Furnas' common and preferred stock is presently owned by Eletrobras.

1.02 The name of the company derives from its first plant built at Furnas Rapids and partly commissioned in 1963 with an initial generating capacity of 300 MW. The installed capacity of the company was about 2,300 MW by the end of 1970, of which about 200 MW were thermal and 1,600 MW were partly financed by Bank loans. The transmission system of Furnas consists of about 2,700 km of transmission lines in operation, most of them at 345 kv; about 1,300 km of existing transmission lines were financed by the Bank. The annual peak demand on Furnas' system grew from 290 MW in 1963 to 2,070 MW in 1970, i.e., by an average of 32% p.a.

1.03 All power generated by Furnas has been sold in bulk under contract to other utilities for resale to the ultimate consumers. These utilities are located in the South-Central region of Brazil; the principal generating companies in the region are:

*Furnas - Centrais Electricas,*  
~~Centrais Eletricas de Furnas~~, S.A. (Furnas),

Centrais Eletricas de Sao Paulo, S.A. (CESP), state-owned  
company,

Centrais Eletricas de Minas Gerais, S.A. (CEMIG), state-  
owned company, and

Light Servicos de Eletricidade, S.A. (Light), a subsidi-  
ary of a foreign company.

These companies are interconnected by a transmission system and up until now the major exchange of power has been from Furnas to Light. CESP, which received three loans from the Bank, will supply a large part of the Sao Paulo market; CEMIG received also three Bank loans and supplies the state of Minas Gerais. Furnas is presently the principal supplier of the Rio de Janeiro area where Light will continue to be the principal distributor. The transmission grid makes it possible for these utilities to obtain substantial advantages from coordinated operation; Furnas <sup>*assisted by Eletrobras*</sup> has taken the lead in organizing recently a Committee for the Coordination of Integrated Operation which includes the companies operating in the South-Central region. This Committee which meets regularly on technical matters is expected to achieve for the region a high quality of service at low cost.

1.04 The South-Central region is the industrial heart of the country; it contains 45% of the country's population, accounts for 40% of its agricultural production and 70% of its industrial production, and consumed in 1970 about 29 billion kwh of electricity or about 78% of the country's total consumption. Commercial and industrial sales of electricity have amounted to nearly 60% of total sales in the region.

A study made under a UNDP grant and updated in 1968 by a market study undertaken by Eletrobras yielded a program for the region's power development through 1980 when total consumption is expected to reach at least 75 billion kwh. The development program is predominantly hydroelectric since there are many such sites that can be developed at low unit cost, whereas the known indigenous fossil fuels are either scarce or of poor quality and remote from the region. All the companies have adhered to the program for their ongoing investments and

*was* ~~are~~ expected to continue doing so; *some companies, however, are now thinking of building small thermal plants. The program is now being updated by Eletrobras to take account of the most recent developments in demand.*

II. The Association Between the Bank and Furnas

2.01 The Furnas Company received over the period 1958-1970 five loans from the Bank as follows:

Loan No.	Date of Loan Agreement	Effective Date	Closing Date	Amounts (\$ mln)		Interest (%)	Period (years)	
				Committed	Disbursed <sup>a/</sup>		Grace	Term
211-BR	10/58	2/59	1/66 <sup>b/</sup>	73.0	73.0	5-3/4	5	25
403-474-BR: Tranche I	2/65	7/65	4/72 <sup>c/</sup>	57.0	<del>52.2</del> 55.7	5-1/2	6	25
Tranche II	12/66	6/67	6/74 <sup>c/</sup>	39.0	<del>0</del> 13.9	6-6-1/4	5	25
565-BR	10/68	2/69	3/75	22.3	<del>1.7</del> 4.2	6-1/2	6	25
677-BR	5/70	9/70	8/77	80.0	<del>0</del> 8.9	7	7	30
Total				<u>271.3</u>	<u>155.7</u> <del>126.9</del>			

a/ As of December 31, 1970<sup>1</sup>

b/ Extended three times from September 1963 to January 1966

c/ Extended once.

2.02 In 1957, <sup>M</sup> most of Brazil's industry <sup>has been</sup> was situated in the South-Central region; <sup>Demand for electricity in the area had been growing rapidly</sup> ~~The growth of the demand in the area had been between~~ <sup>before 1957</sup> 9% and 14% annually and <sup>it</sup> was expected <sup>to continue to do so.</sup> to grow very rapidly. Generating resources of the eight utilities supplying the area with power were barely sufficient ~~in 1957~~ to meet the demand. Power plant development promoted by individual utilities was largely parochial and there was no coordinated long-term plan; the power deficit in the area was expected to grow from 11 MW in 1958 to 1010 MW in 1964 and increase faster afterwards. Official Brazilian agencies entered into a joint venture with private foreign-owned power companies to establish and finance Furnas; three of the four entities entering the venture were already directly or indirectly IBRD borrowers. The capital of Furnas was agreed to be 50% common and 50% preferred stock and subscriptions were to be made to a total of Cr 6 billion for the first stage of the Furnas plant with a final capacity of 1100 MW. The electricity produced by the Furnas Company was to be sold only to the shareholders, with 50% of the output assured for supply in the State of Sao Paulo and 50% for supply in the State of Minas Gerais. The Government-controlled National Economic Development Bank (BNDE) was to subscribe 51% of the common stock. Moreover, long-term loans from BNDE and the Federal Electrification Fund were to be made to Furnas to cover the local expenditures of the Furnas plant.

2.03 The Bank made ~~the~~ loan 211-BR to cover the foreign exchange required for the project consisting of the 460 MW first stage of the Furnas plant and associated transmission facilities to be commissioned by mid-1963. Assurances were obtained before the loan became effective that:

- (a) the capital and long-term loans be available as required for the expeditious construction of the project;
- (b) the Company seek to obtain the maximum revenues permitted under the relevant regulations;
- (c) enactment of a bill then before the Brazilian Congress, permitting the periodic revaluation of assets to make public utilities attractive for investment despite the rapid depreciation of the cruzeiro, be pressed through as quickly as possible by the Government.

The Government also agreed to discuss with the Bank the question of setting up a joint planning board in which all major utilities in South-Central Brazil would cooperate in jointly planning the future generation and transmission expansion in order to assure a sound development, both technically and economically.

2.04 Under a UNDP grant administered by the Bank, a consortium of consulting engineers (Canambra) made during 1963-1966 a survey of the requirements and resources of power in the South-Central region and recommended that a group of hydroelectric plants be built to supply the anticipated market. Many of these were to be located on the Rio Grande with transmission systems to connect the cities of Sao Paulo, Rio de Janeiro and Belo Horizonte. The highest priority in this power program was given to the Estreito plant downstream from the Furnas plant and associated transmission, the construction of which was assigned to the Furnas company by the Federal Government. The Bank made the loan 403-474-BR in two steps:

- (a) Loan 403-BR of \$57 million of February 1965 was to finance the Estreito plant with a planned capacity of 533 MW and the minimum transmission facilities needed to connect the plant to the existing transmission system. The plant was to be completed early in 1971.
- (b) A supplementary loan 474-BR of \$39 million was made at the end of 1966 to finance the extension of existing transmission system by about 950 km of 345 kv to be completed early in 1971.

The reasons given for this were that, at the time of the first loan, no decision had been made as to the voltage of the additional transmission facilities needed to carry the full output of Estreito and there was no need to start construction of these lines at the same time as construction of the plant was started; the Bank also preferred to stretch its commitments over two years because its funds were not ample at that time.

2.05 The Bank obtained during negotiations for 403-474-BR assurances that:

- (a) Furnas would revalue its assets at least once a year and apply for adjusted tariffs to produce revenues resulting in at least a 10% return on its average net revalued fixed plant in operation (before taxes);
- (b) Eletrobras would convert into equity such amounts of outstanding long-term debt as to allow debt not to exceed two-thirds of the total net revalued fixed assets;



- (c) the Government would take all necessary action for coordination of operation of facilities of the integrated system which would use Furnas' power, and also take effective action in regard to the expansion of the distribution facilities in the Rio de Janeiro and Sao Paulo areas where many of the distribution systems were at the saturation point because the principal distributing companies had not been allowed to earn sufficient income to expand the systems.

Also, because it was finally agreed by the Bank that Brazilian manufacturers would compete with a 15% maximum protection in the international bidding for the contracts covering materials and equipment to be financed by the proposed loans, a <sup>supplementary</sup> ~~side~~ letter detailed the basis and method for comparing bids of Brazilian and foreign manufacturers.

2.06 Until September 1966, when it began bulk deliveries to CEMIG, Furnas' sole customer was Brazilian Light S.A. for its own market in Sao Paulo. According to arrangements agreed by the Government and the companies involved in the supply of power in the South-Central region, Furnas was committed for 1968 and ~~the~~ subsequent years to supply power in bulk to other utilities (Light Rio, CEMIG and Companhia Paulista de Forca e Luz ~~(CPFL)~~); these commitments were covered by power contracts made on conventional lines as required by the Loan Agreement 403-474-BR (1965-1966). In order to provide adequate capacity to meet the contract commitments, Furnas had in 1968 an expansion program for 1969-1974

which included the completion of the Funil and Estreito hydroelectric plants, the extension by 400 MW of the Santa Cruz thermal plant with the help of a U.S. AID loan (see para. 7.02) and the Porto Colombia hydroelectric project downstream from the Furnas and Estreito hydroelectric stations. The Bank made in 1968 the loan 565-BR of US\$ 22.3 million to cover the estimated cost of equipment to be purchased after international competitive bidding, including contracts won by Brazilian suppliers, for a project to be completed in Spring 1974 consisting of the 360 MW Porto Colombia plant, the construction of a 345 kv transmission line to connect the plant to the terminus of the Furnas system at Estreito and 138 kv transmission facilities for connection to the Paulista system. Loan Agreement covenants and ~~side~~<sup>supplementary</sup> letters were the same as in the previous Loan Agreement ~~404-474~~<sup>403</sup>-BR (1965-1966).

2.07 Among the projects which had been under ~~Furnas' study~~<sup>study by Furnas</sup> since 1967 was the Marimbondo hydroelectric project with a 1,400 MW installed capacity. ~~The~~<sup>The</sup> updating review of the Canambra demand-projection made in 1968 by ~~Electrobras~~<sup>Electrobras</sup> projected an annual rate of expansion of demand by 9% over 1969-1980 and indicated a small shortage of energy in the South-Central region by 1974-1975, so that, to avoid substantial shortages in reserve capacity starting then, it was necessary to add the final two units to the Furnas plant by 1973-1974 and to put the Marimbondo plant in operation in early 1975. The Bank made in 1970 the loan 677-BR to partially finance a project consisting in the construction of the Marimbondo plant, associated transmission at 500 kv

between the plant and Rio de Janeiro, and 300 MW generator capacity in the existing Furnas plant. The project was estimated to cost \$287 million, of which \$57.7 million in foreign exchange; the external financing was arranged to be US\$ 106 million, of which \$80 million to be provided by the Bank loan and \$26 million by supplier credits from industrialized countries under joint financing arrangements. On the basis of past experience, Brazilian manufacturers were expected to secure a substantial part of the equipment orders, and these would be financed entirely by the Bank; financing for other equipment would be provided on a 50/50 basis by the Bank and the countries in which contracts were placed. In addition to the covenants adopted in the previous Loan Agreements, Furnas agreed to make its best efforts to obtain joint loans.

### III. The Power Sector in the South-Central Region of Brazil

#### Coordination

3.01 Some ten public utilities have been supplying electric power in the South-Central region. The Federal Government sector, which accounts for more than half of the total capacity in the area, is headed by Eletrobras, a majority stockholder in its subsidiary (Federal) companies. Eletrobras administers public funds to expand the Federal power systems and makes loans to state utilities. Eight of these utilities, including the four major ones (para. 1.03) have received over the period 1949-1970 twenty loans from the Bank totalling US\$ 597 million, of which \$363.3 million were disbursed by the end of 1970. Prior to the 1964 tariff regulation revisions, the private capital companies which are the

principal distributors had not been allowed to earn sufficient income to expand their distribution systems so that they were by then at the saturation point, with frequent load shedding and substantial repressed demand as a result. As required in the 403-BR Loan Agreement, the Government took effective action to develop the distribution systems in the area commensurately with the expansion of generation and transmission facilities. Four Bank loans (475-478-BR of December 1966) totaling US\$ 61.6 million (of which \$28 million were disbursed by the end of 1970) have been helping the rehabilitation and expansion of four distribution systems in the area; a U.S. AID loan of US\$ 40 million to Light helped finance a program of distribution improvements in Rio de Janeiro and Sao Paulo; and other companies in the region, with the improved earnings based on revalued assets permitted since 1964, have been engaged in similar programs. The Rio Light system which was the only one by 1960 operating at 50 cycles was gradually converted to 60 cycles in order to facilitate exchanges of energy; conversion was completed early in 1971.

3.02 The urging of the foreign and international lending agencies has also been important with respect to coordination of the planning and operations of electric power facilities in the area (Covenants to Loan Agreements 211-BR and 403-474-BR). The priority list of power development sites provided in the Canambra study made in 1963-1966 under a UNDP grant (para. 2.04) was followed by the main utilities concerned (Furnas, CESP, CEMIG) and by the lending agencies in orienting their assistance. Despite the reluctance of some utilities, a system

interconnection committee which had been recommended by the Bank since 1958 (para. 2.03) was eventually established in 1968 and has met regularly since under Furnas' lead to coordinate operations. There still does not exist, however, inter-utility load dispatch centers, but the first one is expected to be established in Furnas by 1972. An important step toward the orderly marketing of power in the region was the signature of marketing and pooling agreements in 1968, concretized by regular long-term power contracts between Furnas and its present customer companies and by the agreement that Furnas would market energy from the 250 MW expansion of the Peixoto plant owned by the CPFL.

#### Tariffs

3.03 Prior to 1964, tariffs were based on historic value of investments and became unrealistic as inflation developed, causing many utilities to incur losses. The 1964 decrees, which had been expected to be passed shortly after Loan 211-BR was made in 1958 (para. 2.03), allowed utilities to revalue their investment, and the 1966 legislation made yearly revaluation of assets mandatory. Under the decrees tariffs were allowed to yield revenues covering: (a) operating costs and income taxes; (b) provisions for depreciation and "amortization"<sup>1/</sup> up to a maximum of 5% of gross fixed assets for each; and (c) a return of 10% (after taxes) on the estimated net plant in service at the end of the year plus some allowance for working capital. Applications for tariff adjustments, which have to be approved by the Ministry of Mines and

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<sup>1/</sup> This provision for "amortization" is not based on actual debt repayments but is intended to pay off the whole investment over the concession period.

Energy, are thus based on analyses of anticipated operating costs during the year in which the tariffs will apply and anticipated net plant in service at the end of that year, with allowances for expected interim inflation on both items. In the accounts of the utilities, by contrast, assets actually in existence at the end of each year are revalued by the official price correction factor applying to the previous year -- simply for reasons of timing in the issuance of the official price correction factors. Tariff adjustments are also permitted to recover shortfalls in achieving the 10% return, and these may be made at two year intervals.

3.04 The implementation of the revaluation and tariff adjustment provisions were not satisfactory during the initial years after 1964, because many of the provisions were at first permissive rather than obligatory and some utilities hesitated to adopt them wholly or partly. The Bank was concerned that different tariff policies might be followed by interconnected utilities, leading to the use of conflicting principles in calculating the cost of power blocks and resulting in economic decisions based on erroneous assumptions. During negotiations for Loan 474-BR, the Government objected to the Bank's proposed tariff covenants, and negotiations were suspended until legislation was changed by measures alleviating much of the Bank's concerns. Furnas took immediate and full advantage of the new regulations and, after revaluing its 1963 and 1964 assets, obtained corresponding tariff increases in early and mid-1965. As a result of this and the maximum permitted 5% rates taken by Furnas for both depreciation and amortization, tariffs introduced in mid-1965 were four times the 1964 tariffs. CEMIG, which had the right to purchase Furnas power, did not do so in 1965, although Furnas had both the

capacity and energy available due to a good water year; hence, Furnas did not market all of its power in that year. This was due to the substantially higher level of Furnas' wholesale tariff in comparison with both alternative sources and the retail tariffs of CEMIG which had revalued its assets only for 1963 and charged depreciation at 3% only. Expert assistance was needed in 1967 to reach agreement upon the power contract. During negotiations for Loan 474-BR (1966) and 565-BR (1968), Furnas indicated to the Bank that, when CEMIG would purchase large amounts of power starting in 1968, it would lower its 5% depreciation rate to a normal rate (estimated at 2.5%) based on the lives of its assets, and eliminate its provision for amortization, which had been reduced to 3% according to changes in regulations. At first Furnas did not reduce its provisions for depreciation and amortization, but the Government in 1969 restricted the depreciation rate to a maximum of 3%. Furnas' inability to market part of its power resulted also from its tariff structure. The demand charge which accounts for 90% of Furnas' revenues not only reflects the high depreciation charges but also allocates total capital cost to actual sales rather than to available capacity. There has been in addition a "ratchet" provision by which the highest demand registered in a given month establishes the charge for the year, regardless of subsequent demands. If Furnas had marketed all its available power, its ~~demand~~ <sup>instead of spilling water</sup> charges could have been lower and its <sup>net</sup> ~~total~~ revenues greater.

3.05 The average price per kwh sold by Furnas grew from US¢ 0.5 in 1964 to US¢ 1.4 in 1966, and US¢ 1.6 in 1970 (including indirect

taxes paid by ultimate consumers which amount to about 30% of the base tariff). The increase of US¢ 0.66 which occurred in 1965 reflects the triple impact of the foregone revenue due to the non-marketed Furnas power (US¢ 0.2), ~~of~~ the first revaluation of Furnas' assets and ~~of~~ the increases in depreciation costs. The guaranteed rate of return in Furnas' concession might endanger the efficiency of Furnas since increases in operating costs due to labor pressure or operational inefficiency as well as decreases in sales (due to inability to sell the power as in 1965 or as in 1970) would be compensated for by tariff increases borne by the consumers. *when power from other sources is not available.*

#### IV. Load Forecasting and Investment Planning

4.01 The construction of the Furnas plant and the establishment of the company was originally based on the projections made in 1958 for the power market in the South-Central region (para. 2.02). The demand in the area was expected to grow at 10.8% p.a. over 1958-1970 from 2,600 MW to 8,800 MW and, with the then existing investment programs of the utilities supplying the area, the power deficit would grow from 122 MW in 1962 to about 4,400 MW in 1970 (see following table, item 4); the Furnas plant with its final capacity of 1,100 MW was expected to reduce the deficit temporarily and further new projects totalling some 3,000 MW by 1970 would have to be built between 1965 and 1970. The output of the first stage of Furnas was expected to be fully absorbed as it was built, and the output of the complete plant by 1965.

4.02 Although the full 3,000 MW deficit projected was never made up, installed capacity in the South-Central region was in fact substantially



higher after 1968 than originally forecast, mainly due to the greater capacity of the Furnas Company itself, as illustrated by the following table (summary of Table II-A.1):

	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>
<u>Forecasts (MW)</u>						
1. Installed capacity in South-Central region	5208	5328	5388	5448	5448	5448
2. Installed capacity of Furnas	1104	1104	1104	1104	1104	1104
3. Deficit with Furnas	363	752	1283	1858	2547	3315
4. Deficit without Furnas (2 + 3)	1467	1856	2387	2962	3651	4419
<u>Actual (MW)</u>						
5. Installed capacity in South-Central region	4910	5058	5267	5485	6451	6803
6. Installed capacity of Furnas	900	900	980	1260	2154	2294
<u>Difference between Forecast and Actual Capacity</u>						
7. In the South-Central region (1 - 5)	298	270	121	(37)	(1003)	(1355)
8. Of Furnas (2 - 6)	204	204	124	(156)	(1050)	(1190)

The expected power deficit turned out actually to be a gross reserve capacity exceeding 1,000 MW in 1964-1966, and peaking at 1,350 MW in 1969 with the increase of capacity which took place between 1968 and 1969, or about 25% of demand in 1969. This was due mainly to a lower level of

demand, which grew only by 8.3% p.a. over 1958-1970 and reached 5,830 MW in 1970 as against 8,760 MW forecast. The slower growth of demand was due primarily to the economic slowdown which took place in 1963-1967 but also to the deficiencies in the distribution systems of electricity in the area which could not carry the whole demand through to the generation level (para. 3.01).

4.03 The output from Furnas was fully absorbed in 1963-1964 and after 1967, but part of Furnas' capacity was not marketed in 1964 to 1967 because of a lower demand from its shareholders and clients (economic slow-down and insufficient substation capacity) and because of Furnas' high tariffs (para. 3.04). For these reasons, and also because Furnas' installed capacity up to 1968 was lower than forecast, revenues and operating income during 1963-1967 were substantially lower than expected in the first appraisal report. The financial return, <sup>on net fixed assets</sup> however, reached satisfactory levels after 1964 when legislation for tariff increases was changed to yield satisfactory returns.

4.04 Forecasts made in the second appraisal report (1965) for the period 1965-1970 ~~underestimated~~ <sup>underestimated</sup> substantially Furnas' expansion, sales and income during this period. Installed capacity was expected to increase from 900 MW in 1965-1969 to 1,430 MW in 1970. Sales and income were expected to increase by about 15% p.a. on average between 1965 and 1970. The larger capacity installed in the Estreito plant and the acquisition by Furnas of the Chevap properties and Peixoto plant facilities (paras. 3.02 and 7.02) led to an installed capacity in 1970 outgrowing by far the forecasts; sales, revenues and incomes were actually substantially larger than expected. The financial return

(after taxes) was higher, except in 1969, than the expected 9% (Table II-A.2).

4.05 The records on the effective-peak spare capacity indicate that the large investments made by Furnas have been necessary to meet the demand. Small load shedding occurred in 1963 and 1964. Spare capacity at the effective peak was between 30 MW and 80 MW in 1965-1967 (para. 4.02) but decreased to less than 10 MW in 1968-1969. Furnas was severely affected in 1970 by drought, which reduced its capacity to meet demand and caused energy sales to fall 7% from 1969.

#### V. Project Implementation and Costs

5.01 Two plants out of the four financed by Bank loans to Furnas have been partly completed, i.e., the Furnas and Estreito plants aggregating 1,600 MW. An extensive transmission network partly financed by Bank loans has also been completed.

5.02 The first stage of the Furnas hydroelectric plant financed by ~~the~~ Loan 211-BR (1958) had been originally planned to consist of five 92 MW or four 110 MW generating sets, the size depending on the weights to be transported over the Brazilian railroads. The capacity was to be expanded ultimately to about 1,100 MW in a second stage expected to follow quickly on the first stage, scheduled for completion in June 1963. Subsequent investigation showed the desirability of installing four 150 MW units in the first stage, and a corresponding change in the description of the project in the Loan Agreement was approved in June 1959. In view of the low prices obtained for the electrical equipment, the project was again increased with Bank consent to

six 150 MW units which did not increase the foreign cost but did affect the local cost.

5.03 Construction of the first stage of the Furnas plant began in June 1958. The first unit was commissioned in September 1963 and the fourth in September 1964, that is with a 15-month delay behind schedule due to the large amount of excavation in excess of that originally estimated. The last unit was commissioned in May 1965. Transmission lines were originally designed to connect the plant to Sao Paulo and to Lafayette and were actually built between the plant and Sao Paulo and Belo Horizonte. The first line to Sao Paulo started operating in September 1963; the line to Belo Horizonte had been completed in September 1960. Total cost of the 900 MW plant was \$130 million, and about \$27 million for the transmission lines and substations (Table III). The total foreign exchange cost of \$58 million (excluding \$14.4 million interest during construction) did not exceed the appraisal estimates; the local cost for generation and transmission together was 36% higher than expected. Due to the doubling of installed capacity, the unit cost has been \$145 per kw installed against \$236 estimate. Most of the equipment was supplied by foreign manufacturers after international competitive bidding, and the civil works contract was won by a British firm in association with a Brazilian firm.

5.04 Substantial savings were made also on the equipment cost of the Estreito hydroelectric plant financed by the Loan 403-474-BR (1965-1966) and originally designed to receive four 133 MW units. Because of very good foundation conditions, work progressed satisfactorily and the

first four 175 MW units were commissioned between March and November 1969, more than one year ahead of schedule. Due to the good prices obtained for equipment, the Bank agreed in 1968 to permit use of loan savings to add to the plant two more 175 MW units, expected to be in operation in 1972, and to extend the project transmission lines from 1,060 km to 1,560 km. By the end of 1970, 560 km had been erected and the \$57 million Loan 403-BR was nearly fully disbursed. The \$39 million Loan 474-BR will be used to finance the two additional units in the plant and the remaining transmission lines amounting to about 1,000 km. Total cost of the 700 MW first stage of Estreito and its associated minimum 160 km transmission lines has been \$96 million, of which \$22 million for foreign exchange, leading to a unit cost of \$137 per kw installed against \$153 forecast. The 400 km of transmission lines already completed cost \$23 million, of which \$9.6 million for foreign components. Out of the \$44.2 million disbursed from the Loan 403-BR for purchases of materials and equipment, \$12.8 million were used to finance equipment from Brazilian manufacturers who won, with the 15% protection, about 30% of the orders.

## VI. Financing of the Investment Programs

6.01 Although there were in 1958 no definite plans for the financing of the second stage of the Furnas plant, the Furnas Company was planning to invest \$303 million over 1958-1965 for the construction of the 1,100 MW Furnas plant, of which \$209 million for the first stage of the plant and its associated transmission (Table II-B). Foreign

borrowing was expected to contribute \$127 million (42% of total), of which \$54 million for the second stage from unspecified sources. The expected \$156 million (51% of total) domestic contribution was to come mainly from loans from the BNDE and the Federal Electrification Fund, with share capital from the shareholders representing \$52 million, equivalent to 17% of total required funds. Net internal cash generation was expected to contribute \$20 million after 1963 to the cost of the second stage.

6.02 Actual investments amounted to \$227 million during 1958-1965; this was the result of the low cost of the first phase of Furnas (para. 5.03), of the non-implementation of the second phase and of additional transmission investments (transmission line from Furnas to Rio) financed with the help of a \$17.6 million U.S. AID loan after 1964. Foreign borrowing amounted to about \$74 million representing 32% of total required funds, of which \$1 million from the first disbursements from the U.S. AID loan. Total domestic contribution was \$147 million (63% of total), most of it in the form of loans from the public sector; share capital was only \$24 million because the shareholders did not have sufficient funds before 1964 as a result of the inflation and the lack of adequate tariff legislation. Furnas' own resources contributed only \$10 million, due to the delay in the commissioning of the plant with resulting reduced earnings in 1963 (para. 5.03).

6.03 The investment program for the period 1964-1970, as forecast in the second appraisal report (1965), was to comprise the completion of the Furnas plant's first stage with its six units and associated

transmission, and the two stages of the Estreito project to be covered by loans 403-474-BR. The cost of this investment program was estimated at \$217 million. Furnas' own resources were expected to cover one third of total required funds, loans from the public sector (Eletrobras) 20%, and foreign borrowing was projected to amount to \$111 million of which \$17.6 million from U.S. AID for the additional transmission line from Furnas to Rio. Actual investments were more than twice the expected amount. Investments on Furnas and Estreito plants and transmission facilities amounted to \$230 million, the acquisition of Chevap's properties in 1967 cost \$81 million (see para. 7.02) and investments in the acquired Funil and Santa Cruz plants were \$111 million; initial work on the new projects of Porto Colombia (Loan 565-BR) and Marimbondo (Loan 677-BR) took \$35 million investments. Furnas was still able to finance 30% of required funds from its own resources; the public sector had to increase substantially its contribution to \$239 million (48% of total), primarily in the form of share capital and loans. Foreign borrowing contributed only 22% to total required funds, amounting to \$112 million of which \$60 million only from the Bank (para. 5.04) and \$52 million from U.S. AID which transferred to Furnas its first loan of US\$ 15.5 million to Chevap for the Santa Cruz plant (para. 7.02) and also made in 1967 a second loan of US\$ 41.2 million for the extension of this plant.

## VII. Institutional Development

7.01 The management of the Furnas Company in 1958 was drawn from the electricity supply industry in Brazil and composed of a group of competent executives with extensive experience in this field. The organization of

Furnas has developed well, due to this aggressive and competent management and to the technical and financial assistance furnished by the Bank and other lenders. All Bank loans have included funds for personnel training, and some 100 employees have been sent since 1960 to the United States and European countries for graduate study and training in technical and financial matters. Some buildings at the Furnas Dam were converted into a training school for operation and maintenance technicians drawn from all utilities in Brazil. Furnas' financial statements have been audited since 1958 by the Brazilian branch of Arthur Andersen and Company; as required by the Loan Agreement 403-474-BR (1965-1966), Furnas, when converting to an operating company, contracted with Arthur Andersen Company to reorganize the accounting department, train accounting personnel and supervise the installation of a computerized accounting system. The contract was satisfactorily completed in 1966-1967. Furnas has employed consulting engineers and contractors when necessary to complement its own forces for the design and construction of its large investment program. Planning for the Marimbondo transmission system (Loan 677-BR of 1970) at 500 kv, a voltage which is relatively new, has been assisted by consultant firms specializing in this field. Relations of Furnas with its consultants and services rendered by the latter have been satisfactory.

7.02 Over 1963-1970, total revalued net fixed assets of Furnas increased from NCr 192 million to NCr 2,634 million. This large increase consisted of three elements: (1) the large construction program, (2) revaluation of assets, and (3) the acquisition in 1967 of the assets of the



Companhia Hidroeletrica do Vale do Paraiba (Chevap). Chevap had under construction since 1963 two generating stations intended to supply the Rio market: the 160 MW Santa Cruz thermal plant (near Rio) scheduled to be in service by 1967 and the 210 MW Funil hydroelectric plant scheduled for 1969. Construction had been financed by loans from Eletrobras and U.S. AID. The Government, in view of Chevap's unsatisfactory organization, rescinded in 1965 the concession granted to Chevap, which was taken over by Eletrobras. In 1967, the Government transferred the former Chevap concessions and assets to Furnas who obtained the Bank's consent.

7.03 Financing for Furnas' large assets originally came from borrowing from Eletrobras and others, and the debt/equity ratio in 1964 was 82/18. In 1964 and 1965, Eletrobras converted substantial parts of its long-term loans to Furnas into share capital, which is presently almost entirely owned by Eletrobras. This and the systematic reinvestment into equity of the dividends paid to the shareholders brought the debt/equity ratio under the 67/33 debt limitation (provided in the Loan Agreements) for 1965 and following years.

7.04 Other management indicators reflect the sound financial situation of Furnas due to the automatic adjustments of tariffs. The financial rate of return of Furnas has been steadily over 9%, except in 1964 before the tariff increases and in 1965 when Furnas did not market all its capacity (para. 3.04). Dividend payments on share capital have increased from 4% in 1965 to more than 12% in 1970. Furnas has been able since 1964 to finance 30% of its investments from its own resources, this proportion being about 50% in 1970.

7.05 The average cost per kwh sold, however, increased from US¢ 0.2 in 1963-1964 to US¢ 0.4 in 1965 and US¢ 0.6 in 1970. Depreciation and amortization provisions share in cost increased from 67% in 1964 to 90% in 1965 and 1966 and decreased after 1967 to about 60%, amortization being responsible for about half of this, as shown in the following table:

	<u>Average Cost/kwh Sold (US¢)</u>						
	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>
1. Depreciation	0.10	0.21	0.24	0.22	0.12	0.14	0.17
2. Amortization	<u>0.07</u>	<u>0.15</u>	<u>0.16</u>	<u>0.16</u>	<u>0.15</u>	<u>0.14</u>	<u>0.18</u>
3. Sub-total	0.17	0.36	0.40	0.38	0.27	0.28	0.35
4. Fuel	-	-	-	0.01	0.07	0.06	0.03
5. Energy Purchases	-	-	-	-	0.11	0.14	0.12
6. Administration	0.02	0.01	0.01	0.02	0.02	0.01	0.02
7. Others	<u>0.01</u>	<u>0.02</u>	<u>0.03</u>	<u>0.04</u>	<u>0.04</u>	<u>0.04</u>	<u>0.06</u>
8. Sub-total	<u>0.03</u>	<u>0.03</u>	<u>0.04</u>	<u>0.07</u>	<u>0.24</u>	<u>0.25</u>	<u>0.23</u>
9. Total Unit Cost	<u>0.20</u>	<u>0.39</u>	<u>0.44</u>	<u>0.45</u>	<u>0.51</u>	<u>0.53</u>	<u>0.58</u>

The average operating cost/kwh sold (excluding depreciation and amortization), shown in line 8, doubled between 1964 and 1967, due principally to labor pressure. The large increase in the average operating cost experienced since 1968 was due for the most part to the operation of the thermal plants (line 4) and to the rents paid for the Peixoto hydro plant (line 5); also the other average operating costs increased, indicating a continuing labor pressure (line 7) and increasing administrative responsibilities (line 6) handed over to Furnas by Government agencies (Eletro-

bras, Ministry of Mines and Energy). The average cost of thermal and purchased energy (about US\$ 1.0) was higher than the average cost in the company's hydroelectric plants (US\$ 0.4).

7.06 The average revenue per kwh sold (excluding indirect taxes) increased from US\$ 0.4 in 1963-1964 to US\$ 0.9 in 1965 due to the first revaluation of assets, and from US\$ 1.1 in 1969 to US\$ 1.3 in 1970 due to the decrease in sales caused by the 1970 drought. Transmission losses (about 5% of the energy sent out) and the amount of capacity out of service for maintenance and failures of equipment have been kept at satisfactory levels.

#### VIII. Conclusion

8.01 The development of Furnas over the 1963-1970 period has been impressive and the Bank's contribution to this achievement substantial; the cooperative and positive attitude of the Federal Government has been an essential factor. Due to its effective management Furnas has been able to build its large plants with substantial savings in costs and in time over original forecasts. It has grown in its short life to service satisfactorily nearly one-third of the total power demand in the large market of the South-Central region of Brazil. Recognition of the Company's capabilities by the Government authorities is indicated by the responsibilities assigned to it to take over Chevap's plants, to build the first nuclear power plant in Brazil, and to lead the committee for coordinating operation and expansion of the power systems in its region. The Bank also appears to have played a useful role in helping to set the financial situation of the Brazilian power sector on a sounder footing, enabling it to keep up with growth of demand more satisfactorily than in the 1950s. However the

steady upward trend in Furnas' real unit costs, due principally to changes in the legislation on depreciation before 1967 and to thermal and purchased energy afterwards but also to a continuous labor pressure -- does raise a question as to whether the existing regulatory structure of the industry provides sufficient incentive to efficiency in operations. Moreover, the tariff structure of Furnas may have introduced some distortion in the power investments for the whole region, since the high revenues it earned have *allowed* ~~led~~ it to expand its capacity and has led Cemig to build ~~thermal and hydro-~~ electric plants in order to reduce its dependence on the relatively expensive energy supply from Furnas; when Cemig <sup>*completes its*</sup> Sao Simao 1,500 MW hydro plant *and has* ~~is completed~~, Furnas may face some difficulty in selling its energy. To *sufficient power* assess the real extent of these problems, if any, would require a more intensive study than has been possible here.

8.02 According to Furnas and the Canambra study, the electric power system in the South-Central region which has been supplied primarily by hydroelectric plants needs to be complemented by thermal plants. Because of the lack of adequate fossil fuels in Brazil, the Government has decided to construct a nuclear plant, the responsibility for which has been given to Furnas in view of its past performance. The nuclear plant of about 500 MW is expected to be constructed during 1972-1978 in order to meet market requirements. It will be necessary also to build other plants in the 1970's and Furnas' present plan, beyond the ongoing projects, is to build the Itumbiara hydroelectric plant (about 1,000 MW) on the Paranaiba River during 1974-1978. The internal capital market is still insufficient and bond issues by Furnas on the foreign market would probably meet Government

opposition. Financing of future investments, therefore, is expected by Furnas to come partly from its own resources, and partly from Eletrobras and Bank loans; the atomic plant would be financed partly by tied supplier credits.

8.03 The Bank loans are still considered by Furnas as a very good source of financing, because of the substantial help received from the Bank in technical and financial matters and because of the low prices obtained from foreign or Brazilian suppliers by international bidding.

Equipment has been substantially more expensive when purchased with U.S. AID loans than with Bank loans. However, <sup>arrangements made in connection with</sup> the ~~use of~~ Bank loans could become <sup>more complicated</sup> ~~hampered~~ <sup>as a result of</sup> in the future ~~by the increasing~~ pressure from the Brazilian industries to supply a major part of the equipment in the projects irrespective of international competitive bidding. Furnas would also prefer not to receive joint financing for its future projects, in view of the substantial administrative costs and complexity involved in arranging such an operation as it experienced in the last Loan 677-BR (1970).

BRAZIL CENTRAIS ELETRICAS DE FURNAS, S.A.

TABLE I

Av. ann. incr. rate % 1963-1970

	UNIT	1963	1964	1965	1966	1967	1968	1969	1970		
<b>OPERATIONS</b>											
1.	Installed Capacity (yr.-end)	MW	300	600	900	900	980	1260	2154	2294	33.8
	of which: Hydro	MW	300	600	900	900	900	1100	1950	2090	
	Total as % of S.-Cent. Region	%	6.6	12.1	16.5	16.0	16.8	20.8	27.0	30.4	
	Total as % of Country	%	4.7	8.8	12.1	11.9	12.2	14.7	21.0	20.4	
2.	Peak Demand	MW	289	555	570	620	828	1285	1710	2069	32.5
3.	Gross Reserves (1-2)	MW	11	45	330	280	152	0 <sup>a</sup>	444	225	25.8
	Reserves as % of Peak Demand	%	4	8	58	45	18	--	26	11	
4.	Effective-Peak Spare Capacity <sup>b</sup>	MW	(12)	(2)	27	81	42	9	1	48	
5.	Gross Generation	GWh	413	3416	2842	3944	4637	6044	10528	9814	19.2
	Total as % of Country	%	1.5	11.6	9.3	11.9	13.4	15.6	24.5	21.1	
6.	Generation Sent Out	GWh	412	3416	2837	3936	4609	5983	10457	9731	19.1
	Total as % of S.-Cent. Region	%	1.9	15.1	11.9	15.2	16.9	20.2	34.1	28.8	
7.	Total Sales	GWh	397	3215	2681	3713	4406	5733	9937	9255	19.3
	of which: to Light S.A. (in %)	%	99	99	98	98	97	89	86	81	
	to Cemig (in %)	%	1	1	2	2	2	5	8	11	
8.	Number of Employees	no.	2840	2505	2650	1911	2286	2491	3015	3775	4.1
<b>FINANCES</b>											
9.	Sales Revenues <sup>d</sup>	NCrmln	1.30	22.59	61.65	114.53	162.57	268.12	522.33	686.40	42.5 <sup>h</sup>
10.	Operating Costs <sup>e</sup>	NCrmln	0.45	8.25	20.40	36.30	52.28	99.19	216.28	245.91	41.4
11.	Average Revenue/kwh sold	NCr¢	0.33	0.70	2.30	3.08	3.69	4.68	5.26	7.42	
12.	Average Cost/kwh sold	NCr¢	0.11	0.26	0.76	0.98	1.19	1.73	2.18	2.66	
13.	Exchange rate used <sup>f</sup>	US\$1=NCr	0.59	1.27	1.90	2.22	2.67	3.40	4.08	4.60	34.1
14.	Average Revenue/kwh sold	US¢	0.55	0.55	1.21	1.39	1.38	1.38	1.29	1.61	16.6
15.	Average Cost/kwh sold	US¢	0.19	0.20	0.40	0.44	0.44	0.51	0.53	0.58	17.3
16.	Net Revenues (9-10)	NCrmln	0.85	14.34	41.25	78.23	110.29	168.93	306.05	440.49	42.8
17.	Gross Fixed Investment	NCrmln	25.88	25.99	35.86	84.14	409.18	258.65	346.49	507.31	14.1
18.	Average net fixed assets in operation <sup>g</sup>	NCrmln	96.02	243.65	330.21	422.31	649.62	916.08	1545.27	2356.33	17.8
<b>MANAGEMENT INDICATORS</b>											
19.	Rate of return (16 as % of 18)	%	0.9	5.9	12.5	18.5	17.0	18.4	19.8	18.7	
20.	Financial rate of return <sup>h</sup>	%	0.5	2.6	7.7	9.7	9.1	9.8	9.9	11.6	
21.	Self-financing rate	%	3.1	23.4	23.4	52.1	16.4	25.2	29.6	47.0	
22.	Debt service coverage	times	--	2.1	1.2	2.5	2.8	1.8	1.6	2.3	
23.	Debt/Equity ratio	./.	94/06	82/18	61/39	61/39	59/41	55/45	57/43	56/44	
24.	Dividends as % of share capital	%	8.4	5.1	3.9	10.9	10.6	10.3	12.0	12.7	
25.	Energy sales per employee	MWh	14.0	1281	1012	1941	1928	2301	3296	2452	11.4
26.	Transmission losses (6-7/6)	%	3.6	5.9	5.5	5.7	4.4	4.2	5.0	4.9	
27.	Average capacity out of service as % of installed capacity	%	6.9	3.3	16.7	19.1	14.3	4.0	5.7	7.9	
<b>ECONOMIC INDICATORS (Sales in South-Central Region)</b>											
28.	Residential	GWh	3362	3600	3861	4167	4584	5129	5674	6112	8.9
29.	Commercial	GWh	2307	2356	2579	2722	2890	3254	3616	3901	7.8
30.	Industrial	GWh	7707	7865	7972	9145	9291	10838	12338	13584	8.4
31.	Rural	GWh	242	258	297	307	339	366	192	223	
32.	Pub. serv., Lighting, Traction	GWh	2060	2055	2121	2114	2411	2587	2591	2858	
33.	Others	GWh	314	366	400	446	448	167			
34.	Total	GWh	15992	16500	17230	18601	19663	22341	24411	26679	7.6
35.	Captive Plants	GWh	1690	1866	1984	2081	2188	2208	1764	1860	1.4
36.	FURNAS sales as % of S.-Cent Region	%	2.3	17.5	14.0	18.0	20.2	23.4	37.3	31.9	
37.	FURNAS sales as % of total country	%	1.8	13.3	11.0	14.0	15.8	18.3	29.0	24.6	
38.	Number of residential customers in South-Central Region	000's	2751	2908	3052	3241	3479	3762	4004	n.a.	
39.	Consumption per residential customer	MWh	1.22	1.24	1.26	1.29	1.32	1.36	1.42	n.a.	

a/ Includes captive plants.

b/ Figures between brackets indicate load shedding.

c/ Load shed was avoided due to an instantaneous peak capacity which was sufficient to cover the indicated peak demand.

d/ Revenues from electricity sales, and indirect taxes generated by these sales through Furnas' clients. In historic Cruzeiros.

e/ Including depreciation, but excluding interest and direct taxation on utility. In historic Cruzeiros.

f/ Average of net fixed assets in service revalued using correction factors for the same year (except for 1963).

g/ Operating income after taxes (including miscellaneous revenues) as % of 18. See line 24 of Table II-A.1.

h/ Rates of increase for financial data were computed over 1964-1970 after deflating by inflation index (rate of exchange).

i/ Average over each year of the monthly quotations of the exchange rate on the free market. This average is very close to the average official rate.

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BRAZIL CENTRAIS ELETRICAS DE FURNAS, S.A.

TABLE II-A.1

LOAN 211-BR (October, 1958)

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	Av. ann. incr. rate (%)		
														1958-1970	1963-1970	
<u>SOUTH-CENTRAL REGION</u>																
<u>LOAD FORECASTS (MW)</u>																
1.	Installed Capacity <sup>a/</sup>	2559	2783	3344	3629	3900	4444	4780	5208	5328	5388	5448	5448	5448	6.5	2.9
2.	Annual Peak Demand	2570	2892	3239	3627	4022	4524	5056	5571	6080	6671	7306	7995	8763	10.8	9.9
3.	Gross Reserve Capacity (1-2)	-11	-109	105	2	-122	-80	-276	-363	-752	-1283	-1858	-2547	-3315		
<u>ACTUAL LOAD (MW)</u>																
4.	Installed Capacity <sup>a/</sup>	n.a.	n.a.	n.a.	3308	3631	4114	4456	4910	5058	5267	5485	6451	6803	8.3	7.4
5.	Annual Peak Demand	2240	2474	2698	2898	3096	3249	3378	3673	3971	4467	4773	5088	5831		8.7
6.	Gross Reserve Capacity (4-5)	n.a.	n.a.	n.a.	410	535	865	1078	1237	1087	800	712	1363	972		
<u>LOAD FORECAST ACCURACY <sup>c/</sup></u>																
7.	Installed Capacity	n.a.	n.a.	n.a.	110	107	108	107	106	105	102	99	84	80		
8.	Annual Peak Demand	115	117	120	125	130	139	150	152	153	149	153	157	150		
<u>FURNAS</u>																
<u>FORECAST (MW)</u>																
9.	Installed Capacity					460	736	1104	1104	1104	1104	1104	1104	1104		13.3
<u>ACTUAL (MW)</u>																
10.	Installed Capacity					300	600	900	900	980	1260	2154	2294			33.8
11.	Effective Peak Capacity <sup>b/</sup>					277	305	584	679	821	1294	1279	2091			
12.	Effective Peak Demand <sup>b/</sup>					289	307	557	598	779	1285	1278	2043			
13.	Effective Peak Spare Capacity (11-12)					-12	-2	27	81	42	9	1	48			
<u>FORECAST ACCURACY <sup>c/</sup></u>																
14.	Installed Capacity					153	123	123	123	113	88	51	48			
<u>SALES FORECAST (Gwh)</u>																
15.	Sales					2200	4400	4600	5700	5700	5700	5700	5700	5700		14.6
<u>ACTUAL SALES (Gwh)</u>																
16.	Sales					397	3215	2681	3713	4406	5733	9937	9255			19.2 <sup>f/</sup>
<u>SALES FORECAST ACCURACY <sup>c/</sup></u>																
17.	Sales					554	137	172	154	129	99	57	62			
<u>RETURN FORECAST (Ncr mln historic) <sup>d/</sup></u>																
18.	Operating Revenues					27.83	119.75	187.5	223.8	269.2	342.8	411.0	464.0			11.5 <sup>e/</sup>
19.	less: Operating Costs					14.74	45.20	92.4	121.6	142.3	185.1	227.0	261.0			12.4
20.	Operating Income					13.09	74.55	95.1	102.2	126.9	157.7	184.0	203.0			10.3
21.	Financial rate of return (%)					9.7	11.9	9.9	9.6	9.8	9.9	9.9	10.0			
<u>ACTUAL RETURN (Ncr mln historic)</u>																
22.	Operating Revenues					.96	15.86	48.42	84.18	122.03	206.22	407.30	590.04			47.5 <sup>f/</sup>
23.	less: Operating Costs					.50	9.63	23.11	43.20	62.94	116.65	254.57	316.24			44.5
24.	Operating Income					.46	6.23	25.31	40.98	59.09	89.57	152.73	273.80			51.5
25.	Financial rate of return (%)					0.7	3.1	8.0	10.5	9.4	11.4	8.5	12.1			
<u>FORECAST ACCURACY <sup>c/</sup></u>																
26.	Operating Revenues					2899	755	387	266	221	166	101	79			
27.	Operating Costs					2948	469	400	281	226	159	89	82			
28.	Operating Income					2846	1197	376	249	215	176	120	74			

a/ Does not include captive plants.

b/ Effective peak: peak load at the critical time in the year when margin between demand and available capacity was least or load shedding greatest (excluding short-term outages).

c/ Defined by the ratio Forecast/Actual.

d/ Forecasts converted into historic Cruzeiros.

e/ Rates of increase for financial data were computed after deflating by inflation index (rate of exchange).

f/ Average annual rate of increase over 1964-1970.

BRAZIL    CENTRAIS ELETRICAS DE FURNAS, S.A.    TABLE II-A.2  
LOAN 403-BR (February, 1965)

	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>Av. ann. incr. rate(%)</u> <u>1965-1970</u>
<u>SOUTH-CENTRAL REGION</u>							
<u>FORECAST (Gwh)</u>							
1. <u>Energy Sent Out</u>	23053	25358	28147	31243	34679	38493	10.8
<u>ACTUAL (Gwh)</u>							
2. <u>Energy Sent Out</u>	23767	25939	27213	29648	30652	33837	7.3
<u>FORECAST ACCURACY<sup>a/</sup></u>							
3. <u>Energy Sent Out</u>	97	98	103	105	113	114	
<u>FURNAS</u>							
<u>FORECAST</u>							
4. <u>Installed Capacity (MW)</u>	900	900	900	900	900	1432	
5. <u>Sales (Gwh)</u>	3900	4500	4500	5000	7600	7700	14.6
<u>ACTUAL</u>							
6. <u>Installed Capacity (MW)</u>	900	900	980	1260	2154	2294	
7. <u>Sales (Gwh)</u>	2681	3713	4406	5733	9937	9255	28.1
<u>FORECAST ACCURACY<sup>a/</sup></u>							
8. <u>Installed Capacity</u>	100	100	92	71	42	62	
9. <u>Sales</u>	145	121	102	87	76	83	
<u>RETURN FORECAST (NCr mln historic)<sup>b/</sup></u>							
10. <u>Operating Revenues</u>	46.55	55.95	70.22	113.59	162.1	197.75	11.9 <sup>c/</sup>
11. <u>less: Operating Costs</u>	20.53	18.88	24.31	39.09	55.1	67.65	6.4
12. <u>Operating Income</u>	26.02	37.07	45.91	74.50	107.0	130.10	15.6
13. <u>Financial rate of return (%)</u>	7.6	9.0	9.0	9.0	9.0	9.0	
<u>ACTUAL RETURN (NCr mln historic)</u>							
14. <u>Operating Revenues</u>	48.42	84.18	122.03	206.22	407.30	590.04	38.2
15. <u>less: Operating Costs</u>	23.11	43.20	62.94	116.65	254.57	316.24	41.4
16. <u>Operating Income</u>	25.31	40.98	59.09	89.57	152.73	273.80	34.9
17. <u>Financial rate of return (%)</u>	8.0	10.5	9.4	11.4	8.5	12.1	
<u>FORECAST ACCURACY<sup>a/</sup></u>							
18. <u>Operating Revenues</u>	96	66	58	55	40	36	
19. <u>Operating Costs</u>	89	44	39	34	22	21	
20. <u>Operating Income</u>	103	90	78	83	70	48	

<sup>a/</sup> Defined by the ratio Forecast/Actual.

<sup>b/</sup> Forecasts converted into historic Cruzeiros.

<sup>c/</sup> All rates of increase for financial data were computed after deflating by the inflation index (rate of exchange).



BRAZIL CENTRAIS ELETRICAS DE FURNAS, S.A.

TABLE II-B

UTILITY INVESTMENT PROGRAMS PARTLY FINANCED BY I.B.R.D. (US\$million)

	<u>LOAN 211-BR (1958)</u>				<u>LOAN 403-BR (1965)</u>			
	<u>PERIOD 1958-1965</u>				<u>PERIOD 1964-1970</u>			
	<u>FORECAST</u>		<u>ACTUAL</u>		<u>FORECAST</u>		<u>ACTUAL</u>	
	<u>Total</u>	<u>% of total</u>	<u>Total</u>	<u>% of total</u>	<u>Total</u>	<u>% of total</u>	<u>Total</u>	<u>% of total</u>
<u>SOURCES OF FUNDS</u>								
1. Net Internal Cash Generation	19.88	7	10.49	5	76.7	33	150.30	30
2. Domestic Contribution:								
from private sector: share capital	15.70	5	4.90	2	--	--	.17	--
from public sector: share capital	36.64	12	19.26	8	.1	--	23.14	5
loans a/	103.88	34	122.56	53	46.4	20	216.09	43
sub-total	<u>140.52</u>	<u>46</u>	<u>141.82</u>	<u>61</u>	<u>46.5</u>	<u>20</u>	<u>239.23</u>	<u>48</u>
Total Domestic Contributions	156.22	51	146.72	63	46.5	20	239.40	48
3. Foreign Borrowing:								
U.S. AID <sup>b/</sup>			1.12	1	17.6	7	51.56	10
I.D.B. <sup>c/</sup>	54.4 <sup>d/</sup>	18	--	--	--	--	.81	--
I.B.R.D.	73.00	24	72.61	31	93.7	40	59.71	12
Total	<u>127.40</u>	<u>42</u>	<u>73.73</u>	<u>32</u>	<u>111.3</u>	<u>47</u>	<u>112.08</u>	<u>22</u>
4. Total Sources	<u>303.50</u>	<u>100</u>	<u>230.94</u>	<u>100</u>	<u>234.5</u>	<u>100</u>	<u>501.78</u>	<u>100</u>
<u>APPLICATIONS OF FUNDS</u>								
5. Total Fixed Investments	303.10	100	226.50	98	217.4	93	474.51	94
6. Changes in Working Capital and Net Cash Accrual	.40	-	4.44	2	17.1	7	27.27	6
7. Total Applications	<u>303.50</u>	<u>100</u>	<u>230.94</u>	<u>100</u>	<u>234.5</u>	<u>100</u>	<u>501.78</u>	<u>100</u>

	<u>Terms of Loans:</u>	<u>Interest(%)</u>	<u>Amortization(yrs)</u>
a/	Elektrobras loans:	8 1/2-10-13	15-20
b/	AID loans (3):	5 1/2-5 3/4-6	22-17-15
c/	IDB loan (1):	6 1/4	11
d/	Loan from unspecified source to cover the foreign exchange cost of the Second Stage of Furnas plant.		

BRAZIL CENTRAIS ELETRICAS DE FURNAS, S.A.

TABLE III

PROJECTS IMPLEMENTATION

		Start Construct.	Commission. Date	Construct. period (months)	Project	Scope <sup>a/</sup>	CONSTRUCTION COST (US\$ million)			COST/KW US\$
							L.C.	F.X.	Total	
<b>LOAN 211-BR (US\$ 73 million)</b> (signed October 1958)										
Furnas Plant	Forecast	June 1958	June 1963	60	460 MW	Hydro	66.96	41.50	108.46	236
	Actual	June 1958	S 63, Ju 65	63-85	900 MW		85.42	44.84	130.26	145
Associated Transmission	Forecast	n.a.	June 1963	n.a.	680 km	610 MVA	5.55	16.50	22.05	
	Actual	n.a.	S 60-S 63		712 km	1,200 MVA	13.09	13.57	26.66	
<b>LOANS 403 AND 474-BR</b> (US\$ 57 + 39 million) (signed Feb. 1965 and Dec. 1966)										
Estreito Plant and associated transmission	Forecast	Dec. 1964	Jan. 1971	73	533 MW	Hydro	45.00	36.50	81.50	153
	Actual	Dec. 1964	Nov. 1969	59	700 MW		74.40	21.80	96.20	137
Transmission Expansion	Forecast	n.a.	Jan. 1971	n.a.	900 km		15.20	29.30	44.50	
	Actual	n.a.	not completed	--	400 km	2,300 MVA	13.35	9.60	22.95	
<b>PROJECTS NOT COVERED BY IBRD LOANS</b>										
Funil plant	Actual	1962	Apr. 1970	n.a.	210 MW	Hydro	-	-	84.89	404
Santa Cruz	Actual	1964	Mar. 1968	n.a.	2 x 80 MW	Thermal	-	-	33.37	208

LOANS DISBURSEMENT PATTERN

LOAN	Forecast:	Amount (US\$mln)	% of total	Cumulative %	1958-1970											Undisbursed 12/31/74	1971	
					1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968			1969
LOAN 211-BR	Forecast:	Amount (US\$mln)			14.70	27.70	16.30	7.10	4.40	2.20	0.60							
		% of total			20.2	38.0	22.3	9.7	6.0	3.0	0.8							
	Actual:	Amount (US\$mln)			20.2	58.2	80.5	90.2	96.2	99.2	100							
		% of total			22.7	14.7	17.1	20.8	15.0	7.9	1.1	0.7						
LOAN 403-BR	Forecast:	Amount (US\$mln)							11.50	12.10	16.80	11.60	5.00					
		% of total							20.2	21.2	29.5	20.3	8.8					
	Actual:	Amount (US\$mln)							0.08	2.40	7.61	11.36	18.11	12.46				
		% of total							0.1	4.2	13.7	19.9	31.8	21.9				
		Cumulative %			22.7	37.4	54.5	75.3	90.3	96.2	99.3	100						
		Cumulative %							0.1	4.3	18.0	37.9	69.7	91.6				

a/ Project scope is Megawatts of installed capacity and source of energy in the case of Generation components and kilometers of lines erected (345 kv) and MVA capacity of substations in the case of Transmission components of the projects.  
 Associated transmission to the Estreito Plant consisted of 160 km of 345 kv transmission lines. Its cost is included in the plant cost.  
 Total foreign exchange cost up to 1971 has been \$31.40 million. Disbursements from Loan 403-474-BR have amounted to \$44.20 million (excluding interest during construction), the \$12.8 million difference originating from the IBRD financing of the equipment and materials manufactured in Brazil. The local currency financing includes \$ 4.95 million for generation and \$ 7.85 million for transmission.  
 Withdrawals on account of the Loan 474-BR will not begin until the first Loan 403-BR has been fully withdrawn; full disbursement of loan 403-BR took place in June 1971.  
 Local Cost of projects was computed by converting for each year the Cruzeiro expenditures incurred during that year with the exchange rate indicated in Table I.

disbursements from 474-BR in 1971 amounted to US\$ 13.89 million.

BRAZIL CENTRAIS ELETRICAS DE FURNAS, S.A.

TABLE III

PROJECTS IMPLEMENTATION

		Start Construct.	Commission. Date	Construct. period (months)	Project	Scope <sup>a/</sup>	CONSTRUCTION COST (US\$ million)			COST/KW US\$
							L.C. <sup>b/</sup>	F.X.	Total	
<u>LOAN 211-BR (US\$ 73 million)</u> (signed October 1958)										
Furnas Plant	Forecast	June 1958	June 1963	60	460 MW	Hydro	66.96	41.50	108.46	236
	Actual	June 1958	S 63, Ju 65	63-85	900 MW		85.42	44.84	130.26	145
Associated Transmission	Forecast	n.a.	June 1963	n.a.	680 km	610 MVA	5.55	16.50	22.05	
	Actual	n.a.	S 60-S 63		712 km	1,200 MVA	13.09	13.57	26.66	
<u>LOANS 403 AND 474-BR</u> (US\$ 57 + 39 million) (signed Feb. 1965 and Dec. 1966)										
Estreito Plant and associated transmission	Forecast	Dec. 1964	Jan. 1971	73	533 MW <sup>c/</sup>	Hydro	45.00	36.50	81.50	153 <sup>c/</sup>
	Actual	Dec. 1964	Nov. 1969	59	700 MW		74.40	21.80 <sup>d/</sup>	96.20	137 <sup>c/</sup>
Transmission Expansion	Forecast	n.a.	Jan. 1971	n.a.	900 km	2,300 MVA	15.20	29.30 <sup>d/</sup>	44.50	
	Actual	n.a.	not completed	--	400 km		13.35	9.60 <sup>d/</sup>	22.95	
<u>PROJECTS NOT COVERED BY IBRD LOANS</u>										
Funil plant	Actual	1962	Apr. 1970	n.a.	210 MW	Hydro	-	-	84.89	404
Santa Cruz	Actual	1964	Mar. 1968	n.a.	2 x 80 MW	Thermal	-	-	33.37	208

LOANS DISBURSEMENT PATTERN

		1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	Undisbursed 12/31/71
<u>LOAN 211-BR</u>	Forecast:															
	Amount (US\$mln)	14.70	27.70	16.30	7.10	4.40	2.20	0.60								
	% of total	20.2	38.0	22.3	9.7	6.0	3.0	0.8								
	Cumulative %	20.2	58.2	80.5	90.2	96.2	99.2	100								
	Actual:															
	Amount (US\$mln)		16.58	10.75	12.50	15.18	10.93	5.78	0.81	0.47						
% of total		22.7	14.7	17.1	20.8	15.0	7.9	1.1	0.7							
Cumulative %		22.7	37.4	54.5	75.3	90.3	98.2	99.3	100							
<u>LOAN 403-BR <sup>e/</sup></u>	Forecast:															
	Amount (US\$mln)							11.50	12.10	16.80	11.60	5.00				
	% of total							20.2	21.2	29.5	20.3	8.8				
	Cumulative %							20.2	41.4	70.9	91.2	100				
	Actual:															
	Amount (US\$mln)								0.08	2.40	7.81	11.36	18.11	12.46	3.44	1.34
% of total								0.1	4.2	13.7	19.9	31.8	21.9	6.0	2.4	
Cumulative %								0.1	4.3	18.0	37.9	69.7	91.6	97.6		

- <sup>a/</sup> Project scope is Megawatts of installed capacity and source of energy in the case of Generation components and kilometers of lines erected (345 kv) and MVA capacity of substations in the case of Transmission components of the projects.
- <sup>b/</sup> Local Cost of projects was computed by converting for each year the Cruzeiro expenditures incurred during that year with the exchange rate indicated in Table I.
- <sup>c/</sup> Associated transmission to the Estreito Plant consisted of 160 km of 345 kv transmission lines. Its cost is included in the plant cost.
- <sup>d/</sup> Total foreign exchange cost up to 1971 has been \$31.40 million. Disbursements from Loan 403-474-BR have amounted to \$44.20 million (excluding interest during construction), the \$12.8 million difference originating from the IBRD financing of the equipment and materials manufactured in Brazil. The local currency financing includes \$4.95 million for generation and \$7.85 million for transmission.
- <sup>e/</sup> Withdrawals on account of the Loan 474-BR did not begin until 1971 when the first Loan 403-BR was nearly fully withdrawn; disbursements from 474-BR in 1971 amounted to US \$13.89 million.

Table with multiple columns, likely containing dates and financial data. The text is mirrored and difficult to read due to bleed-through. Includes dates like 'Jan 1971', 'Nov 1970', 'Jan 1972', 'Apr 1971', 'Mar 1971'.

↑  
60

Table with multiple columns, likely containing percentages and numerical values. Includes values such as '0.1', '0.7', '1.0', '1.5', '2.0', '2.5', '3.0'.

Detailed text providing context or a narrative for the data above. The text is mirrored and difficult to read due to bleed-through. Mentions terms like 'project', 'components', 'expenditures', 'transmission lines', 'exchange', 'mills', and 'loan'.

ROUTING SLIP

Date

March 21, 1972

NAME

ROOM NO.

Mr. John Adler

D630

~~(please <sup>initial</sup> before passing to chief)~~

*CW*

To Handle

Note and File

Appropriate Disposition

Note and Return

Approval

Prepare Reply

Comment

Per Our Conversation

Full Report

Recommendation

Information

Signature

Initial

Send On

REMARKS

I don't know what all  
this is all about. ~~He says~~  
~~he too~~ Is it part of  
the full reports available  
on demand?

*4500*

*A.*

From

Gunter K. Wiese

D630

## OFFICE MEMORANDUM

TO: Mr. Willoughby (through Mr. John Adler)

FROM: Gunter K. Wiese

SUBJECT: BRAZIL: Study of FURNAS

DATE: March 21, 1972

Please find attached a memorandum from Mr. Skillings to me on the above subject. I fully agree with his comments.

Att.

cc: Mr. Skillings

## OFFICE MEMORANDUM

TO: Mr. Gunter K. Wiese

DATE: March 20, 1972

FROM: Robert F. Skillings SUBJECT: BRAZIL - Study of Centrais Eletricas de Furnas, S.A.

1. This study gives a good description of the development of FURNAS since its formation in 1957 and of the role which Bank lending has played.

2. The study requires editing for style and comprehensibility at a number of places. There are, in addition, a few substantive issues which I would challenge. These are:

(a) The study implies that FURNAS has played the leadership role in organizing integrated operations (see paras. 1.03 and 3.02). This may overstate FURNAS' contribution. The leadership role has really been exercised by Eletrobras.

(b) Para. 1.04 should mention the Government's plan to install a number of thermal plants.

(c) On a number of occasions, the study asserts that because of high tariffs, FURNAS' sales were less than they might have been. Para. 3.04 in fact suggests that revenues might have been greater had tariffs been lower. This implies that the elasticity of demand for power was greater than 1, which I think unlikely.

*Note exactly:*

$$\Delta R > 0 \Rightarrow \epsilon_d > 1$$

*But  $\epsilon_d > 1 \Rightarrow \Delta R > 0$  <sup>considered</sup>*

*anyway, net revenues were*

*efficiency is  
different from  
viability!*

(d) The study argues (para. 3.05 and 7.05) that the guaranteed rate of return in FURNAS' concession might endanger its efficiency since operating cost increases will be passed on to the customer through tariff increases. This argument is inconsistent with the earlier suggestion (see (c) above) that the demand for power is highly elastic; moreover, the evidence given (the cost data in para. 7.05) is not detailed enough to be convincing on this point.

(e) In para. 8.01 the study states that FURNAS' high tariff structure may have caused distortions in the power investments for the whole region since the high revenues have led it to expand its own capacity and has led CEMIG to build thermal plants.

In fact, CEMIG has not yet built any thermal plants, but in any event the argument is confusing. FURNAS' high revenues do not "lead it" to expand capacity; demand growth does. Moreover, the study argues earlier that the high tariffs suppressed demand; if so, this would have discouraged capacity expansion.

*Yes when there is no tight constraint on the overall supply. But this has not been the case up to now.*

March 20, 1972

(f) Para. 8.03 speculates that use of Bank loans in the future may be hampered by increasing pressure from Brazilian equipment suppliers who do not like international competitive bidding. Our experience with Sao Simao suggest that this fear may be unwarranted.

3. I have attached a copy of the study with my handwritten comments for reference.

Attachment

cc: Mr. King



## CHAPTER III - FURNAS - BRAZIL

### I. Introduction

1.01 ~~The~~ Centrais Eletricas de Furnas S.A., (FURNAS) was formed in February 1957 and granted in July 1957 a 30-year concession to utilize hydraulic power from the Rio Grande at Furnas Rapids. It is an autonomous Government corporation and the largest subsidiary of Centrais Eletricas Brasileiras, S.A. (ELETROBRAS), a Federal Government holding company created in 1961 to carry out a national electrification plan and implement the Federal Government policy in the electric power sector. More than 95% of Furnas' common and preferred stock is presently owned by Eletrobras.

1.02 The name of the company derives from its first plant built at Furnas Rapids and partly commissioned in 1963 with an initial generating capacity of 300 MW. The installed capacity of the company was about 2,300 MW by the end of 1970, of which about 200 MW were thermal and 1,600 MW were partly financed by Bank loans. The transmission system of Furnas consists of about 2,700 km of transmission lines in operation, most of them at 345 kv; about 1,300 km of existing transmission lines were financed by the Bank. The annual peak demand on Furnas' system grew from 290 MW in 1963 to 2,070 MW in 1970, i.e., by an average of 32% p.a.

1.03 All power generated by Furnas has been sold in bulk under contract to other utilities for resale to the ultimate consumers. These utilities are located in the South-Central region of Brazil; the principal generating companies in the region are:

Centrais Eletricas de Furnas, S.A. (Furnas),  
Centrais Eletricas de Sao Paulo, S.A. (CESP), state-owned  
company,  
Centrais Eletricas de Minas Gerais, S.A. (CEMIG), state-  
owned company, and  
Light Servicos de Eletricidade, S.A. (Light), a subsidi-  
ary of a foreign company.

These companies are interconnected by a transmission system and up until now the major exchange of power has been from Furnas to Light. CESP, which received three loans from the Bank, will supply a large part of the Sao Paulo market; CEMIG received also three Bank loans and supplies the state of Minas Gerais. Furnas is presently the principal supplier of the Rio de Janeiro area where Light will continue to be the principal distributor. The transmission grid makes it possible for these utilities to obtain substantial advantages from coordinated operation; Furnas has taken the lead in organizing recently a Committee for the Coordination of Integrated Operation which includes the companies operating in the South-Central region. This Committee which meets regularly on technical matters is expected to achieve for the region a high quality of service at low cost.

1.04 The South-Central region is the industrial heart of the country; it contains 45% of the country's population, accounts for 40% of its agricultural production and 70% of its industrial production, and consumed in 1970 about 29 billion kwh of electricity or about 78% of the country's total consumption. Commercial and industrial sales of electricity have amounted to nearly 60% of total sales in the region.

A study made under a UNDP grant and updated in 1968 by a market study undertaken by Eletrobras yielded a program for the region's power development through 1980 when total consumption is expected to reach at least 75 billion kwh. The development program is predominantly hydroelectric since there are many such sites that can be developed at low unit cost, whereas the known indigenous fossil fuels are either scarce or of poor quality and remote from the region. All the companies have adhered to the program for their ongoing investments and are expected to continue doing so.

*Some companies are thinking of putting in small thermal plants.*

*Eletrobras is now (March 1972) working on a revision of the program to bring it up to date in accordance with most recent power demand experience.*

II. The Association Between the Bank and Furnas

2.01 The Furnas Company received over the period 1958-1970 five loans from the Bank as follows:

<u>Loan No.</u>	<u>Date of Loan Agreement</u>	<u>Effective Date</u>	<u>Closing Date</u>	<u>Amounts (\$ mln)</u>		<u>Interest (%)</u>	<u>Period (years)</u>	
				<u>Committed</u>	<u>Disbursed<sup>a/</sup></u>		<u>Grace</u>	<u>Term</u>
211-BR	10/58	2/59	1/66 <sup>b/</sup>	73.0	73.0	5-3/4	5	25
403-474-BR: Tranche I	2/65	7/65	4/72 <sup>c/</sup>	57.0	52.2	5-1/2	6	25
Tranche II	12/66	6/67	6/74 <sup>c/</sup>	39.0	0	6-6-1/4	5	25
565-BR	10/68	2/69	3/75	22.3	1.7	6-1/2	6	25
677-BR	5/70	9/70	8/77	<u>80.0</u>	<u>0</u>	7	7	30
Total				<u>271.3</u>	<u>126.9</u>			

<sup>a/</sup> As of December 31, 1970

<sup>b/</sup> Extended three times from September 1963 to January 1966

<sup>c/</sup> Extended once.

2.02 In 1957, most of Brazil's industry was situated in the South-Central region; the growth of the demand in the area had been between 9% and 14% annually and was expected to grow very rapidly. Generating resources of the eight utilities supplying the area with power were barely sufficient ~~in 1957~~ to meet the demand. Power plant development promoted by individual utilities was largely parochial and there was no coordinated long-term plan; the power deficit in the area was expected to grow from 11 MW in 1958 to 1010 MW in 1964 and increase faster afterwards. Official Brazilian agencies entered into a joint venture with private foreign-owned power companies to establish and finance Furnas; three of the four entities entering the venture were already directly or indirectly IBRD borrowers. The capital of Furnas was agreed to be 50% common and 50% preferred stock and subscriptions were to be made to a total of Cr 6 billion for the first stage of the Furnas plant with a final capacity of 1100 MW. The electricity produced by the Furnas Company was to be sold only to the shareholders, with 50% of the output assured for supply in the State of Sao Paulo and 50% for supply in the State of Minas Gerais. The Government-controlled National Economic Development Bank (BNDE) was to subscribe 51% of the common stock. Moreover, long-term loans from BNDE and the Federal Electrification Fund were to be made to Furnas to cover the local expenditures of the Furnas plant.

2.03 The Bank made the loan 211-BR to cover the foreign exchange required for the project consisting of the 460 MW first stage of the Furnas plant and associated transmission facilities to be commissioned by mid-1963. Assurances were obtained before the loan became effective that:

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- (a) the capital and long-term loans be available as required for the expeditious construction of the project;
- (b) the Company seek to obtain the maximum revenues permitted under the relevant regulations;
- (c) enactment of a bill then before the Brazilian Congress, permitting the periodic revaluation of assets to make public utilities attractive for investment despite the rapid depreciation of the cruzeiro, be pressed through as quickly as possible by the Government.

The Government also agreed to discuss with the Bank the question of setting up a joint planning board in which all major utilities in South-Central Brazil would cooperate in jointly planning the future generation and transmission expansion in order to assure a sound development, both technically and economically.

2.04 Under a UNDP grant administered by the Bank, a consortium of consulting engineers (Canambra) made during 1963-1966 a survey of the requirements and resources of power in the South-Central region and recommended that a group of hydroelectric plants be built to supply the anticipated market. Many of these were to be located on the Rio Grande with transmission systems to connect the cities of Sao Paulo, Rio de Janeiro and Belo Horizonte. The highest priority in this power program was given to the Estreito plant downstream from the Furnas plant and associated transmission, the construction of which was assigned to the Furnas company by the Federal Government. The Bank made the loan 403-474-BR in two steps:

- (a) Loan 403-BR of \$57 million of February 1965 was to finance the Estreito plant with a planned capacity of 533 MW and the minimum transmission facilities needed to connect the plant to the existing transmission system. The plant was to be completed early in 1971.
- (b) A supplementary loan 474-BR of \$39 million was made at the end of 1966 to finance the extension of existing transmission system by about 950 km of 345 kv to be completed early in 1971.

The reasons given for this were that, at the time of the first loan, no decision had been made as to the voltage of the additional transmission facilities needed to carry the full output of Estreito and there was no need to start construction of these lines at the same time as construction of the plant was started; the Bank also preferred to stretch its commitments over two years because its funds were not ample at that time.

2.05 The Bank obtained during negotiations for 403-474-BR assurances that:

- (a) Furnas would revalue its assets at least once a year and apply for adjusted tariffs to produce revenues resulting in at least a 10% return on its average net revalued fixed plants in operation (before taxes);
- (b) Eletrobras would convert into equity such amounts of outstanding long-term debt as to allow debt not to exceed two-thirds of the total net revalued fixed assets;

- (c) the Government would take all necessary action for coordination of operation of facilities of the integrated system which would use Furnas' power, and also take effective action in regard to the expansion of the distribution facilities in the Rio de Janeiro and Sao Paulo areas where many of the distribution systems were at the saturation point because the principal distributing companies had not been allowed to earn sufficient income to expand the systems.

Also, because it was finally agreed by the Bank that Brazilian manufacturers would compete with a 15% maximum protection in the international bidding for the contracts covering materials and equipment to be financed by the proposed loans, a side letter detailed the basis and method for comparing bids of Brazilian and foreign manufacturers.

2.06 Until September 1966, when it began bulk deliveries to CEMIG, Furnas' sole customer was Brazilian Light S.A. for its own market in Sao Paulo. According to arrangements agreed by the Government and the companies involved in the supply of power in the South-Central region, Furnas was committed for 1968 and the subsequent years to supply power in bulk to other utilities (Light Rio, CEMIG and Companhia Paulista de Forca e Luz (CPFL)); these commitments were covered by power contracts made on conventional lines as required by the Loan Agreement 403-474-BR (1965-1966). In order to provide adequate capacity to meet the contract commitments, Furnas had in 1968 an expansion program for 1969-1974

which included the completion of the Funil and Estreito hydroelectric plants, the extension by 400 MW of the Santa Cruz thermal plant with the help of a U.S. AID loan (see para. 7.02) and the Porto Colombia hydroelectric project downstream from the Furnas and Estreito hydroelectric stations. The Bank made in 1968 the loan 565-BR of US\$ 22.3 million to cover the estimated cost of equipment to be purchased after international competitive bidding, including contracts won by Brazilian suppliers, for a project to be completed in Spring 1974 consisting of the 360 MW Porto Colombia plant, the construction of a 345 kv transmission line to connect the plant to the terminus of the Furnas system at Estreito and 138 kv transmission facilities for connection to the Paulista system. Loan Agreement covenants and side letters were the same as in the previous Loan Agreement 404-474-BR (1965-1966).

2.07 Among the projects which had been under Furnas' study since 1967 was the Marimbondo hydroelectric project with a 1,400 MW installed capacity. ~~An~~ <sup>The</sup> updating review of the Canambra demand-projection made in 1968 by Electrobras projected an annual rate of expansion of demand by 9% over 1969-1980 and indicated a small shortage of energy in the South-Central region by 1974-1975, so that, to avoid substantial shortages in reserve capacity starting then, it was necessary to add the final two units to the Furnas plant by 1973-1974 and to put the Marimbondo plant in operation in early 1975. The Bank made in 1970 the loan 677-BR to partially finance a project consisting in the construction of the Marimbondo plant, associated transmission at 500 kv



between the plant and Rio de Janeiro, and 300 MW generator capacity in the existing Furnas plant. The project was estimated to cost \$287 million, of which \$57.7 million in foreign exchange; the external financing was arranged to be US\$ 106 million, of which \$80 million to be provided by the Bank loan and \$26 million by supplier credits from industrialized countries under joint financing arrangements. On the basis of past experience, Brazilian manufacturers were expected to secure a substantial part of the equipment orders, and these would be financed entirely by the Bank; financing for other equipment would be provided on a 50/50 basis by the Bank and the countries in which contracts were placed. In addition to the covenants adopted in the previous Loan Agreements, Furnas agreed to make its best efforts to obtain joint loans.

### III. The Power Sector in the South-Central Region of Brazil

#### Coordination

3.01 Some ten public utilities have been supplying electric power in the South-Central region. The Federal Government sector, which accounts for more than half of the total capacity in the area, is headed by Eletrobras, a majority stockholder in its subsidiary (Federal) companies. Eletrobras administers public funds to expand the Federal power systems and makes loans to state utilities. Eight of these utilities, including the four major ones (para. 1.03) have received over the period 1949-1970 twenty loans from the Bank totalling US\$ 597 million, of which \$363.3 million were disbursed by the end of 1970. Prior to the 1964 tariff regulation revisions, the private capital companies which are the

principal distributors had not been allowed to earn sufficient income to expand their distribution systems so that they were by then at the saturation point, with frequent load shedding and substantial repressed demand as a result. As required in the 403-BR Loan Agreement, the Government took effective action to develop the distribution systems in the area commensurately with the expansion of generation and transmission facilities. Four Bank loans (475-478-BR of December 1966) totaling US\$ 61.6 million (of which \$28 million were disbursed by the end of 1970) have been helping the rehabilitation and expansion of four distribution systems in the area; a U.S. AID loan of US\$ 40 million to Light helped finance a program of distribution improvements in Rio de Janeiro and Sao Paulo; and other companies in the region, with the improved earnings based on revalued assets permitted since 1964, have been engaged in similar programs. The Rio Light system which was the only one by 1960 operating at 50 cycles was gradually converted to 60 cycles in order to facilitate exchanges of energy; conversion was completed early in 1971.

3.02 The urging of the foreign and international lending agencies has also been important with respect to coordination of the planning and operations of electric power facilities in the area (Covenants to Loan Agreements 211-BR and 403-474-BR). The priority list of power development sites provided in the Canambra study made in 1963-1966 under a UNDP grant (para. 2.04) was followed by the main utilities concerned (Furnas, CESP, CEMIG) and by the lending agencies in orienting their assistance. Despite the reluctance of some utilities, a system

interconnection committee which had been recommended by the Bank since 1958 (para. 2.03) was eventually established in 1968 and has met regularly since under Furnas' lead to coordinate operations. There still does not exist, however, inter-utility load dispatch centers, but the first one is expected to be established in Furnas by 1972. An important step toward the orderly marketing of power in the region was the signature of marketing and pooling agreements in 1968, concretized by regular long-term power contracts between Furnas and its present customer companies and by the agreement that Furnas would market energy from the 250 MW expansion of the Peixoto plant owned by the CPFL.

#### Tariffs

3.03 Prior to 1964, tariffs were based on historic value of investments and became unrealistic as inflation developed, causing many utilities to incur losses. The 1964 decrees, which had been expected to be passed shortly after Loan 211-BR was made in 1958 (para. 2.03), allowed utilities to revalue their investment, and the 1966 legislation made yearly revaluation of assets mandatory. Under the decrees tariffs were allowed to yield revenues covering: (a) operating costs and income taxes; (b) provisions for depreciation and "amortization"<sup>1/</sup> up to a maximum of 5% of gross fixed assets for each; and (c) a return of 10% (after taxes) on the estimated net plant in service at the end of the year plus some allowance for working capital. Applications for tariff adjustments, which have to be approved by the Ministry of Mines and

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<sup>1/</sup> This provision for "amortization" is not based on actual debt repayments but is intended to pay off the whole investment over the concession period.

Energy, are thus based on analyses of anticipated operating costs during the year in which the tariffs will apply and anticipated net plant in service at the end of that year, with allowances for expected interim inflation on both items. In the accounts of the utilities, by contrast, assets actually in existence at the end of each year are revalued by the official price correction factor applying to the previous year -- simply for reasons of timing in the issuance of the official price correction factors. Tariff adjustments are also permitted to recover shortfalls in achieving the 10% return, and these may be made at two year intervals.

3.04 The implementation of the revaluation and tariff adjustment provisions were not satisfactory during the initial years after 1964, because many of the provisions were at first permissive rather than obligatory and some utilities hesitated to adopt them wholly or partly. The Bank was concerned that different tariff policies might be followed by interconnected utilities, leading to the use of conflicting principles in calculating the cost of power blocks and resulting in economic decisions based on erroneous assumptions. During negotiations for Loan 474-BR, the Government objected to the Bank's proposed tariff covenants, and negotiations were suspended until legislation was changed by measures alleviating much of the Bank's concerns. Furnas took immediate and full advantage of the new regulations and, after revaluing its 1963 and 1964 assets, obtained corresponding tariff increases in early and mid-1965. As a result of this and the maximum permitted 5% rates taken by Furnas for both depreciation and amortization, tariffs introduced in mid-1965 were four times the 1964 tariffs. CEMIG which had the right to purchase Furnas power did not do so in 1965, although Furnas had both the

capacity and energy available due to a good water year; hence, Furnas did not market all of its power in that year. This was due to the substantially higher level of Furnas' wholesale tariff in comparison with both alternative sources and the retail tariffs of CEMIG which had revalued its assets only for 1963 and charged depreciation at 3% only. Expert assistance was needed in 1967 to reach agreement upon the power contract. During negotiations for Loan 474-BR (1966) and 565-BR (1968), Furnas indicated to the Bank that when CEMIG would purchase large amounts of power starting in 1968 it would lower its 5% depreciation rate to a normal rate (estimated at 2.5%) based on the lives of its assets and eliminate its provision for amortization which had been reduced to 3% according to changes in regulations. At first Furnas did not reduce its provisions for depreciation and amortization, but the Government in 1969 restricted the depreciation rate to a maximum of 3%. Furnas' inability to market part of its power resulted also from its tariff structure. The demand charge which accounts for 90% of Furnas' revenues not only reflects the high depreciation charges but also allocates total capital cost to actual sales rather than to available capacity. There has been in addition a "ratchet" provision by which the highest demand registered in a given month establishes the charge for the year, regardless of subsequent demands. If Furnas had marketed all its available power, its demand charges could have been lower and its total revenues greater.

3.05 The average price per kwh sold by Furnas grew from US¢ 0.5 in 1964 to US¢ 1.4 in 1966, and US¢ 1.6 in 1970 (including indirect

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taxes paid by ultimate consumers which amount to about 30% of the base tariff). The increase of US¢ 0.66 which occurred in 1965 reflects the triple impact of the foregone revenue due to the non-marketed Furnas power (US¢ 0.2), of the first revaluation of Furnas' assets and of the increases in depreciation costs. The guaranteed rate of return in Furnas' concession might endanger the efficiency of Furnas since increases in operating costs due to labor pressure or operational inefficiency as well as decreases in sales (due to inability to sell the power as in 1965 or as in 1970) would be compensated for by tariff increases borne by the consumers.

#### IV. Load Forecasting and Investment Planning

4.01 The construction of the Furnas plant and the establishment of the company was originally based on the projections made in 1958 for the power market in the South-Central region (para. 2.02). The demand in the area was expected to grow at 10.8% p.a. over 1958-1970 from 2,600 MW to 8,800 MW and, with the then existing investment programs of the utilities supplying the area, the power deficit would grow from 122 MW in 1962 to about 4,400 MW in 1970 (see following table, item 4); the Furnas plant with its final capacity of 1,100 MW was expected to reduce the deficit temporarily and further new projects totalling some 3,000 MW by 1970 would have to be built between 1965 and 1970. The output of the first stage of Furnas was expected to be fully absorbed as it was built, and the output of the complete plant by 1965.

4.02 Although the full 3,000 MW deficit projected was never made up, installed capacity in the South-Central region was in fact substantially

higher after 1968 than originally forecast, mainly due to the greater capacity of the Furnas Company itself, as illustrated by the following table (summary of Table II-A.1):

	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>
<u>Forecasts (MW)</u>						
1. Installed capacity in South-Central region	5208	5328	5388	5448	5448	5448
2. Installed capacity of Furnas	1104	1104	1104	1104	1104	1104
3. Deficit with Furnas	363	752	1283	1858	2547	3315
4. Deficit without Furnas (2 + 3)	1467	1856	2387	2962	3651	4419
<u>Actual (MW)</u>						
5. Installed capacity in South-Central region	4910	5058	5267	5485	6451	6803
6. Installed capacity of Furnas	900	900	980	1260	2154	2294
<u>Difference between Forecast and Actual Capacity</u>						
7. In the South-Central region (1 - 5)	298	270	121	(37)	(1003)	(1355)
8. Of Furnas (2 - 6)	204	204	124	(156)	(1050)	(1190)

The expected power deficit turned out actually to be a gross reserve capacity exceeding 1,000 MW in 1964-1966, and peaking at 1,350 MW in 1969 with the increase of capacity which took place between 1968 and 1969, or about 25% of demand in 1969. This was due mainly to a lower level of

demand, which grew only by 8.3% p.a. over 1958-1970 and reached 5,830 MW in 1970 as against 8,760 MW forecast. The slower growth of demand was due primarily to the economic slowdown which took place in 1963-1967 but also to the deficiencies in the distribution systems of electricity in the area which could not carry the whole demand through to the generation level (para. 3.01).

4.03 The output from Furnas was fully absorbed in 1963-1964 and after 1967, but part of Furnas' capacity was not marketed in 1964 to 1967 because of a lower demand from its shareholders and clients (economic slow-down and insufficient substation capacity) and because of Furnas' high tariffs (para. 3.04). For these reasons, and also because Furnas' installed capacity up to 1968 was lower than forecast, revenues and operating income during 1963-1967 were substantially lower than expected in the first appraisal report. The financial return, however, reached satisfactory levels after 1964 when legislation for tariff increases was changed to yield satisfactory returns.

4.04 Forecasts made in the second appraisal report (1965) for the period 1965-1970 underestimated substantially Furnas' expansion, sales and income during this period. Installed capacity was expected to increase from 900 MW in 1965-1969 to 1,430 MW in 1970. Sales and income were expected to increase by about 15% p.a. on average between 1965 and 1970. The larger capacity installed in the Estreito plant and the acquisition by Furnas of the Chevap properties and Peixoto plant facilities (paras. 3.02 and 7.02) led to an installed capacity in 1970 outgrowing by far the forecasts; sales, revenues and incomes were actually substantially larger than expected. The financial return

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(after taxes) was higher, except in 1969, than the expected 9% (Table II-A.2).

4.05 The records on the effective-peak spare capacity indicate that the large investments made by Furnas have been necessary to meet the demand. Small load shedding occurred in 1963 and 1964. Spare capacity at the effective peak was between 30 MW and 80 MW in 1965-1967 (para. 4.02) but decreased to less than 10 MW in 1968-1969. Furnas was severely affected in 1970 by drought, which reduced its capacity to meet demand and caused energy sales to fall 7% from 1969.

#### V. Project Implementation and Costs

5.01 Two plants out of the four financed by Bank loans to Furnas have been partly completed, i.e., the Furnas and Estreito plants aggregating 1,600 MW. An extensive transmission network partly financed by Bank loans has also been completed.

5.02 The first stage of the Furnas hydroelectric plant financed by the Loan 211-BR (1958) had been originally planned to consist of five 92 MW or four 110 MW generating sets, the size depending on the weights to be transported over the Brazilian railroads. The capacity was to be expanded ultimately to about 1,100 MW in a second stage expected to follow quickly on the first stage, scheduled for completion in June 1963. Subsequent investigation showed the desirability of installing four 150 MW units in the first stage, and a corresponding change in the description of the project in the Loan Agreement was approved in June 1959. In view of the low prices obtained for the electrical equipment, the project was again increased with Bank consent to

six 150 MW units which did not increase the foreign cost but did affect the local cost.

5.03 Construction of the first stage of the Furnas plant began in June 1958. The first unit was commissioned in September 1963 and the fourth in September 1964, that is with a 15-month delay behind schedule due to the large amount of excavation in excess of that originally estimated. The last unit was commissioned in May 1965. Transmission lines were originally designed to connect the plant to Sao Paulo and to Lafaete and were actually built between the plant and Sao Paulo and Belo Horizonte. The first line to Sao Paulo started operating in September 1963; the line to Belo Horizonte had been completed in September 1960. Total cost of the 900 MW plant was \$130 million, and about \$27 million for the transmission lines and substations (Table III). The total foreign exchange cost of \$58 million (excluding \$14.4 million interest during construction) did not exceed the appraisal estimates; the local cost for generation and transmission together was 36% higher than expected. Due to the doubling of installed capacity, the unit cost has been \$145 per kw installed against \$236 estimate. Most of the equipment was supplied by foreign manufacturers after international competitive bidding, and the civil works contract was won by a British firm in association with a Brazilian firm.

5.04 Substantial savings were made also on the equipment cost of the Estreito hydroelectric plant financed by the Loan 403-474-BR (1965-1966) and originally designed to receive four 133 MW units. Because of very good foundation conditions, work progressed satisfactorily and the

first four 175 MW units were commissioned between March and November 1969, more than one year ahead of schedule. Due to the good prices obtained for equipment, the Bank agreed in 1968 to permit use of loan savings to add to the plant two more 175 MW units, expected to be in operation in 1972, and to extend the project transmission lines from 1,060 km to 1,560 km. By the end of 1970, 560 km had been erected and the \$57 million Loan 403-BR was nearly fully disbursed. The \$39 million Loan 474-BR will be used to finance the two additional units in the plant and the remaining transmission lines amounting to about 1,000 km. Total cost of the 700 MW first stage of Estreito and its associated minimum 160 km transmission lines has been \$96 million, of which \$22 million for foreign exchange, leading to a unit cost of \$137 per kw installed against \$153 forecast. The 400 km of transmission lines already completed cost \$23 million, of which \$9.6 million for foreign components. Out of the \$44.2 million disbursed from the Loan 403-BR for purchases of materials and equipment, \$12.8 million were used to finance equipment from Brazilian manufacturers who won, with the 15% protection, about 30% of the orders.

#### VI. Financing of the Investment Programs

6.01 Although there were in 1958 no definite plans for the financing of the second stage of the Furnas plant, the Furnas Company was planning to invest \$303 million over 1958-1965 for the construction of the 1,100 MW Furnas plant, of which \$209 million for the first stage of the plant and its associated transmission (Table II-B). Foreign

borrowing was expected to contribute \$127 million (42% of total), of which \$54 million for the second stage from unspecified sources. The expected \$156 million (51% of total) domestic contribution was to come mainly from loans from the BNDE and the Federal Electrification Fund, with share capital from the shareholders representing \$52 million, equivalent to 17% of total required funds. Net internal cash generation was expected to contribute \$20 million after 1963 to the cost of the second stage.

6.02 Actual investments amounted to \$227 million during 1958-1965; this was the result of the low cost of the first phase of Furnas (para. 5.03), of the non-implementation of the second phase and of additional transmission investments (transmission line from Furnas to Rio) financed with the help of a \$17.6 million U.S. AID loan after 1964. Foreign borrowing amounted to about \$74 million representing 32% of total required funds, of which \$1 million from the first disbursements from the U.S. AID loan. Total domestic contribution was \$147 million (63% of total), most of it in the form of loans from the public sector; share capital was only \$24 million because the shareholders did not have sufficient funds before 1964 as a result of the inflation and the lack of adequate tariff legislation. Furnas' own resources contributed only \$10 million, due to the delay in the commissioning of the plant with resulting reduced earnings in 1963 (para. 5.03).

6.03 The investment program for the period 1964-1970, as forecast in the second appraisal report (1965), was to comprise the completion of the Furnas plant's first stage with its six units and associated

transmission, and the two stages of the Estreito project to be covered by loans 403-474-BR. The cost of this investment program was estimated at \$217 million. Furnas' own resources were expected to cover one third of total required funds, loans from the public sector (Eletrobras) 20%, and foreign borrowing was projected to amount to \$111 million of which \$17.6 million from U.S. AID for the additional transmission line from Furnas to Rio. Actual investments were more than twice the expected amount. Investments on Furnas and Estreito plants and transmission facilities amounted to \$230 million, the acquisition of Chevap's properties in 1967 cost \$81 million (see para. 7.02) and investments in the acquired Funil and Santa Cruz plants were \$111 million; initial work on the new projects of Porto Colombia (Loan 565-BR) and Marimbondo (Loan 677-BR) took \$35 million investments. Furnas was still able to finance 30% of required funds from its own resources; the public sector had to increase substantially its contribution to \$239 million (48% of total), primarily in the form of share capital and loans. Foreign borrowing contributed only 22% to total required funds, amounting to \$112 million of which \$60 million only from the Bank (para. 5.04) and \$52 million from U.S. AID which transferred to Furnas its first loan of US\$ 15.5 million to Chevap for the Santa Cruz plant (para. 7.02) and also made in 1967 a second loan of US\$ 41.2 million for the extension of this plant.

## VII. Institutional Development

7.01 The management of the Furnas Company in 1958 was drawn from the electricity supply industry in Brazil and composed of a group of competent executives with extensive experience in this field. The organization of

Furnas has developed well, due to this aggressive and competent management and to the technical and financial assistance furnished by the Bank and other lenders. All Bank loans have included funds for personnel training, and some 100 employees have been sent since 1960 to the United States and European countries for graduate study and training in technical and financial matters. Some buildings at the Furnas Dam were converted into a training school for operation and maintenance technicians drawn from all utilities in Brazil. Furnas' financial statements have been audited since 1958 by the Brazilian branch of Arthur Andersen and Company; as required by the Loan Agreement 403-474-BR (1965-1966), Furnas, when converting to an operating company, contracted with Arthur Andersen Company to reorganize the accounting department, train accounting personnel and supervise the installation of a computerized accounting system. The contract was satisfactorily completed in 1966-1967. Furnas has employed consulting engineers and contractors when necessary to complement its own forces for the design and construction of its large investment program. Planning for the Marimbondo transmission system (Loan 677-BR of 1970) at 500 kv, a voltage which is relatively new, has been assisted by consultant firms specializing in this field. Relations of Furnas with its consultants and services rendered by the latter have been satisfactory.

7.02 Over 1963-1970, total revalued net fixed assets of Furnas increased from NCr 192 million to NCr 2,634 million. This large increase consisted of three elements: (1) the large construction program, (2) revaluation of assets, and (3) the acquisition in 1967 of the assets of the

Companhia Hidroelétrica do Vale do Paraíba (Chevap). Chevap had under construction since 1963 two generating stations intended to supply the Rio market: the 160 MW Santa Cruz thermal plant (near Rio) scheduled to be in service by 1967 and the 210 MW Funil hydroelectric plant scheduled for 1969. Construction had been financed by loans from Eletrobras and U.S. AID. The Government, in view of Chevap's unsatisfactory organization, rescinded in 1965 the concession granted to Chevap, which was taken over by Eletrobras. In 1967, the Government transferred the former Chevap concessions and assets to Furnas who obtained the Bank's consent.

7.03 Financing for Furnas' large assets originally came from borrowing from Eletrobras and others, and the debt/equity ratio in 1964 was 82/18. In 1964 and 1965, Eletrobras converted substantial parts of its long-term loans to Furnas into share capital, which is presently almost entirely owned by Eletrobras. This and the systematic reinvestment into equity of the dividends paid to the shareholders brought the debt/equity ratio under the 67/33 debt limitation (provided in the Loan Agreements) for 1965 and following years.

7.04 Other management indicators reflect the sound financial situation of Furnas due to the automatic adjustments of tariffs. The financial rate of return of Furnas has been steadily over 9%, except in 1964 before the tariff increases and in 1965 when Furnas did not market all its capacity (para. 3.04). Dividend payments on share capital have increased from 4% in 1965 to more than 12% in 1970. Furnas has been able since 1964 to finance 30% of its investments from its own resources, this proportion being about 50% in 1970.

7.05 The average cost per kwh sold, however, increased from US¢ 0.2 in 1963-1964 to US¢ 0.4 in 1965 and US¢ 0.6 in 1970. Depreciation and amortization provisions share in cost increased from 67% in 1964 to 90% in 1965 and 1966 and decreased after 1967 to about 60%, amortization being responsible for about half of this, as shown in the following table:

		<u>Average Cost/kwh Sold (US¢)</u>						
		<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>
1.	Depreciation	0.10	0.21	0.24	0.22	0.12	0.14	0.17
2.	Amortization	<u>0.07</u>	<u>0.15</u>	<u>0.16</u>	<u>0.16</u>	<u>0.15</u>	<u>0.14</u>	<u>0.18</u>
3.	Sub-total	0.17	0.36	0.40	0.38	0.27	0.28	0.35
4.	Fuel	-	-	-	0.01	0.07	0.06	0.03
5.	Energy Purchases	-	-	-	-	0.11	0.14	0.12
6.	Administration	0.02	0.01	0.01	0.02	0.02	0.01	0.02
7.	Others	<u>0.01</u>	<u>0.02</u>	<u>0.03</u>	<u>0.04</u>	<u>0.04</u>	<u>0.04</u>	<u>0.06</u>
8.	Sub-total	<u>0.03</u>	<u>0.03</u>	<u>0.04</u>	<u>0.07</u>	<u>0.24</u>	<u>0.25</u>	<u>0.23</u>
9.	Total Unit Cost	<u>0.20</u>	<u>0.39</u>	<u>0.44</u>	<u>0.45</u>	<u>0.51</u>	<u>0.53</u>	<u>0.58</u>

The average operating cost/kwh sold (excluding depreciation and amortization), shown in line 8, doubled between 1964 and 1967, due principally to labor pressure. The large increase in the average operating cost experienced since 1968 was due for the most part to the operation of the thermal plants (line 4) and to the rents paid for the Peixoto hydro plant (line 5); also the other average operating costs increased, indicating a continuing labor pressure (line 7) and increasing administrative responsibilities (line 6) handed over to Furnas by Government agencies (Eletro-



bras, Ministry of Mines and Energy). The average cost of thermal and purchased energy (about US¢ 1.0) was higher than the average cost in the company's hydroelectric plants (US¢ 0.4).

7.06 The average revenue per kwh sold (excluding indirect taxes) increased from US¢ 0.4 in 1963-1964 to US¢ 0.9 in 1965 due to the first revaluation of assets, and from US¢ 1.1 in 1969 to US¢ 1.3 in 1970 due to the decrease in sales caused by the 1970 drought. Transmission losses (about 5% of the energy sent out) and the amount of capacity out of service for maintenance and failures of equipment have been kept at satisfactory levels.

#### VIII. Conclusion

8.01 The development of Furnas over the 1963-1970 period has been impressive and the Bank's contribution to this achievement substantial; the cooperative and positive attitude of the Federal Government has been an essential factor. Due to its effective management Furnas has been able to build its large plants with substantial savings in costs and in time over original forecasts. It has grown in its short life to service satisfactorily nearly one-third of the total power demand in the large market of the South-Central region of Brazil. Recognition of the Company's capabilities by the Government authorities is indicated by the responsibilities assigned to it to take over Chevap's plants, to build the first nuclear power plant in Brazil, and to lead the committee for coordinating operation and expansion of the power systems in its region. The Bank also appears to have played a useful role in helping to set the financial situation of the Brazilian power sector on a sounder footing, enabling it to keep up with growth of demand more satisfactorily than in the 1950s. However the

steady upward trend in Furnas' real unit costs, due principally to changes in the legislation on depreciation before 1967 and to thermal and purchased energy afterwards but also to a continuous labor pressure -- does raise a question as to whether the existing regulatory structure of the industry provides sufficient incentive to efficiency in operations. Moreover, the tariff structure of Furnas may have introduced some distortion in the power investments for the whole region, since the high revenues it earned have led it to expand its capacity and has led Cemig to build thermal and hydroelectric plants in order to reduce its dependence on the relatively expensive energy supply from Furnas; when Cemig's Sao Simao 1,500 MW hydro plant is completed, Furnas may face some difficulty in selling its energy. To assess the real extent of these problems, if any, would require a more intensive study than has been possible here.

not yet

Doubtful overall regional planning should be taking care of this.

8.02 According to Furnas and the Canabira study, the electric power system in the South-Central region which has been supplied primarily by hydroelectric plants needs to be complemented by thermal plants. Because of the lack of adequate fossil fuels in Brazil, the Government has decided to construct a nuclear plant, the responsibility for which has been given to Furnas in view of its past performance. The nuclear plant of about 500 MW is expected to be constructed during 1972-1978 in order to meet market requirements. It will be necessary also to build other plants in the 1970's and Furnas' present plan, beyond the ongoing projects, is to build the Itumbiara hydroelectric plant (about 1,000 MW) on the Paranaiba River during 1974-1978. The internal capital market is still insufficient and bond issues by Furnas on the foreign market would probably meet Government

?

Doubtful on state builds. But don't they prefer to centralise in its own name

... of ... ?

This implies that Furnas has or will have excess capacity. Is there evidence of this

opposition.] Financing of future investments, therefore, is expected by Furnas to come partly from its own resources, and partly from Eletrobras and Bank loans; the atomic plant would be financed partly by tied supplier credits.

*Parallel supplies just once*

8.03 The Bank loans are still considered by Furnas as a very good source of financing, because of the substantial help received from the Bank in technical and financial matters and because of the low prices obtained from foreign or Brazilian suppliers by international bidding. Equipment has been substantially more expensive when purchased with U.S. AID loans than with Bank loans. However, the use of Bank loans could be hampered in the future by the increasing pressure from the Brazilian industries to supply a major part of the equipment in the projects irrespective of international competitive bidding. Furnas would also prefer not to receive joint financing for its future projects, in view of the substantial administrative costs and complexity involved in arranging such an operation as it experienced in the last Loan 677-BR (1970).

*This is pure speculation without any real base.*

*Parallel?*

## OFFICE MEMORANDUM

TO: Mr. Mervyn L. Weiner → *FA*

FROM: Christopher R. Willoughby *CRW*

SUBJECT: Operations Evaluation Report on Power.

DATE: March 7, 1972

Please find attached the revised drafts of four of the 'case' studies chapters on each individual company part of the Power Review. You will receive within a few days the revised drafts of the chapters on the six remaining companies. These drafts take account of the comments which we received from your Department.

We envisage including a note in the main report to the effect that these case studies will be available on request to the Executive Directors.

We would appreciate it to have these studies once more reviewed by the staff of your Department. In order to expedite processing and enable us to keep on schedule, we have marked in red in the margin the sections of the Preliminary Draft dated 12/22/71 which were changed to take account of your previous comments. We would appreciate it if any further comments you might have could take the form of specific suggestions of changes to be made, and if they were to reach us by Wednesday, March 15th.

We are sending copies of these drafts also to the Area Departments with a request to check the references to countries and country policies.

## CHAPTER III - FURNAS - BRAZIL

### I. Introduction

1.01 <sup>Furnas -</sup> The Centrais Eletricas ~~de Furnas~~ S.A., (FURNAS) was formed in February 1957 and granted in July 1957 a 30-year concession to utilize hydraulic power from the Rio Grande at Furnas Rapids. It is an autonomous Government corporation and the largest subsidiary of Centrais Eletricas Brasileiras, S.A. (ELETROBRAS), a Federal Government holding company created in 1961 to carry out a national electrification plan and implement the Federal Government policy in the electric power sector. More than 95% of Furnas' common and preferred stock is presently owned by Eletrobras.

1.02 The name of the company derives from its first plant built at Furnas Rapids and partly commissioned in 1963 with an initial generating capacity of 300 MW. The installed capacity of the company was about 2,300 MW by the end of 1970, of which about 200 MW were thermal and 1,600 MW were partly financed by Bank loans. The transmission system of Furnas consists of about 2,700 km of transmission lines in operation, most of them at 345 kv; about 1,300 km of existing transmission lines were financed by the Bank. The annual peak demand on Furnas' system grew from 290 MW in 1963 to 2,070 MW in 1970, i.e., by an average of 32% p.a.

1.03 All power generated by Furnas has been sold in bulk under contract to other utilities for resale to the ultimate consumers. These utilities are located in the South-Central region of Brazil; the principal generating companies in the region are:

Centrais Eletricas de Furnas, S.A. (Furnas),  
Centrais Eletricas de Sao Paulo, S.A. (CESP), state-owned  
company,  
Centrais Eletricas de Minas Gerais, S.A. (CEMIG), state-  
owned company, and  
Light Servicos de Eletricidade, S.A. (Light), a subsidi-  
ary of a foreign company.

These companies are interconnected by a transmission system and up until now the major exchange of power has been from Furnas to Light. CESP, which received three loans from the Bank, will supply a large part of the Sao Paulo market; CEMIG received also three Bank loans and supplies the state of Minas Gerais. Furnas is presently the principal supplier of the Rio de Janeiro area where Light will continue to be the principal distributor. The transmission grid makes it possible for these utilities to obtain substantial advantages from coordinated operation; Furnas has taken the lead in organizing recently a Committee for the Coordination of Integrated Operation which includes the companies operating in the South-Central region. This Committee which meets regularly on technical matters is expected to achieve for the region a high quality of service at low cost.

1.04 The South-Central region is the industrial heart of the country; it contains 45% of the country's population, accounts for 40% of its agricultural production and 70% of its industrial production, and consumed in 1970 about 29 billion kwh of electricity or about 78% of the country's total consumption. Commercial and industrial sales of electricity have amounted to nearly 60% of total sales in the region.

A study made under a UNDP grant and updated in 1968 by a market study undertaken by Eletrobras yielded a program for the region's power development through 1980 when total consumption is expected to reach at least 75 billion kwh. The development program is predominantly hydroelectric since there are many such sites that can be developed at low unit cost, whereas the known indigenous fossil fuels are either scarce or of poor quality and remote from the region. All the companies have adhered to the program for their ongoing investments and are expected to continue doing so.

II. The Association Between the Bank and Furnas

2.01 The Furnas Company received over the period 1958-1970 five loans from the Bank as follows:

<u>Loan No.</u>	<u>Date of Agreement</u>	<u>Effective Date</u>	<u>Closing Date</u>	<u>Amounts (\$ mln)</u>		<u>Interest (%)</u>	<u>Period (years)</u>	
				<u>Committed</u>	<u>Disbursed<sup>a/</sup></u>		<u>Grace</u>	<u>Term</u>
211-BR	10/58	2/59	1/66 <sup>b/</sup>	73.0	73.0	5-3/4	5	25
403-474-BR: Tranche I	2/65	7/65	4/72 <sup>c/</sup>	57.0	52.2	5-1/2	6	25
Tranche II	12/66	6/67	6/74 <sup>c/</sup>	39.0	0	6-6-1/4	5	25
565-BR	10/68	2/69	3/75	22.3	1.7	6-1/2	6	25
677-BR	5/70	9/70	8/77	<u>80.0</u>	<u>0</u>	7	7	30
Total				<u>271.3</u>	<u>126.9</u>			

<sup>a/</sup> As of December 31, 1970

<sup>b/</sup> Extended three times from September 1963 to January 1966

<sup>c/</sup> Extended once.

2.02 In 1957, most of Brazil's industry was situated in the South-Central region; the growth of the demand in the area had been between 9% and 14% annually and was expected to grow very rapidly. Generating resources of the eight utilities supplying the area with power were barely sufficient in 1957 to meet the demand. Power plant development promoted by individual utilities was largely parochial and there was no coordinated long-term plan; the power deficit in the area was expected to grow from 11 MW in 1958 to 1010 MW in 1964 and increase faster afterwards. Official Brazilian agencies entered into a joint venture with private foreign-owned power companies to establish and finance Furnas; three of the four entities entering the venture were already directly or indirectly IBRD borrowers. The capital of Furnas was agreed to be 50% common and 50% preferred stock and subscriptions were to be made to a total of Cr 6 billion for the first stage of the Furnas plant with a final capacity of 1100 MW. The electricity produced by the Furnas Company was to be sold only to the shareholders, with 50% of the output assured for supply in the State of Sao Paulo and 50% for supply in the State of Minas Gerais. The Government-controlled National Economic Development Bank (BNDE) was to subscribe 51% of the common stock. Moreover, long-term loans from BNDE and the Federal Electrification Fund were to be made to Furnas to cover the local expenditures of the Furnas plant.

2.03 The Bank made the loan 211-BR to cover the foreign exchange required for the project consisting of the 460 MW first stage of the Furnas plant and associated transmission facilities to be commissioned by mid-1963. Assurances were obtained before the loan became effective that:



- (a) the capital and long-term loans be available as required for the expeditious construction of the project;
- (b) the Company seek to obtain the maximum revenues permitted under the relevant regulations;
- (c) enactment of a bill then before the Brazilian Congress, permitting the periodic revaluation of assets to make public utilities attractive for investment despite the rapid depreciation of the cruzeiro, be pressed through as quickly as possible by the Government.

The Government also agreed to discuss with the Bank the question of setting up a joint planning board in which all major utilities in South-Central Brazil would cooperate in jointly planning the future generation and transmission expansion in order to assure a sound development, both technically and economically.

2.04 Under a UNDP grant administered by the Bank, a consortium of consulting engineers (Canambra) made during 1963-1966 a survey of the requirements and resources of power in the South-Central region and recommended that a group of hydroelectric plants be built to supply the anticipated market. Many of these were to be located on the Rio Grande with transmission systems to connect the cities of Sao Paulo, Rio de Janeiro and Belo Horizonte. The highest priority in this power program was given to the Estreito plant downstream from the Furnas plant and associated transmission, the construction of which was assigned to the Furnas company by the Federal Government. The Bank made the loan 403-474-BR in two steps:

- (a) Loan 403-BR of \$57 million of February 1965 was to finance the Estreito plant with a planned capacity of 533 MW and the minimum transmission facilities needed to connect the plant to the existing transmission system. The plant was to be completed early in 1971.
- (b) A supplementary loan 474-BR of \$39 million was made at the end of 1966 to finance the extension of existing transmission system by about 950 km of 345 kv to be completed early in 1971.

The reasons given for this were that, at the time of the first loan, no decision had been made as to the voltage of the additional transmission facilities needed to carry the full output of Estreito and there was no need to start construction of these lines at the same time as construction of the plant was started; the Bank also preferred to stretch its commitments over two years because its funds were not ample at that time.

2.05 The Bank obtained during negotiations for 403-474-BR assurances that:

- (a) Furnas would revalue its assets at least once a year and apply for adjusted tariffs to produce revenues resulting in at least a 10% return on its average net revalued fixed plants in operation (before taxes);
- (b) Eletrobras would convert into equity such amounts of outstanding long-term debt as to allow debt not to exceed two-thirds of the total net revalued fixed assets;

- (c) the Government would take all necessary action for coordination of operation of facilities of the integrated system which would use Furnas' power, and also take effective action in regard to the expansion of the distribution facilities in the Rio de Janeiro and Sao Paulo areas where many of the distribution systems were at the saturation point because the principal distributing companies had not been allowed to earn sufficient income to expand the systems.

Also, because it was finally agreed by the Bank that Brazilian manufacturers would compete with a 15% maximum protection in the international bidding for the contracts covering materials and equipment to be financed by the proposed loans, a side letter detailed the basis and method for comparing bids of Brazilian and foreign manufacturers.

2.06        Until September 1966, when it began bulk deliveries to CEMIG, Furnas' sole customer was Brazilian Light S.A. for its own market in Sao Paulo. According to arrangements agreed by the Government and the companies involved in the supply of power in the South-Central region, Furnas was committed for 1968 and the subsequent years to supply power in bulk to other utilities (Light Rio, CEMIG and Companhia Paulista de Forca e Luz (CPFL)); these commitments were covered by power contracts made on conventional lines as required by the Loan Agreement 403-474-BR (1965-1966). In order to provide adequate capacity to meet the contract commitments, Furnas had in 1968 an expansion program for 1969-1974

which included the completion of the Funil and Estreito hydroelectric plants, the extension by 400 MW of the Santa Cruz thermal plant with the help of a U.S. AID loan (see para. 7.02) and the Porto Colombia hydroelectric project downstream from the Furnas and Estreito hydroelectric stations. The Bank made in 1968 the loan 565-BR of US\$ 22.3 million to cover the estimated cost of equipment to be purchased after international competitive bidding, including contracts won by Brazilian suppliers, for a project to be completed in Spring 1974 consisting of the 360 MW Porto Colombia plant, the construction of a 345 kv transmission line to connect the plant to the terminus of the Furnas system at Estreito and 138 kv transmission facilities for connection to the Paulista system. Loan Agreement covenants and side letters were the same as in the previous Loan Agreement 404-474-BR (1965-1966).

2.07 Among the projects which had been under Furnas' study since 1967 was the Marimondo hydroelectric project with a 1,400 MW installed capacity. An updating review of the Canambra demand-projection made in 1968 by Eletrobras projected an annual rate of expansion of demand by 9% over 1969-1980 and indicated a small shortage of energy in the South-Central region by 1974-1975, so that, to avoid substantial shortages in reserve capacity starting then, it was necessary to add the final two units to the Furnas plant by 1973-1974 and to put the Marimondo plant in operation in early 1975. The Bank made in 1970 the loan 677-BR to partially finance a project consisting in the construction of the Marimondo plant, associated transmission at 500 kv

between the plant and Rio de Janeiro, and 300 MW generator capacity in the existing Furnas plant. The project was estimated to cost \$287 million, of which \$57.7 million in foreign exchange; the external financing was arranged to be US\$ 106 million, of which \$80 million to be provided by the Bank loan and \$26 million by supplier credits from industrialized countries under joint financing arrangements. On the basis of past experience, Brazilian manufacturers were expected to secure a substantial part of the equipment orders, and these would be financed entirely by the Bank; financing for other equipment would be provided on a 50/50 basis by the Bank and the countries in which contracts were placed. In addition to the covenants adopted in the previous Loan Agreements, Furnas agreed to make its best efforts to obtain joint loans.

### III. The Power Sector in the South-Central Region of Brazil

#### Coordination

3.01 Some ten public utilities have been supplying electric power in the South-Central region. The Federal Government sector, which accounts for more than half of the total capacity in the area, is headed by Eletrobras, a majority stockholder in its subsidiary (Federal) companies. Eletrobras administers public funds to expand the Federal power systems and makes loans to state utilities. Eight of these utilities, including the four major ones (para. 1.03) have received over the period 1949-1970 twenty loans from the Bank totalling US\$ 597 million, of which \$363.3 million were disbursed by the end of 1970. Prior to the 1964 tariff regulation revisions, the private capital companies which are the

principal distributors had not been allowed to earn sufficient income to expand their distribution systems so that they were by then at the saturation point, with frequent load shedding and substantial repressed demand as a result. As required in the 403-BR Loan Agreement, the Government took effective action to develop the distribution systems in the area commensurately with the expansion of generation and transmission facilities. Four Bank loans (475-478-BR of December 1966) totaling US\$ 61.6 million (of which \$28 million were disbursed by the end of 1970) have been helping the rehabilitation and expansion of four distribution systems in the area; a U.S. AID loan of US\$ 40 million to Light helped finance a program of distribution improvements in Rio de Janeiro and Sao Paulo; and other companies in the region, with the improved earnings based on revalued assets permitted since 1964, have been engaged in similar programs. The Rio Light system which was the only one by 1960 operating at 50 cycles was gradually converted to 60 cycles in order to facilitate exchanges of energy; conversion was completed early in 1971.

3.02 The urging of the foreign and international lending agencies has also been important with respect to coordination of the planning and operations of electric power facilities in the area (Covenants to Loan Agreements 211-BR and 403-474-BR). The priority list of power development sites provided in the Canambra study made in 1963-1966 under a UNDP grant (para. 2.04) was followed by the main utilities concerned (Furnas, CESP, CEMIG) and by the lending agencies in orienting their assistance. Despite the reluctance of some utilities, a system

interconnection committee which had been recommended by the Bank since 1958 (para. 2.03) was eventually established in 1968 and has met regularly since under Furnas' lead to coordinate operations. There still does not exist, however, inter-utility load dispatch centers, but the first one is expected to be established in Furnas by 1972. An important step toward the orderly marketing of power in the region was the signature of marketing and pooling agreements in 1968, concretized by regular long-term power contracts between Furnas and its present customer companies and by the agreement that Furnas would market energy from the 250 MW expansion of the Peixoto plant owned by the CPFL.

#### Tariffs

3.03 Prior to 1964, tariffs were based on historic value of investments and became unrealistic as inflation developed, causing many utilities to incur losses. The 1964 decrees, which had been expected to be passed shortly after Loan 211-BR was made in 1958 (para. 2.03), allowed utilities to revalue their investment, and the 1966 legislation made yearly revaluation of assets mandatory. Under the decrees tariffs were allowed to yield revenues covering: (a) operating costs and income taxes; (b) provisions for depreciation and "amortization"<sup>1/</sup> up to a maximum of 5% of gross fixed assets for each; and (c) a return of 10% (after taxes) on the estimated net plant in service at the end of the year plus some allowance for working capital. Applications for tariff adjustments, which have to be approved by the Ministry of Mines and

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<sup>1/</sup> This provision for "amortization" is not based on actual debt repayments but is intended to pay off the whole investment over the concession period.

Energy, are thus based on analyses of anticipated operating costs during the year in which the tariffs will apply and anticipated net plant in service at the end of that year, with allowances for expected interim inflation on both items. In the accounts of the utilities, by contrast, assets actually in existence at the end of each year are revalued by the official price correction factor applying to the previous year -- simply for reasons of timing in the issuance of the official price correction factors. Tariff adjustments are also permitted to recover shortfalls in achieving the 10% return, and these may be made at two year intervals.

3.04 The implementation of the revaluation and tariff adjustment provisions were not satisfactory during the initial years after 1964, because many of the provisions were at first permissive rather than obligatory and some utilities hesitated to adopt them wholly or partly. The Bank was concerned that different tariff policies might be followed by interconnected utilities, leading to the use of conflicting principles in calculating the cost of power blocks and resulting in economic decisions based on erroneous assumptions. During negotiations for Loan 474-BR, the Government objected to the Bank's proposed tariff covenants, and negotiations were suspended until legislation was changed by measures alleviating much of the Bank's concerns. Furnas took immediate and full advantage of the new regulations and, after revaluing its 1963 and 1964 assets, obtained corresponding tariff increases in early and mid-1965. As a result of this and the maximum permitted 5% rates taken by Furnas for both depreciation and amortization, tariffs introduced in mid-1965 were four times the 1964 tariffs. CEMIG which had the right to purchase Furnas power did not do so in 1965, although Furnas had both the



capacity and energy available due to a good water year; hence, Furnas did not market all of its power in that year. This was due to the substantially higher level of Furnas' wholesale tariff in comparison with both alternative sources and the retail tariffs of CEMIG which had revalued its assets only for 1963 and charged depreciation at 3% only. Expert assistance was needed in 1967 to reach agreement upon the power contract. During negotiations for Loan 474-BR (1966) and 565-BR (1968), Furnas indicated to the Bank that when CEMIG would purchase large amounts of power starting in 1968 it would lower its 5% depreciation rate to a normal rate (estimated at 2.5%) based on the lives of its assets and eliminate its provision for amortization which had been reduced to 3% according to changes in regulations. At first Furnas did not reduce its provisions for depreciation and amortization, but the Government in 1969 restricted the depreciation rate to a maximum of 3%. Furnas' inability to market part of its power resulted also from its tariff structure. The demand charge which accounts for 90% of Furnas' revenues not only reflects the high depreciation charges but also allocates total capital cost to actual sales rather than to available capacity. There has been in addition a "ratchet" provision by which the highest demand registered in a given month establishes the charge for the year, regardless of subsequent demands. If Furnas had marketed all its available power, its demand charges could have been lower and its total revenues greater.

3.05      The average price per kwh sold by Furnas grew from US¢ 0.5 in 1964 to US¢ 1.4 in 1966, and US¢ 1.6 in 1970 (including indirect

taxes paid by ultimate consumers which amount to about 30% of the base tariff). The increase of US¢ 0.66 which occurred in 1965 reflects the triple impact of the foregone revenue due to the non-marketed Furnas power (US¢ 0.2), of the first revaluation of Furnas' assets and of the increases in depreciation costs. The guaranteed rate of return in Furnas' concession might endanger the efficiency of Furnas since increases in operating costs due to labor pressure or operational inefficiency as well as decreases in sales (due to inability to sell the power as in 1965 or as in 1970) would be compensated for by tariff increases borne by the consumers.

#### IV. Load Forecasting and Investment Planning

4.01 The construction of the Furnas plant and the establishment of the company was originally based on the projections made in 1958 for the power market in the South-Central region (para. 2.02). The demand in the area was expected to grow at 10.8% p.a. over 1958-1970 from 2,600 MW to 8,800 MW and, with the then existing investment programs of the utilities supplying the area, the power deficit would grow from 122 MW in 1962 to about 4,400 MW in 1970 (see following table, item 4); the Furnas plant with its final capacity of 1,100 MW was expected to reduce the deficit temporarily and further new projects totalling some 3,000 MW by 1970 would have to be built between 1965 and 1970. The output of the first stage of Furnas was expected to be fully absorbed as it was built, and the output of the complete plant by 1965.

4.02 Although the full 3,000 MW deficit projected was never made up, installed capacity in the South-Central region was in fact substantially

higher after 1968 than originally forecast, mainly due to the greater capacity of the Furnas Company itself, as illustrated by the following table (summary of Table II-A.1):

	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>
<u>Forecasts (MW)</u>						
1. Installed capacity in South-Central region	5208	5328	5388	5448	5448	5448
2. Installed capacity of Furnas	1104	1104	1104	1104	1104	1104
3. Deficit with Furnas	363	752	1283	1858	2547	3315
4. Deficit without Furnas (2 + 3)	1467	1856	2387	2962	3651	4419
<u>Actual (MW)</u>						
5. Installed capacity in South-Central region	4910	5058	5267	5485	6451	6803
6. Installed capacity of Furnas	900	900	980	1260	2154	2294
<u>Difference between Forecast and Actual Capacity</u>						
7. In the South-Central region (1 - 5)	298	270	121	(37)	(1003)	(1355)
8. Of Furnas (2 - 6)	204	204	124	(156)	(1050)	(1190)

The expected power deficit turned out actually to be a gross reserve capacity exceeding 1,000 MW in 1964-1966, and peaking at 1,350 MW in 1969 with the increase of capacity which took place between 1968 and 1969, or about 25% of demand in 1969. This was due mainly to a lower level of

demand, which grew only by 8.3% p.a. over 1958-1970 and reached 5,830 MW in 1970 as against 8,760 MW forecast. The slower growth of demand was due primarily to the economic slowdown which took place in 1963-1967 but also to the deficiencies in the distribution systems of electricity in the area which could not carry the whole demand through to the generation level (para. 3.01).

4.03 The output from Furnas was fully absorbed in 1963-1964 and after 1967, but part of Furnas' capacity was not marketed in 1964 to 1967 because of a lower demand from its shareholders and clients (economic slow-down and insufficient substation capacity) and because of Furnas' high tariffs (para. 3.04). For these reasons, and also because Furnas' installed capacity up to 1968 was lower than forecast, revenues and operating income during 1963-1967 were substantially lower than expected in the first appraisal report. The financial return, however, reached satisfactory levels after 1964 when legislation for tariff increases was changed to yield satisfactory returns.

4.04 Forecasts made in the second appraisal report (1965) for the period 1965-1970 underestimated substantially Furnas' expansion, sales and income during this period. Installed capacity was expected to increase from 900 MW in 1965-1969 to 1,430 MW in 1970. Sales and income were expected to increase by about 15% p.a. on average between 1965 and 1970. The larger capacity installed in the Estreito plant and the acquisition by Furnas of the Chevap properties and Peixoto plant facilities (paras. 3.02 and 7.02) led to an installed capacity in 1970 outgrowing by far the forecasts; sales, revenues and incomes were actually substantially larger than expected. The financial return

(after taxes) was higher, except in 1969, than the expected 9% (Table II-A.2).

4.05 The records on the effective-peak spare capacity indicate that the large investments made by Furnas have been necessary to meet the demand. Small load shedding occurred in 1963 and 1964. Spare capacity at the effective peak was between 30 MW and 80 MW in 1965-1967 (para. 4.02) but decreased to less than 10 MW in 1968-1969. Furnas was severely affected in 1970 by drought, which reduced its capacity to meet demand and caused energy sales to fall 7% from 1969.

#### V. Project Implementation and Costs

5.01 Two plants out of the four financed by Bank loans to Furnas have been partly completed, i.e., the Furnas and Estreito plants aggregating 1,600 MW. An extensive transmission network partly financed by Bank loans has also been completed.

5.02 The first stage of the Furnas hydroelectric plant financed by the Loan 211-BR (1958) had been originally planned to consist of five 92 MW or four 110 MW generating sets, the size depending on the weights to be transported over the Brazilian railroads. The capacity was to be expanded ultimately to about 1,100 MW in a second stage expected to follow quickly on the first stage, scheduled for completion in June 1963. Subsequent investigation showed the desirability of installing four 150 MW units in the first stage, and a corresponding change in the description of the project in the Loan Agreement was approved in June 1959. In view of the low prices obtained for the electrical equipment, the project was again increased with Bank consent to

six 150 MW units which did not increase the foreign cost but did affect the local cost.

5.03 Construction of the first stage of the Furnas plant began in June 1958. The first unit was commissioned in September 1963 and the fourth in September 1964, that is with a 15-month delay behind schedule due to the large amount of excavation in excess of that originally estimated. The last unit was commissioned in May 1965. Transmission lines were originally designed to connect the plant to Sao Paulo and to Lafaiete and were actually built between the plant and Sao Paulo and Belo Horizonte. The first line to Sao Paulo started operating in September 1963; the line to Belo Horizonte had been completed in September 1960. Total cost of the 900 MW plant was \$130 million, and about \$27 million for the transmission lines and substations (Table III). The total foreign exchange cost of \$58 million (excluding \$14.4 million interest during construction) did not exceed the appraisal estimates; the local cost for generation and transmission together was 36% higher than expected. Due to the doubling of installed capacity, the unit cost has been \$145 per kw installed against \$236 estimate. Most of the equipment was supplied by foreign manufacturers after international competitive bidding, and the civil works contract was won by a British firm in association with a Brazilian firm.

5.04 Substantial savings were made also on the equipment cost of the Estreito hydroelectric plant financed by the Loan 403-474-BR (1965-1966) and originally designed to receive four 133 MW units. Because of very good foundation conditions, work progressed satisfactorily and the

first four 175 MW units were commissioned between March and November 1969, more than one year ahead of schedule. Due to the good prices obtained for equipment, the Bank agreed in 1968 to permit use of loan savings to add to the plant two more 175 MW units, expected to be in operation in 1972, and to extend the project transmission lines from 1,060 km to 1,560 km. By the end of 1970, 560 km had been erected and the \$57 million Loan 403-BR was nearly fully disbursed. The \$39 million Loan 474-BR will be used to finance the two additional units in the plant and the remaining transmission lines amounting to about 1,000 km. Total cost of the 700 MW first stage of Estreito and its associated minimum 160 km transmission lines has been \$96 million, of which \$22 million for foreign exchange, leading to a unit cost of \$137 per kw installed against \$153 forecast. The 400 km of transmission lines already completed cost \$23 million, of which \$9.6 million for foreign components. Out of the \$44.2 million disbursed from the Loan 403-BR for purchases of materials and equipment, \$12.8 million were used to finance equipment from Brazilian manufacturers who won, with the 15% protection, about 30% of the orders.

## VI. Financing of the Investment Programs

6.01 Although there were in 1958 no definite plans for the financing of the second stage of the Furnas plant, the Furnas Company was planning to invest \$303 million over 1958-1965 for the construction of the 1,100 MW Furnas plant, of which \$209 million for the first stage of the plant and its associated transmission (Table II-B). Foreign

borrowing was expected to contribute \$127 million (42% of total), of which \$54 million for the second stage from unspecified sources. The expected \$156 million (51% of total) domestic contribution was to come mainly from loans from the BNDE and the Federal Electrification Fund, with share capital from the shareholders representing \$52 million, equivalent to 17% of total required funds. Net internal cash generation was expected to contribute \$20 million after 1963 to the cost of the second stage.

6.02 Actual investments amounted to \$227 million during 1958-1965; this was the result of the low cost of the first phase of Furnas (para. 5.03), of the non-implementation of the second phase and of additional transmission investments (transmission line from Furnas to Rio) financed with the help of a \$17.6 million U.S. AID loan after 1964. Foreign borrowing amounted to about \$74 million representing 32% of total required funds, of which \$1 million from the first disbursements from the U.S. AID loan. Total domestic contribution was \$147 million (63% of total), most of it in the form of loans from the public sector; share capital was only \$24 million because the shareholders did not have sufficient funds before 1964 as a result of the inflation and the lack of adequate tariff legislation. Furnas' own resources contributed only \$10 million, due to the delay in the commissioning of the plant with resulting reduced earnings in 1963 (para. 5.03).

6.03 The investment program for the period 1964-1970, as forecast in the second appraisal report (1965), was to comprise the completion of the Furnas plant's first stage with its six units and associated



transmission, and the two stages of the Estreito project to be covered by loans 403-474-BR. The cost of this investment program was estimated at \$217 million. Furnas' own resources were expected to cover one third of total required funds, loans from the public sector (Eletrobras) 20%, and foreign borrowing was projected to amount to \$111 million of which \$17.6 million from U.S. AID for the additional transmission line from Furnas to Rio. Actual investments were more than twice the expected amount. Investments on Furnas and Estreito plants and transmission facilities amounted to \$230 million, the acquisition of Chevap's properties in 1967 cost \$81 million (see para. 7.02) and investments in the acquired Funil and Santa Cruz plants were \$111 million; initial work on the new projects of Porto Colombia (Loan 565-BR) and Marimbondo (Loan 677-BR) took \$35 million investments. Furnas was still able to finance 30% of required funds from its own resources; the public sector had to increase substantially its contribution to \$239 million (48% of total), primarily in the form of share capital and loans. Foreign borrowing contributed only 22% to total required funds, amounting to \$112 million of which \$60 million only from the Bank (para. 5.04) and \$52 million from U.S. AID which transferred to Furnas its first loan of US\$ 15.5 million to Chevap for the Santa Cruz plant (para. 7.02) and also made in 1967 a second loan of US\$ 41.2 million for the extension of this plant.

## VII. Institutional Development

7.01 The management of the Furnas Company in 1958 was drawn from the electricity supply industry in Brazil and composed of a group of competent executives with extensive experience in this field. The organization of

Furnas has developed well, due to this aggressive and competent management and to the technical and financial assistance furnished by the Bank and other lenders. All Bank loans have included funds for personnel training, and some 100 employees have been sent since 1960 to the United States and European countries for graduate study and training in technical and financial matters. Some buildings at the Furnas Dam were converted into a training school for operation and maintenance technicians drawn from all utilities in Brazil. Furnas' financial statements have been audited since 1958 by the Brazilian branch of Arthur Andersen and Company; as required by the Loan Agreement 403-474-BR (1965-1966), Furnas, when converting to an operating company, contracted with Arthur Andersen Company to reorganize the accounting department, train accounting personnel and supervise the installation of a computerized accounting system. The contract was satisfactorily completed in 1966-1967. Furnas has employed consulting engineers and contractors when necessary to complement its own forces for the design and construction of its large investment program. Planning for the Marimbondo transmission system (Loan 677-BR of 1970) at 500 kv, a voltage which is relatively new, has been assisted by consultant firms specializing in this field. Relations of Furnas with its consultants and services rendered by the latter have been satisfactory.

7.02 Over 1963-1970, total revalued net fixed assets of Furnas increased from NCr 192 million to NCr 2,634 million. This large increase consisted of three elements: (1) the large construction program, (2) revaluation of assets, and (3) the acquisition in 1967 of the assets of the

Companhia Hidroeletrica do Vale do Paraiba (Chevap). Chevap had under construction since 1963 two generating stations intended to supply the Rio market: the 160 MW Santa Cruz thermal plant (near Rio) scheduled to be in service by 1967 and the 210 MW Funil hydroelectric plant scheduled for 1969. Construction had been financed by loans from Eletrobras and U.S. AID. The Government, in view of Chevap's unsatisfactory organization, rescinded in 1965 the concession granted to Chevap, which was taken over by Eletrobras. In 1967, the Government transferred the former Chevap concessions and assets to Furnas who obtained the Bank's consent.

7.03 Financing for Furnas' large assets originally came from borrowing from Eletrobras and others, and the debt/equity ratio in 1964 was 82/18. In 1964 and 1965, Eletrobras converted substantial parts of its long-term loans to Furnas into share capital, which is presently almost entirely owned by Eletrobras. This and the systematic reinvestment into equity of the dividends paid to the shareholders brought the debt/equity ratio under the 67/33 debt limitation (provided in the Loan Agreements) for 1965 and following years.

7.04 Other management indicators reflect the sound financial situation of Furnas due to the automatic adjustments of tariffs. The financial rate of return of Furnas has been steadily over 9%, except in 1964 before the tariff increases and in 1965 when Furnas did not market all its capacity (para. 3.04). Dividend payments on share capital have increased from 4% in 1965 to more than 12% in 1970. Furnas has been able since 1964 to finance 30% of its investments from its own resources, this proportion being about 50% in 1970.

7.05 The average cost per kwh sold, however, increased from US\$ 0.2 in 1963-1964 to US\$ 0.4 in 1965 and US\$ 0.6 in 1970. Depreciation and amortization provisions share in cost increased from 67% in 1964 to 90% in 1965 and 1966 and decreased after 1967 to about 60%, amortization being responsible for about half of this, as shown in the following table:

Average Cost/kwh Sold (US\$)

	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>
1. Depreciation	0.10	0.21	0.24	0.22	0.12	0.14	0.17
2. Amortization	<u>0.07</u>	<u>0.15</u>	<u>0.16</u>	<u>0.16</u>	<u>0.15</u>	<u>0.14</u>	<u>0.18</u>
3. Sub-total	0.17	0.36	0.40	0.38	0.27	0.28	0.35
4. Fuel	-	-	-	0.01	0.07	0.06	0.03
5. Energy Purchases	-	-	-	-	0.11	0.14	0.12
6. Administration	0.02	0.01	0.01	0.02	0.02	0.01	0.02
7. Others	<u>0.01</u>	<u>0.02</u>	<u>0.03</u>	<u>0.04</u>	<u>0.04</u>	<u>0.04</u>	<u>0.06</u>
8. Sub-total	<u>0.03</u>	<u>0.03</u>	<u>0.04</u>	<u>0.07</u>	<u>0.24</u>	<u>0.25</u>	<u>0.23</u>
9. Total Unit Cost	<u>0.20</u>	<u>0.39</u>	<u>0.44</u>	<u>0.45</u>	<u>0.51</u>	<u>0.53</u>	<u>0.58</u>

The average operating cost/kwh sold (excluding depreciation and amortization), shown in line 8, doubled between 1964 and 1967, due principally to labor pressure. The large increase in the average operating cost experienced since 1968 was due for the most part to the operation of the thermal plants (line 4) and to the rents paid for the Peixoto hydro plant (line 5); also the other average operating costs increased, indicating a continuing labor pressure (line 7) and increasing administrative responsibilities (line 6) handed over to Furnas by Government agencies (Eletro-

bras, Ministry of Mines and Energy). The average cost of thermal and purchased energy (about US¢ 1.0) was higher than the average cost in the company's hydroelectric plants (US¢ 0.4).

7.06 The average revenue per kwh sold (excluding indirect taxes) increased from US¢ 0.4 in 1963-1964 to US¢ 0.9 in 1965 due to the first revaluation of assets, and from US¢ 1.1 in 1969 to US¢ 1.3 in 1970 due to the decrease in sales caused by the 1970 drought. Transmission losses (about 5% of the energy sent out) and the amount of capacity out of service for maintenance and failures of equipment have been kept at satisfactory levels.

#### VIII. Conclusion

8.01 The development of Furnas over the 1963-1970 period has been impressive and the Bank's contribution to this achievement substantial; the cooperative and positive attitude of the Federal Government has been an essential factor. Due to its effective management Furnas has been able to build its large plants with substantial savings in costs and in time over original forecasts. It has grown in its short life to service satisfactorily nearly one-third of the total power demand in the large market of the South-Central region of Brazil. Recognition of the Company's capabilities by the Government authorities is indicated by the responsibilities assigned to it to take over Chevap's plants, to build the first nuclear power plant in Brazil, and to lead the committee for coordinating operation and expansion of the power systems in its region. The Bank also appears to have played a useful role in helping to set the financial situation of the Brazilian power sector on a sounder footing, enabling it to keep up with growth of demand more satisfactorily than in the 1950s. However the

steady upward trend in Furnas' real unit costs, due principally to changes in the legislation on depreciation before 1967 and to thermal and purchased energy afterwards but also to a continuous labor pressure -- does raise a question as to whether the existing regulatory structure of the industry provides sufficient incentive to efficiency in operations. Moreover, the tariff structure of Furnas may have introduced some distortion in the power investments for the whole region, since the high revenues it earned have led it to expand its capacity and has led Cemig to build thermal and hydroelectric plants in order to reduce its dependence on the relatively expensive energy supply from Furnas; when Cemig's Sao Simao 1,500 MW hydro plant is completed, Furnas may face some difficulty in selling its energy. To assess the real extent of these problems, if any, would require a more intensive study than has been possible here.

8.02 According to Furnas and the Canambra study, the electric power system in the South-Central region which has been supplied primarily by hydroelectric plants needs to be complemented by thermal plants. Because of the lack of adequate fossil fuels in Brazil, the Government has decided to construct a nuclear plant, the responsibility for which has been given to Furnas in view of its past performance. The nuclear plant of about 500 MW is expected to be constructed during 1972-1978 in order to meet market requirements. It will be necessary also to build other plants in the 1970's and Furnas' present plan, beyond the ongoing projects, is to build the Itumbiara hydroelectric plant (about 1,000 MW) on the Paranaiba River during 1974-1978. The internal capital market is still insufficient and bond issues by Furnas on the foreign market would probably meet Government

opposition. Financing of future investments, therefore, is expected by Furnas to come partly from its own resources, and partly from Eletrobras and Bank loans; the atomic plant would be financed partly by tied supplier credits.

8.03 The Bank loans are still considered by Furnas as a very good source of financing, because of the substantial help received from the Bank in technical and financial matters and because of the low prices obtained from foreign or Brazilian suppliers by international bidding. Equipment has been substantially more expensive when purchased with U.S. AID loans than with Bank loans. However, the use of Bank loans could be hampered in the future by the increasing pressure from the Brazilian industries to supply a major part of the equipment in the projects irrespective of international competitive bidding. Furnas would also prefer not to receive joint financing for its future projects, in view of the substantial administrative costs and complexity involved in arranging such an operation as it experienced in the last Loan 677-BR (1970).