

CHAPTER 9

CONSTRUCTION COST

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CHAPTER 9 CONSTRUCTION COST

9.1 Basic Conditions

In estimation of the construction cost of the Julumito Hydroelectric Project, the natural conditions of the project sites, regional conditions, project scale and the technical levels which can presently be anticipated were taken into consideration and calculations are made based on the commodity prices in Colombia as of March 1972.

The basic conditions for estimation of construction cost are the followings:

(1) Scope of Construction Cost Estimation

The scope of construction cost estimation covers Julumito Power Station, the transmission line of approximately 10 km from the power station to Popayan Substation and the additional switching equipment installation work at the substation for lead-in of the transmission line. Further, the construction cost includes the telecommunications facilities to be provided between Julumito Power Station and Popayan Substation and all costs necessary prior to start of construction and up to letting of contracts such as surveying costs, detailed design costs and preparatory works costs.

(2) Civil Works Construction Costs

- (a) The work quantities are estimated preparing the preliminary design drawings attached to Chapter 8, and as necessary, even more detailed design drawings.
- (b) Regarding basic unit prices, the costs of materials procured in Colombia and laborers are based on commodity prices as of March 1972, while the prices of imported materials and imported construction machines are estimated based on C.I.F. prices in 1972.
- (c) The unit construction prices are calculated based on recent performances in constructions of hydroelectric power projects in the Republic of Colombia (Florida II, Chivor, Alto Anchikaya, etc.) and in consideration of construction experiences in recent years in Japan, besides which the regional conditions of the Julumito site are taken into account.
- (d) Contingency funds corresponding to 20% are included in the civil works construction costs.

(3) Equipment Costs

(a) It is considered that equipment such as penstock pipe, major gates and the like, electrical equipment, transforming facilities and telecommunication facilities would be manufactured in foreign countries and supplied to the Project and their costs are calculated including ocean freight, insurance, landing costs, overland transportation costs inside Colombia and field installation costs.

(b) Contingency funds of 10% of the cost of each piece of equipment are included.

(4) Engineering Fee

Detailed designing fees and construction supervision fees are included in the engineering fee.

(5) Administration Cost

Personnel costs and equipment costs of the construction office of CEDELCA and expenses required in administration are included in the administration costs.

(6) Compensation Costs

The costs of purchase of land for the reservoir and for construction of other structures are budgeted.

(7) Interest during Construction

Interest during construction is estimated based on the fund requirement by year indicated in Table 9-2. The interest rate is taken to be 7.25% per annum for foreign currency requirements and 12.0% per annum for local currency requirements.

(8) Division of Local Currency and Foreign Currency

The construction cost is estimated dividing it into local currency requirements and foreign currency requirements. The local currency requirements include wages of local laborers, local costs of foreign laborers resident on the Project, costs of construction materials procured in Colombia, transportation costs in Colombia on imported materials and imported construction machinery. Other costs are included in foreign currency requirements. The foreign currency exchange rate is taken to be U.S. \$1.00 = 21,0 Colombia pesos.

9.2 Summarization of Construction Cost

It is calculated that the total construction cost required for carrying out the Julumito Project would be 352,400,000 Colombian pesos. Of this amount, the payment in foreign currency will be 220,900,000 pesos and the payment in local currency 131,500,000 pesos. Of the total construction cost, the power generation equipment cost will be 341,600,000 pesos of which the foreign currency requirement is 211,400,000 pesos and the local currency requirement 130,200,000 pesos. The transmission line and transforming facilities construction costs would be 10,800,000 pesos of which the foreign currency requirements would be 9,500,000 pesos and local currency requirements 1,300,000 pesos.

A summarization of the construction costs is given in Table 9-1.

As for the fund requirements by year determined based on the construction schedule, these are as shown in Table 9-2. The payment conditions in this case are considered to be as described below. In effect, for civil works, 10% of work completed would be withheld, this amount withheld being paid to the contractor at the start of operation of the power station. For equipment, payments would be made at the rate of 10% at the time of signing of the contract, 50% on lading on board ship and 40% at the time of start of operation.

For penstock pipe, gates and the like and other hardware, the payments are considered to be 10% at signing of contract, 80% at completion of installation and 10% after completion of passage of water.

Table 9-1 Summary of Estimated Construction Cost

(Unit; 10³ Colombian Pesos)

Item	Total Cost	Foreign Currency	Local Currency
1. Generating Facility	292,000	184,800	107,200
1.1 Civil Works	209,400	111,500	97,900
(1) Diversion Dam	10,200	4,000	6,200
(2) Waterway	38,700	18,300	20,400
(3) Dam	54,900	37,800	17,100
(4) Dike	4,300	2,800	1,500
(5) Intake	7,600	2,700	4,900
(6) Headrace Tunnel	29,100	13,200	15,900
(7) Surge Tank	5,700	2,800	2,900
(8) Penstock Foundation	4,600	2,000	2,600
(9) Powerhouse Building	13,100	6,000	7,000
(10) Switch Yard	1,100	600	500
(11) Miscellaneous	5,300	2,800	2,500
(12) Contingency	34,800	18,500	16,400
1.2 Hydraulic Equipment	18,300	17,200	1,100
(1) Gate	3,600	3,600	0
(2) Penstock	7,800	7,800	0
(3) Miscellaneous	2,800	2,800	0
(4) Installation Cost	2,500	1,500	1,000
(5) Contingency	1,600	1,500	100
1.3 Electrical Equipment	64,300	56,500	7,800
(1) Turbine	20,600	20,600	0
(2) Generator	15,300	15,300	0
(3) Transformer	3,600	3,600	0
(4) Miscellaneous	11,800	11,800	0
(5) Installation Cost	7,200	0	7,200
(6) Contingency	5,800	5,200	600

(Unit: 10³ Colombian Pesos)

Item	Total Cost	Foreign Currency	Local Currency
2. Transmission Line	9,800	8,800	1,000
2.1 Transmission Line	1,500	1,100	400
2.2 Substation	6,300	5,700	600
2.3 Communication System	1,100	1,100	0
2.4 Contingency	900	900	0
3. Preparation Work	2,300	900	1,400
3.1 Access Road	600	200	400
3.2 Electrical Equipment for construction	800	600	200
3.3 Surveying	900	100	800
4. Engineering Fee	10,300	10,300	0
5. Administration Cost	4,800	0	4,800
6. Compensation	2,200	0	2,200
7. Interest during Construction	31,000	15,700	15,300
Grand Total	352,400	220,900	131,500

Table 9-2 Fund Requirement in Each Year

(Unit: 10⁶ Pesos)

	Total Fund Requirement		Sum of Fund Invested until end of 1977				1978			1979			1980			Remarks
	Total	L.C.	Total	L.C.	F.C.	Total	L.C.	F.C.	Total	L.C.	F.C.	Total	L.C.	F.C.		
															F.C.	
[1] Generating Facilities																
Civil Works	209.4	97.9	111.5			47.6	23.3	24.3	88.8	39.9	48.9	73.0	34.7	38.3		
Hydraulic Equipment	18.3	1.1	17.2			1.1	0	1.1	2.2	0.1	2.1	15.0	1.0	14.0		
Electric Equipment	64.3	7.8	56.5			6.6	0.9	5.7	37.5	3.7	33.8	20.2	3.2	17.0		
Others	4.5	3.6	0.9	2.5	1.6	0.9	0.3	0	1.7	1.7	0					
Engineering Fee	9.3	0	9.3	3.3	0	3.3	2.0	2.0	2.7	0	2.7	1.8	0	1.8		
Administration Cost	4.6	4.6	0			1.3	1.3	0	1.6	1.6	0	1.7	1.7	0		
Sub Total	310.9	115.0	195.9	5.8	1.6	4.2	58.9	33.1	134.5	47.0	87.5	111.7	40.6	71.1		
Interest during Construction	30.7	15.2	15.5	1.3	0.4	0.9	2.7	1.4	10.8	5.6	5.2	15.9	7.8	8.1		Preparation Works Compensation.
Total	341.6	130.2	211.4	7.1	2.0	5.1	61.6	34.4	145.3	52.6	92.7	127.6	48.4	79.2		
[2] Transmission Line																
Transmission Line, Communication System, Substation and Contingency	9.3	1.0	8.3						2.0	0.3	1.7	7.8	0.7	7.1		
Engineering Fee	0.5	0	0.5	0.3	0	0.3						0.2	0	0.2		
Administration Cost	0.2	0.2	0						0.1	0.1	0	0.1	0.1	0		
Sub Total	10.5	1.2	9.3	0.3	0	0.3			2.1	0.4	1.7	8.1	0.8	7.3		
Interest during Construction	0.3	0.1	0.2									0.3	0.1	0.2		
Total	10.8	1.3	9.5	0.3	0	0.3			2.1	0.4	1.7	8.4	0.9	7.5		
Grand Total	352.4	131.5	220.9	7.4	2.0	5.4	61.6	34.4	147.4	53.0	94.4	136.0	49.3	86.7		

Note: L.C.: Local Currency
F.C.: Foreign Currency

CHAPTER 10

ECONOMIC EVALUATION

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CHAPTER 10 ECONOMIC EVALUATION

10.1 Salable Energy

As stated in Chapter 7, "ENERGY PRODUCTION", available annual energy of Julumito Power Station will be 285,400,000 kWh at the generating end. This energy will not all be used effectively for several years after start of operation of Julumito Power Station. It will not be until 1985 that the energy will be completely salable.

The transmission loss from Julumito Power Station to Popayan Substation is estimated to be 1%. Therefore, the salable energy at Popayan Substation will be 163,100,000 kWh in 1982 and 282,600,000 kWh in 1985.

Table 10-1 gives the yearly salable energy at Popayan Substation.

10.2 Annual Cost and Energy Cost

10.2.1 Annual Cost

As stated in Chapter 9, "CONSTRUCTION COST", the total construction cost of Julumito Power Station is 352,400,000 Colombian pesos. The construction cost by facility and the respective serviceable years are as indicated in Table 10-2.

The equalized annual costs for the 50-year serviceable life of this Project are given in Table 10-3. In this case interest rates of 7.25% for foreign currency requirements and 12.00% for local currency requirements are applied.

As is seen from this table, the annual cost will be 37,106,000 pesos.

The bases for calculation of annual cost are as given below.

1. Interest Rate
 - 7.25% per annum for foreign currency (F.C.)
 - 12.00% per annum for local currency (L.C.)
2. Amortization
 - 2.1 Civil Works (50 years)
 - F.C.: 0.07476 x (investment cost of civil works)
 - L.C.: 0.12042 x (investment cost of civil works)

Table 10-2 Construction Cost and Serviceable Years of Facilities

(Unit: 10³ Colombian Pesos)

Item	Serviceable Years	Total Cost	Foreign Currency	Local Currency
1. Generating Facilities				
Civil Works	50	209,400	111,500	97,900
Hydraulic Equipment	30	18,300	17,200	1,100
Electric Equipment	25	64,300	56,500	7,800
Engineering Fee		9,800	9,800	0
Administration Cost		4,600	0	4,600
Others		4,500	900	3,600
Interest during Construction		30,700	15,500	15,200
Total		341,600	211,400	130,200
2. Transmission Line and Other Facilities				
Transmission Line and Others	50	9,800	8,800	1,000
Engineering Fee		500	500	0
Administration Cost		200	0	200
Interest during Construction		300	200	100
Total		10,800	9,500	1,300
3. Total Construction Cost		352,400	220,900	131,500

Table 10-3 Annual Cost

(Unit: 10³ Colombian Pesos)

Item	Invested Cost	Annual Cost
1. Amortization	352,400	33,431
1.1 Civil Works	246,600	23,892
1.2 Electrical Equipment	74,000	6,875
1.3 Hydraulic Equipment	21,000	1,797
1.4 Transmission Line Substation and Communication System	10,800	867
2. Maintenance and Operation	352,400	2,266
2.1 Generating Facilities	341,600	2,050
2.2 Transmission Line, Substation and Communication System	10,800	216
3. Administration Expense	352,400	1,057
4. Other Expense	352,400	352
Total Annual Cost (C)	--	37,106

- 2.2 Electrical Equipment (25 years)
 - F.C.: 0.08775 x (investment cost of electrical equipment)
 - L.C.: 0.12750 x (investment cost of electrical equipment)
- 2.3 Hydraulic Equipment (30 years)
 - F.C.: 0.08262 x (investment cost of hydraulic equipment)
 - L.C.: 0.12414 x (investment cost of hydraulic equipment)
- 2.4 Transmission Line, Substation and Communication System (50 years)
 - F.C.: 0.07476 x (investment cost of above facilities)
 - L.C.: 0.12042 x (investment cost of above facilities)

3. Maintenance and Operation

- 3.1 Generating Facilities
 - 0.006 x (investment cost of generating facilities)
- 3.2 Transmission Line, Substation and Communication System
 - 0.020 x (investment cost of above facilities)

4. Administrative Expense
0.003 x (total investment cost)

5. Other Expenses
0.001 x (total investment cost)

10.2.2 Energy Cost

Dividing the annual cost of Julumito Power Station determined in 10.2.1 by the salable energy determined in 10.1, the energy cost of Julumito Power Station per kWh delivered at Popayan Substation is obtained.

From the salable energy the energy cost will be as indicated below.

Table 10-4 Energy Cost

Year	Salable Annual Energy (MWh)	Annual Cost (10 ³ Pesos)	Energy Cost (Pesos/kWh)
1982	163,100	37,106	0.228
1983	202,300	37,106	0.183
1984	240,200	37,106	0.155
1985	282,600	37,106	0.131
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2031	282,600	37,106	0.131

10.3 Economic Evaluation

10.3.1 Method of Economic Evaluation

As stated in Chapter 3, "LOAD FORECAST", the electric power systems of CEDELCA and CEDENAR have been already interconnected with the 115-kV transmission line, 1 circuit, connecting the substations of Pasto and Popayan. Further, an interconnecting transmission line (115 kV, 1 circuit) connecting these systems with the CVC Power System interconnected to the central trunk transmission line (230 kV) is now under construction. When this is completed, interchange of power between the CVC System and the CEDELCA-CEDENAR System will become possible.

Under such circumstances, the economic evaluation for Julumito Power Station must be made considering also a comparison with the case of purchase of power through this

interconnecting transmission line.

Therefore, there are 3 methods conceivable by which the power shortages in the CEDELCA-CEDENAR System arising from 1975 can be filled in lieu of the Julumito Project, and these are:

- (1) Construction of another hydroelectric power station within the area concerned.
- (2) Construction of an alternative thermal power station within the area concerned.
- (3) Purchase of power from the CVC System through the interconnecting transmission line.

Of the three, in regard to (1) construction of a hydroelectric power station other than Julumito Power Station, no concrete plan exists at the moment and it would be impossible to select within a short time a site that would serve as an alternative to Julumito.

Therefore, since the methods of (2) and (3) are considered to be practicable, the economic evaluation will be made for these two cases.

10.3.2 Economic Comparison with Alternative Thermal Power Station

(1) Selection of Alternative Thermal Power Station

In selection of an alternative thermal power station, the following conditions are used as criteria:

- (i) The scale of the alternative thermal power station is to be roughly equal to that of the Julumito Hydroelectric Power Project, and moreover, is to be a scale practicable from the standpoint of construction now being carried out in Colombia.
- (ii) The place of construction is to be in the vicinity of Popayan City.
- (iii) The construction cost is to be based on recent data from construction in Colombia of a thermal power station of similar scale.

On consideration of the above conditions, the alternative thermal power station is assumed to be a fuel-oil thermal power station with unit output of 25 MW, 2 units, installed capacity of 50 MW constructed in the neighborhood of Popayan Substation. The particulars of this alternative thermal power station are given in Table 10-5.

Table 10-5 Alternative Thermal Power Plant

Installed Capacity	(MW)	50
Unit Capacity	(MW x Unit)	25 x 2
Annual Plant Factor	(%)	60
Thermal Efficiency at Sending End	(%)	28
Annual Energy Production	(10 ⁶ kWh)	263
Percent of Powerhouse Service Use	(%)	5
Annual Available Energy	(10 ⁶ kWh)	250
Annual Energy Consumption	(10 ³ kL)	80
Construction Cost	(10 ⁶ C. Pesos)	200

(2) Annual Cost of Alternative Thermal Power Station

The annual cost of the alternative thermal power station, namely, a fuel-oil thermal power station with unit output of 25 MW, 2 units, installed capacity of 50 MW, when calculated divided into fixed costs and variable costs will be as shown in Table 10-6.

In the calculations, the discount rate is taken to be 10%.

The benefit per kW is taken to be the annual fixed cost per kW of the alternative thermal power plant multiplied by a kW adjustment factor. The reason for multiplying by a kW adjustment factor is described below. A thermal power station compared with a hydro power station has higher rates of outage from faults and due to periodical repairs. Therefore, for the same reliability as in the case of a hydroelectric power station being added to the system, a thermal power station requires an installed capacity which is larger by an extent corresponding to the outage rate. This additional installation required should be considered as a benefit of the hydroelectric power station and the coefficient for taking this into consideration is the kW adjustment factor.

However, since the kW adjustment factor is influenced by the difference in the rate of fault occurrence between thermal and hydro, the unit capacity of thermal, the proportion between hydro and thermal in the system, reserve supply capability, etc., it is difficult for it to be calculated precisely. In this case, it was decided to adopt 1.10 as a value which could be expected.

Table 10-6 Estimated Annual Cost of Alternative Thermal Power Plant

Item	Unit	Fixed Cost	Variable Cost	Notes
Interest and Depreciation	(10 ³ \$)	21,216	—	Serviceable Year: 30 *1 D.R. 10.0% *2 C.R.F. 0.10608
Operation and Maintenance Cost	(10 ³ \$)	5,000	800	
Wage and Salary	(10 ³ \$)	1,600	—	40 x 40,000 \$
Repair Expense	(10 ³ \$)	2,800	1,200	Const. Cost x 0.02
Miscellaneous	(10 ³ \$)	600	—	Const. Cost x 0.003
Administration Cost	(10 ³ \$)	432	64	Op. and Maint. Cost x 0.08
Tax and Duties	(10 ³ \$)	0	0	
Fuel Cost	(10 ³ \$)	—	28,800	0.36 k/l x 80 x 10 ⁶ l
Total	(10³ \$)	26,648	30,064	
Annual Cost at Sending End				
Cost per kW	(\$)	620		$\frac{26,648,000}{50,000 (1-0.05) \times 1.1^{*3}}$
Cost per kWh	(\$)		0.120	$30,064,000^{\$} / 250 \times 10^6 \text{ kWh}$

Note: *1 D.R.: Discount Rate
*2 C.P.R.: Capital Recovery Factor
*3 kW adjustment factor

Based on the above, the fixed cost per kW of the alternative thermal power station is taken to be the basis to evaluate the kW benefit of the relevant hydroelectric power station and the variable cost per kWh to be the basis for the kWh benefit, which would be as follows:

Benefit per kW	620 pesos
Benefit per kWh	0.12 pesos

(3) Annual Benefit

The annual benefit of Julumito Power Station is calculated employing the benefit per kW and benefit per kWh above.

As an alternative thermal power station is used as the criterion for economic evaluation, the time is taken to be when the output and energy production of Julumito Power Station are all actualized and are all effectively consumed. The annual benefit of Julumito Power Station obtained in this manner would be 66,760,000 pesos annually as shown in Table 10-7.

Table 10-7 Annual Benefit

	Unit	Annual Benefit
Dependable Capability	(kW)	53,000
Salable Energy	(10 ⁶ kWh)	282.6
Value per kW	(Pesos)	620
Value per kWh	(Pesos)	0.12
Benefit of kW (B ₁)	(10 ³ Pesos)	32,860
Benefit of kWh (B ₂)	(10 ³ Pesos)	33,900
Total Annual Benefit (B) = (B ₁) + (B ₂)	(10 ³ Pesos)	66,760

(4) Annual Cost

Based on the annual cost calculation criteria of 10.2.1, the annual cost determined for the case of discount rate of 10.0% would be 40,017,000 pesos.

(5) Benefit-Cost Ratio

The annual cost of Julumito Power Station as calculated in (4) above is 40,017,000 pesos while the annual benefit as indicated in Table 10-7 is 66,760,000 pesos. Therefore, the annual surplus benefit is 26,743,000 pesos and the benefit (B)/cost (C) ratio is 1.67.

10.3.3 Economic Comparison with Interconnecting Transmission Line

The economic comparison in case the shortage of power is covered with supply through the interconnecting transmission line is made as described below.

The interconnecting transmission line tying Pance Substation (Cali City) of the CVC System with Popayan Substation of CEDELCA is presently under construction and will shortly be completed. The outline of this interconnecting transmission line is as follows:

Location	Pance Substation, CVC	Popayan Substation, CEDELCA
Length	111 km	
Voltage	115 kV	
Number of Circuits	2 circuits	
Conductor	397.5 MCM	
Support	Steel tower, 282 towers	
Total Construction Cost	42,800,000 pesos	

The annual cost and annual purchase amount of energy in case of purchase from the CVC System through this interconnecting transmission line are indicated in Table 10-8 and Table 10-9 respectively.

When the total of the annual cost of the transmission line and the energy purchase amount in case Julumito Power Station is not constructed and energy of an amount equal to the salable energy of the power station is purchased through the interconnecting transmission line and the annual cost in case Julumito Power Station is constructed are compared, the result would be the as given below.

Namely, the annual cost of Julumito Power Station is 40,017,000 pesos, on the other hand the total of the annual costs in case supply is made through the transmission line, from Table 10-8 and Table 10-9, is $5,601,000 + 46,315,000 = 51,916,000$ pesos.

Therefore, the ratio of the annual cost of the transmission line to the annual cost of Julumito Power Station is

$$51,916,000/40,017,000 = 1.30$$

In other words, from the aspect of power supply, it is of more advantage to construct Julumito Power Station to carry out supply than to supply by purchase through the inter-connecting transmission line.

Table 10-8 Annual Cost of Transmission Line

I t e m	Construction Cost (x 10 ³ pesos)	Cost Factor	Annual Cost (x 10 ³ pesos)
Amortization	42,800	0.10086	4,317
Operation & Maintenance	42,800	0.025	1,070
Administration	42,800	0.005	214
Total			5,601

Note:

Construction cost	42,800 x 10 ³ Pesos
Discount Rate	10.0%
Capital Recovery Factor	0.10086

Table 10-9 Annual Purchased Cost of Energy from Transmission Line

Year	Purchased Energy (MWh)	Purchased Cost (10 ³ pesos)	Present Worth (10 ³ pesos)	Note
1982	163,100	31,152	28,318	
1983	202,400	38,658	31,931	
1984	240,200	45,878	34,454	
1985	282,600	53,977	} 364,495	
1986	282,600	53,977		
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2031	282,600	53,977		
Total			459,198	
Annual Purchased Cost for 50 Year			46,315	

Note: assumed discount rate 10.0%

10.3.4 Result of Economic Evaluation

As described above, economic comparisons with the construction of Julumito Power Station were made for the case if an alternative thermal power station were to be constructed and for the case if purchase were to be made from the CVC System through the inter-connecting transmission line, and in both cases it is obvious that supplying electricity by constructing Julumito Power Station is economically superior.

CHAPTER 11

FINANCIAL SCHEDULE

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CHAPTER 11 FINANCIAL SCHEDULE

11.1 Fund Requirement and Procurement

The total construction cost of this Project, as described in Chapter 9 is

Total Amount	352,400,000 pesos
Foreign currency	200,900,000 pesos
Local currency	131,500,000 pesos

and the fund requirement by year is as shown in Table 11-1. The procurement of funds was considered to be from international financing institutions at the same conditions as for current World Bank loans in regard to foreign currency requirements and from domestic financing organs in regard to local currency requirements, while the interest rates and repayment periods were assumed to be the following:

Foreign Currency

Interest rate, 7.25% and commitment charge 1%.

Repayment method, 4-year grace period, 16-year
principal and interest equalized repayment.

Local Currency

Interest rate, 12%.

Repayment method, 4-year grace period, 11-year
principal and interest equalized repayment.

11.2 Income and Expense

11.2.1 Electricity Charge Income

The electric power produced at Julumito Power Station is to be supplied within the CEDELCA System and to the CEDENAR System. The salable energy is therefore as given in Table 10-1.

The electricity charge, based on data obtained from CEDELCA, "Documentos Credito Externo, Diciembre de 1971," is taken to be a unit sales price of

1982 and after: 26.1 cvs/kWh

at the outlet of Popayan Substation directed to CEDENAR, while the average sales price at consumer end for power sold within the same system was taken to be

1982 and after: 34.8 cvs/kWh

As a result of the above, the electricity charge income will be as indicated in Table 11-1 (1).

11.2.2 Operation and Maintenance Costs

The operation and maintenance costs of the various facilities were taken to be as follows:

Dam, powerhouse	1% of construction cost
Transmission, transforming and telecommunications facilities	2% of construction cost

11.2.3 Depreciation Costs

The depreciation cost was based on residual value of zero and the straight line method.

The serviceable years of the various facilities were taken to be as follows in accordance with Decreto No. 2286 (7. 7. 1948), the Republic of Colombia.

Civil works	50 years
Electrical equipment	25 years
Transmission line	50 years
Gate, penstock	30 years

11.2.4 Net Profit

When the maintenance costs, depreciation costs and interest payments on loans are deducted from the annual income calculated in accordance with the above conditions, the result would be as given in Table 11-1 (1) and Table 11-1 (2) showing that there would be deficits during the initial 5 years, but that net profits as indicated in (D) in Table 11-1 (2) would be obtained from 1986 and after.

11.3 Repayment Program

The funds for repayment of borrowings would be the net profit in ordinary profit and the fund appropriated for depreciation.

Calculating the cash balance assuming repayment of local and foreign currency borrowings based on the loan conditions described in 11.1, the results would be as shown in Table 11-1 (1) and Table 11-1 (2). Further, from the aspect of repayment of invested capital, the results of calculation of cash balances for start of operation of Julumito Power Station at the end of 1976 and at the end of 1986 are as indicated in Table 11-3 and Table 11-4.

As seen from these tables and Table 11-1, it may be said it is reasonable for start of operation of Julumito Power Station to be at the end of 1981 from the aspect of recovery of invested funds also.

Based on the above, it may be said this Project is quite justifiable from the standpoint of financing.

As a reference, the results of calculations of the respective internal rate of return rates for the cases of start of operation of Julumito Power Station at the ends of 1981, 1976 and 1986 are as shown in Tables 11-5, 11-6 and 11-7.

As for the cash flow demanded under the item "Justificacion del Proyecto de Julumito" in the CEDELCA memorandum dated 25 February 1972,

Primera Alternativa : Table 11-3

Segunda Alternativa : Table 11-1

correspond to this, while as for the Tercera Alternativa, since it is considered that addition to the interconnecting transmission line, from the aspect of transmission capacity, would be acceptable from 1985 and after (provided that it should be necessary for static condensers to be installed at Popayan Substation) and in the current calculations, calculations of cash flow in the case of purchase of power only from the interconnecting transmission line were not made.

As the average energy sales price at consumer end was used as the income from energy sales of the Julumito Project in the CEDELCA Power System, for the energy sales income of the Julumito Project, it is necessary for the costs of the secondary transforming facilities and the costs of the distribution lines to be deducted from the energy sales income.

Based on the examinations of distribution costs per kWh of energy sold to consumers for the entire CEDELCA System according to the investment amounts for secondary transmission facilities and distribution facilities scheduled to be constructed from 1971 through 1980, a figure of 15.9 centavos was obtained.

Therefore, the distribution cost was taken to be the energy sold to consumers from Julumito Power Station multiplied by 15.9 centavos.

Further, for calculation of costs of secondary transmission and transforming facilities, the investment amounts were considered to be according to the abovementioned data, while in regard to serviceable years, average residual years of 25 years for existing facilities, 40 years for newly installed portions and applied average interest 10% were assumed on top of which operation and maintenance costs were further added.

Table 11-1 (1) Case I. Income Statement (Julumito Project in Service 1982)

Unit: 10³ Pesos

	1 1978	2 1979	3 1980	4 1981	5 1982	6 1983	7 1984	8 1985	9 1986	10 1987	11 1988	12 1989	13 1990	14 1991	15 1992	16 1993	17 1994
(A) Gross Income					43,480	54,320	64,860	77,660	77,440	78,270	79,210	80,230	81,350	82,550	83,860	84,420	84,420
CEDENAR																	
Sales Energy (MWh)					139,100	162,360	182,660	209,980	185,230	162,560	137,900	110,980	81,580	49,600	14,750	14,750	14,750
Unit Price (\$/kWh)					0.261	0.261	0.261	0.261	0.261	0.261	0.261	0.261	0.261	0.261	0.261	0.261	0.261
Income					36,310	42,380	47,670	54,800	48,350	42,430	35,990	28,970	21,290	12,950	3,850	3,850	3,850
CEDELCA																	
Sales Energy (MWh)					20,600	34,300	49,400	65,700	83,600	103,000	124,200	147,300	172,600	200,000	229,900	242,600	242,600
Unit Price (\$/kWh)					0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348
Income					7,170	11,940	17,190	22,860	29,090	35,840	43,220	51,260	60,060	69,600	80,010	84,420	84,420
(B) Total Operation Costs					15,770	17,940	20,340	22,940	25,780	28,870	32,240	35,910	39,930	44,290	49,040	51,060	51,060
1. Julumito Project					12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490
Operation & Maintenance					2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270
Administration & Others					1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410
Depreciation					8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810
2. Transforming & Distribution					3,280	5,450	7,850	10,450	13,290	16,380	19,750	23,420	27,440	31,800	36,550	38,570	38,570
(C) Operating Income (A) - (B)					27,710	36,380	44,520	54,720	51,660	49,400	46,970	44,320	41,420	38,260	34,820	33,360	33,360
(D) Financial Expenditure (Interest)					31,795	29,798	27,761	25,680	23,552	21,373	19,141	16,851	14,499	12,081	9,590	7,024	5,810
1. Foreign Loan					16,015	15,453	14,850	14,204	13,510	12,766	11,969	11,113	10,196	9,212	8,156	7,024	5,810
2. Local Loan					15,780	14,345	12,911	11,476	10,042	8,607	7,172	5,738	4,303	2,869	1,434	---	---
(E) Net Income (C) - (D)					-4,085	6,582	16,759	29,040	28,108	28,027	27,829	27,469	26,921	26,179	25,230	26,336	27,550

Table 11-1 (2) Case I. Cash Flow Statement (Julumito Project in Service 1982)

Unit: 10³ Pesos

	1 1978	2 1979	3 1980	4 1981	5 1982	6 1983	7 1984	8 1985	9 1986	10 1987	11 1988	12 1989	13 1990	14 1991	15 1992	16 1993	17 1994
(A) Cash Receipt	7,400	61,600	147,400	136,000	36,520	45,190	53,330	63,530	60,470	58,210	55,780	53,130	50,230	47,070	43,630	42,170	42,170
1. Operation Income before Interest					27,710	36,380	44,520	54,720	51,660	49,400	46,970	44,320	41,420	38,260	34,820	33,360	33,360
2. Depreciation					8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810
3. Exterior Borrowing	7,400	61,600	147,400	136,000													
Foreign Fund	5,400	34,400	94,400	86,700													
Local Fund	2,000	27,200	53,000	49,300													
(B) Cash Disbursement	9,609	63,755	149,211	136,867	51,504	50,069	48,635	47,200	45,766	44,331	42,896	41,462	40,027	38,593	37,153	23,769	23,769
1. Construction Expenditure	7,400	61,600	147,400	136,000													
2. Interest					31,795	29,798	27,761	25,680	23,552	21,373	19,141	16,851	14,499	12,081	9,590	7,024	5,810
3. Commitment Charge (Foreign Loan: 1% by year)	2,209	2,155	1,811	867													
4. Amortization of Debit (Principal)					19,709	20,271	20,874	21,520	22,214	22,958	23,755	24,611	25,528	26,512	27,563	16,745	17,959
Foreign Fund					7,754	8,316	8,919	9,565	10,259	11,003	11,800	12,656	13,573	14,557	15,613	16,745	17,959
Local Fund					11,955	11,955	11,950	11,950	11,950	11,950	11,950	11,950	11,950	11,950	11,950		
(C) Cash Balance (A) - (B)	-2,209	-2,155	-1,811	-867	-14,984	-4,879	4,695	16,330	14,704	13,879	12,884	11,668	10,203	8,477	6,477	18,401	18,401
(D) Accumulated Total	-2,209	-4,364	-6,175	-7,042	-22,026	-26,905	-22,210	-5,880	-8,824	22,703	35,587	47,255	57,458	65,935	72,412	90,813	109,214

Table 11-2 Amortization Schedule

Unit: 10³ Pesos

Year	Borrowing		Total	Redemption		Total	Outstanding Balance	
	Hydro-Power Plant	Trans-mission Line		Principal	Interest			
1st	5,100	300	5,400					
2nd	34,400	0	34,400					
3rd	92,700	1,700	94,400					
4th	79,200	7,500	86,700				220,900	} Foreign Fund (i = 7.25%)
5th				7,754	16,015	23,769	213,146	
6th				8,316	15,453	23,769	204,830	
7th				8,919	14,850	23,769	195,911	
8th				9,565	14,204	23,769	186,346	
9th				10,259	13,510	23,769	176,087	
10th				11,003	12,766	23,769	165,084	
11th				11,800	11,969	23,769	153,284	
12th				12,656	11,113	23,769	140,628	
13th				13,573	10,196	23,769	127,055	
14th				14,557	9,212	23,769	112,498	
15th				15,613	8,156	23,769	96,885	
16th				16,745	7,024	23,769	80,140	
17th				17,959	5,810	23,769	62,181	
18th				19,261	4,508	23,769	42,920	
19th				20,657	3,112	23,769	22,263	
20th				22,155	1,614	23,769	0	
1st	2,000	0	2,000					} Local Fund (i = 12%)
2nd	27,200	0	27,200					
3rd	52,600	400	53,000					
4th	48,400	900	49,300				131,500	
5th				11,955	15,780	27,735	119,545	
6th				11,955	14,345	26,300	107,590	
7th				11,955	12,911	24,866	95,635	
8th				11,955	11,476	23,431	83,680	
9th				11,955	10,042	21,997	71,725	
10th				11,955	8,607	20,562	59,770	
11th				11,955	7,172	19,127	47,815	
12th				11,955	5,738	17,693	35,860	
13th				11,955	4,303	16,258	23,905	
14th				11,955	2,869	14,824	11,950	
15th				11,955	1,434	13,384	0	

Table 11-3 (1) Case II. Income Statement (Julumito Project in Service 1977)

Unit: 10³ Pesos

	1 1973	2 1974	3 1975	4 1976	5 1977	6 1978	7 1979	8 1980	9 1981	10 1982	11 1983	12 1984	13 1985	14 1986	15 1987	16 1988	17 1989
(A) Gross Income					6,460	10,810	15,680	22,310	31,290	43,480	54,320	64,860	77,660	77,440	78,270	79,210	80,230
CEDENAR																	
Sales Energy (MWh)					38,210	58,410	78,010	100,580	119,990	139,100	162,360	182,660	209,980	185,230	162,560	137,910	110,980
Unit Price (\$/kWh)					0.169	0.185	0.201	0.219	0.239	0.261	0.261	0.261	0.261	0.261	0.261	0.261	0.261
Income					6,460	10,810	15,680	22,030	28,680	36,310	42,380	47,670	54,800	48,350	42,430	35,990	28,970
CEDELCA																	
Sales Energy (MWh)					0	0	0	900	7,900	20,600	34,300	49,400	65,700	83,600	103,000	124,200	147,300
Unit Price (\$/kWh)					0.272	0.286	0.300	0.315	0.331	0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348
Income					0	0	0	280	2,610	7,170	11,940	17,190	22,860	29,090	35,840	43,220	51,260
(B) Total Operation Costs					12,490	12,490	12,490	12,540	13,750	15,770	17,940	20,340	22,940	25,780	28,870	32,240	35,910
1. Julumito Project					12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490
Operation & Maintenance					2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270
Administration & Others					1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410
Depreciation					8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810
2. Transforming & Distribution					0	0	0	50	1,260	3,280	5,450	7,850	10,450	13,290	16,380	19,750	23,420
(C) Operating Income (A) - (B)					-6,030	-1,680	3,190	9,770	17,540	27,710	36,380	44,520	54,720	51,660	49,400	46,970	44,320
(D) Financial Expenditure (Interest)					31,795	29,798	27,761	25,680	23,552	21,373	19,141	16,851	14,499	12,081	9,590	7,024	5,810
1. Foreign Loan					16,015	15,453	14,850	14,204	13,510	12,766	11,969	11,113	10,196	9,212	8,156	7,024	5,810
2. Local Loan					15,780	14,345	12,911	11,476	10,042	8,607	7,172	5,738	4,303	2,869	1,434	---	---
(E) Net Income (C) - (D)					-37,825	-31,478	-24,571	-15,910	-6,012	6,337	17,239	27,669	40,221	39,579	39,810	39,946	38,510

Table 11-3 (2) Case II. Cash Flow Statement (Julumito Project in Service 1977)

Unit: 10³ Pesos

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
(A) Cash Receipt	7,400	61,600	147,400	136,000	2,780	7,130	12,000	18,580	26,350	36,520	45,190	53,330	63,530	60,470	58,210	55,780	53,130
1. Operation Income before Interest					-6,030	-1,680	3,190	9,770	17,540	27,710	36,380	44,520	54,720	51,660	49,400	46,970	44,320
2. Depreciation					8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810
3. Exterior Borrowing	7,400	61,600	147,400	136,000													
Foreign Fund	5,400	34,400	94,400	86,700													
Local Fund	2,000	27,200	53,000	49,300													
(B) Cash Disbursement	9,609	63,755	149,211	136,867	51,504	50,069	48,635	47,200	45,766	44,331	42,896	41,462	40,027	38,593	37,153	23,769	23,769
1. Construction Expenditure	7,400	61,600	147,400	136,000													
2. Interest					31,795	29,798	27,761	25,680	23,552	21,373	19,141	16,851	14,499	12,081	9,590	7,024	5,810
3. Commitment Charge (Foreign Loan: 1% by year)	2,209	2,155	1,811	867													
4. Amortization of Debit (Principal)					19,709	20,271	20,874	21,520	22,214	22,958	23,755	24,611	25,528	26,512	27,563	16,745	17,959
Foreign Fund					7,754	8,316	8,919	9,565	10,259	11,003	11,800	12,656	13,573	14,557	15,613	16,745	17,959
Local Fund					11,955	11,955	11,955	11,955	11,955	11,955	11,955	11,955	11,955	11,955	11,950	---	---
(C) Cash Balance (A) - (B)	-2,209	-2,155	-1,811	-867	-48,724	-42,939	-36,635	-28,620	-19,416	-7,811	2,294	11,868	23,503	21,877	21,057	32,011	29,361
(D) Accumulated Total	-2,209	-4,364	-6,175	-7,042	-55,766	-98,705	-135,340	-163,960	-183,376	-191,187	-188,893	-177,025	-153,522	-131,645	-110,588	-78,577	-49,216

Table 11-4 (1) Case III. Income Statement (Julumito Project in Service 1987)

Unit: 10³ Pesos

	1 1983	2 1984	3 1985	4 1986	5 1987	6 1988	7 1989	8 1990	9 1991	10 1992	11 1993	12 1994	13 1995	14 1996	15 1997	16 1998	17 1999
(A) Gross Income					78,270	79,210	80,230	81,350	82,550	83,860	84,420	84,420	84,420	84,420	84,420	84,420	84,420
CEDENAR																	
Sales Energy (MWh)					162,560	137,910	110,980	81,580	49,600	14,750	0	0	0	0	0	0	0
Unit Price (\$/kWh)					0.261	0.261	0.261	0.261	0.261	0.261	0	0	0	0	0	0	0
Income					42,430	35,990	28,970	21,290	12,950	3,850	0	0	0	0	0	0	0
CEDELCA																	
Sales Energy (MWh)					103,000	124,200	147,300	172,600	200,000	229,900	242,600	242,600	242,600	242,600	242,600	242,600	242,600
Unit Price (\$/kWh)					0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348	0.348
Income					35,840	43,220	51,260	60,060	69,600	80,010	84,420	84,420	84,420	84,420	84,420	84,420	84,420
(B) Total Operation Costs					28,870	32,240	35,910	39,930	44,290	49,040	51,060	51,060	51,060	51,060	51,060	51,060	51,060
1. Julumito Project					12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490	12,490
Operation & Maintenance					2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270	2,270
Administration & Others					1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410	1,410
Depreciation					8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810
2. Transforming & Distribution					16,380	19,750	23,420	27,440	31,800	36,550	38,570	38,570	38,570	38,570	38,570	38,570	38,570
(C) Operating Income (A) - (B)					49,400	46,970	44,320	41,420	38,260	34,820	33,360	33,360	33,360	33,360	33,360	33,360	33,360
(D) Financial Expenditure (Interest)					31,795	29,798	27,761	25,680	23,552	21,373	19,141	16,851	14,499	12,081	9,590	7,024	5,810
1. Foreign Loan					16,015	15,453	14,850	14,204	13,510	12,766	11,969	11,113	10,196	9,212	8,156	7,024	5,810
2. Local Loan					15,780	14,345	12,911	11,476	10,042	8,607	7,172	5,738	4,303	2,869	1,434	---	---
(E) Net Income (C) - (D)					17,605	17,172	16,559	15,740	14,708	13,447	14,219	16,509	18,861	21,279	23,770	26,336	27,550

Table 11-4 (2) Case III. Cash Flow Statement (Julumito Project in Service 1987)

Unit: 10³ Pesos

	1 1983	2 1984	3 1985	4 1986	5 1987	6 1988	7 1989	8 1990	9 1991	10 1992	11 1993	12 1994	13 1995	14 1996	15 1997	16 1998	17 1999
(A) Cash Receipt	7,400	61,600	147,400	136,000	58,210	55,780	53,130	50,230	47,070	43,630	42,170	42,170	42,170	42,170	42,170	42,170	42,170
1. Operation Income before Interest					49,400	46,970	44,320	41,420	38,260	34,820	33,360	33,360	33,360	33,360	33,360	33,360	33,360
2. Depreciation					8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810	8,810
3. Exterior Borrowing	7,400	61,600	147,400	136,000													
Foreign Fund	5,400	34,400	94,400	86,700													
Local Fund	2,000	27,200	53,000	49,300													
(B) Cash Disbursement	9,609	63,755	149,211	136,867	51,504	50,069	48,635	47,200	45,766	44,331	42,896	41,462	40,027	38,593	37,153	23,769	23,769
1. Construction Expenditure	7,400	61,600	147,400	136,000													
2. Interest					31,795	29,798	27,761	25,680	23,552	21,373	19,141	16,851	14,499	21,081	9,590	7,024	5,810
3. Commitment Charge (Foreign Loan: 1% by year)	2,209	2,155	1,811	867													
4. Amortization of Debit (Principal)					19,709	20,271	20,874	21,520	22,214	22,958	23,755	24,611	25,528	26,512	27,563	16,745	17,959
Foreign Fund					7,754	8,316	8,919	9,565	10,259	11,003	11,800	12,656	13,573	14,557	15,613	16,745	17,959
Local Fund					11,955	11,955	11,955	11,955	11,955	11,955	11,955	11,955	11,955	11,955	11,950	---	---
(C) Cash Balance (A) - (B)	-2,209	-2,155	-1,811	-867	6,706	5,711	4,495	3,030	1,304	-701	-726	708	2,143	3,577	5,017	18,401	18,401
(D) Accumulated Total	-2,209	-4,364	-6,175	-7,042	-336	5,375	9,870	12,900	14,204	13,503	12,777	13,485	15,628	19,205	24,222	42,623	61,024

Table 11-7 Case III. Internal Rate of Return (In Service 1987)

Year	Construction Costs			Income by Energy Sales								Costs			Revenue	Internal Rate of Return		
	Generating Facilities (10 ³ Pesos)	Transmission Line (10 ³ Pesos)	Total (10 ³ Pesos)	Generating Energy (MWh)	CEDENAR			CEDELCA			Total (A) Income (10 ³ Pesos)	Generating & Transmission (10 ³ Pesos)	Transforming & Distribution (10 ³ Pesos)	Total (B) (10 ³ Pesos)	(A) - (B) (10 ³ Pesos)	Present Worth Factor (i = 13%)	Construction Cost (10 ³ Pesos)	Revenue (10 ³ Pesos)
					Sales Energy (MWh)	Unit Price (\$/kWh)	Income (10 ³ Pesos)	Sales Energy (MWh)	Unit Price (\$/kWh)	Income (10 ³ Pesos)								
1983	5,800	300	6,100												0.885	5,399		
1984	58,900	0	58,900												0.783	46,119		
1985	134,500	2,100	136,600												0.693	94,664		
1986	111,700	8,100	119,800												0.613	73,437		
1987	0	0	0	285,400	162,560	0.261	42,430	103,000	0.348	35,840	78,270	3,680	16,380	20,060	0.543		31,608	
1988	0	0	0	285,400	137,910	0.261	35,990	124,200	0.348	43,220	79,210	3,680	19,750	23,430	0.480		26,774	
1989	0	0	0	285,400	110,980	0.261	28,970	147,300	0.348	51,260	80,230	3,680	23,420	27,100	0.425		22,580	
1990	0	0	0	285,400	81,580	0.261	21,290	172,600	0.348	60,060	81,350	3,680	27,440	31,120	0.376		18,886	
1991	0	0	0	285,400	49,600	0.261	12,950	200,000	0.348	69,600	82,550	3,680	31,800	35,480	0.333		15,674	
1992	0	0	0	285,400	14,750	0.261	3,850	229,900	0.348	80,010	83,860	3,680	36,550	40,230	0.295		12,871	
1993	0	0	0	285,400	0		0	242,600	0.348	84,420	84,420	3,680	38,570	42,250			(128,393)	
1994	0	0	0	285,400	0		0	242,600	0.348	84,420	84,420	3,680	38,570	42,250				
1995	0	0	0	285,400	0		0											
1935	0	0	0	285,400	0	0.261	0	242,600	0.348	84,420	84,420	3,680	38,570	42,250				
1936	0	0	0	285,400	0	0.261	0	242,600	0.348	84,420	84,420	3,680	38,570	42,250				
Total	310,900	10,500	321,400													219,619	220,647	

$$42,170 \times 0.295 \times 7.657 = 92,254$$

