

G U A T E M A L A

PUEBLO VIEJO-QUIXAL HYDROELECTRIC PROJECT ON THE CHIXOY RIVER

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I. INTRODUCTION

A. Background

- 1.01 The Pueblo Viejo-Quixal hydroelectric project in the Chixoy River has been under execution since 1976 with financing from the four loans from the IDB, the utilization of which is evaluated in chapter II of this report. The total cost of the project has increased by the equivalent of US\$289,126,000, which is an increase of 84% approximately over the estimate originally made at March 1975 prices. A significant portion of this cost overrun is due to additional works. They would be the only works that would be covered chargeable to the additional financing that the IDB could grant from its own resources and which is analyzed in this report.
- 1.02 From the beginning, the analysis of the project and its possible costs was approached with great care, owing to the magnitude of the works - including a power tunnel 26 kms. long, which is among the longest built in Latin America, and the difficult geological conditions typifying the Central American region. Consequently, it was felt that this project would be difficult to execute, that it would require the maximum input that could be given by international firms of great experience and recognized capacity, as well as the greatest efforts of local technicians confronting for the first time a work of such proportions. There was also awareness that in the final analysis the execution of the project would depend upon the financial contributions from the government and the sustained cooperation of the Bank and other international lending sources.
- 1.03 In February of 1976 Guatemala was hit by a devastating earthquake. It was necessary to adopt a number of emergency measures, owing to the need to protect future works against other possible earthquakes of an intensity not experienced by the country up to that time. Some of these measures were: the replacement of the powershed and the relocating of the substation, as well as the design and construction of a diversion canal, all of which became necessary when a geological fault was found in the Quixal river when it was temporarily diverted, and which was believed to be potentially active; the elevation of the dam and the redesign of other works to support an earthquake of a force of 0.65 G, as well as the redesign of the spillway to manage a surge of water resulting from a seismic wave with a probability of 10,000 years.
- 1.04 Besides the greater protection from earthquakes, during the construction itself karstic rock was found in the area where the tunnels are excavated, which resulted in landslides and which in certain cases required greater injections of concrete. Other reasons for the cost increment which occurred during the execution are, by way of example: the different rate of exchange of the U.S. dollar with respect to other hard currencies in which some construction contracts that had been signed and paid in part were denominated; and the cost overruns associated with the

greater need for equipment, manpower, etc. to reduce the delay in the entry into service of the first unit of the project, in view of the high cost to the country of producing electric power currently being produced primarily in thermal plants.

- 1.05 None of the factors mentioned above can be attributed to the borrower or to the executing agency. The variations between what was projected in the original feasibility study and the actual reality should not be considered shortcomings of the study, given the size of the work and the peculiar feature that in Central America no other project with a tunnel of similar length had been built.
- 1.06 The difficulties referred to above led to a number of cost revisions on the operation. In effect, the estimate originally established in analyzing the operation was US\$340.8 million equivalent. Of that total, the IDB (with two loans from its own resources and another two loans from the Fondo Venezolano de Fomento and a complementary line of credit), the IBRD, CABEI and suppliers' credits would finance 61.8% and the remaining 38.2% would have to come from the local contribution. As of December 31 of 1980, the estimate of the work had been changed on two occasions and came to US\$446.5 million. Of this amount, the local contribution from internal sources exclusively would finance 51.5% while the external sources would finance the remaining 48.5%. At the present time it is estimated that the local contribution from internal sources exclusively, most of which is being contributed by special efforts on the part of the government and supplied in due time as required by the execution of the project, would cover 49% of the total cost of the project, and the external sources would cover the remaining 51%. This reveals that although the total cost has increased by 84%, the local contribution requirements have increased by 137%, going in absolute terms from the equivalent of US\$131.1 million to the equivalent of US\$308.5 million.
- 1.07 Despite the cost increases indicated above, the project continues to be profitable and of vital importance to the country. This is primarily because, as analyzed in other parts of this report, electric power is being generated primarily in thermal plants in Guatemala, which represents a very sizable annual outlay in fuel. In this regard, it should be taken into account that at the time the original analysis was made, the prices that were used were those in existence in the month of March of 1975, which were US\$13.25 per barrel of bunker C and US\$17.05 per barrel of gas oil. For the present analysis, the pertinent prices are US\$33.43 per barrel of bunker C, US\$43.10 for diesel and US\$34.60 per barrel of crude oil. These price increases have been reflected in the rates charged by INDE to its consumers, since the average price per kilowatt/hour sold has increased by 143% between 1976 and 1980.

B. The Application

- 1.08 Numerous contacts have been established between the borrower, the IDB and the executing agency, adjusting the estimates as necessary. The costs overruns have been financed through additional contributions by the government and the Fondo de Inversiones de Venezuela. Finally, on March 5 of 1981 the government of Guatemala applied to the Bank for an additional loan to cooperate in the financing of the increase in the cost of the works of the project and the IDB was also requested to obtain financing from other sources.

C. Priority of the Project

- 1.09 Since 1979 the economy of Guatemala has been experiencing a decline in private investment owing to the flight of capital, which the government began to control in 1980 by establishing foreign exchange control. Much more important was the investment policy of the government, which since 1979 has sought to offset the decline in private investment and the flight of capital through significant increases in public investment. A large part of that investment has been directed towards the social sectors, but the government has not disregarded projects of an economic nature such as the present one owing to the importance they have to the future development of the country. In effect, if the Pueblo Viejo project is delayed by one year and if it enters into service in November of 1983 (instead of November of 1982) this would represent an additional cost to the country of US\$40 million as a minimum only in terms of fuel.
- 1.10 Guatemala has been producing petroleum in small quantities since 1979, which could eventually be used to replace imports of fuel intended for other purposes than the production of electricity, or for exports. However, owing to the world energy crisis, it would be very difficult economically to use it in the future for thermal power generation. With the entry into service of the Pueblo Viejo project (with 300 MW) and the Aguacapa hydroelectric plant (90 MW) the country would only be using between 7% and 9% of its identified hydroelectric potential. The soils of Guatemala are fertile and its climate is favorable to the production of all types of food. At the present time the only thing in the way of the development of the country basically is the political situation it is going through and the need to incorporate a very large segment of the population into the market economy, supplying it in turn with basic social services. After this first circumstance has been overcome, it will become even more evident that Guatemala has one of the best development outlooks in the entire region.
- 1.11 It is not a feasible alternative for the Pueblo Viejo project not to be concluded. Its delay would be even more costly to Guatemalans. The additional financing requested from the Bank would assure that the delay in the startup of the project would be reduced to the minimum.

D. Analysis Mission

- 1.12 Besides particularly intensive supervision on the part of the field office of the Bank and the pertinent sector specialist, during the month of April of 1981 the IDB sent an analysis mission to Guatemala which had the basic purpose of carrying out the following activities: to estimate a realistic schedule for completing the project and to determine the additional costs that would be incurred for the complete execution of the project; to reevaluate the economic rate of return of the project in view of the higher costs and the greater time needed for its construction, comparing the alternative recommended in this report (that the IDB finance the project now) with various alternatives that would involve primarily a delay in the works; to determine the capacity of the country and of the executing agency to meet the higher cost of this project, without overlooking their other obligations which include the program to expand the electric sector; and, based on the above, to make a preliminary analysis with the Guatemalan authorities of the criteria for the new financing scheme proposed and the terms and conditions of the various complementary loans that are required.

II. EVALUATION OF LOANS 301/OC-GU, 302/OC-GU,
454/SF-GU AND 6/VF-GU 1/

A. Background

(a) Of the project

- 2.01 The above-mentioned loans are contributing to the financing of a hydroelectric project in the middle reaches of the Chixoy River (Negro River), located in the Department of Alta Verapaz in the Republic of Guatemala. The Executing Agency of the project is the National Electrification Institute (INDE). 2/ The project uses a gross head of 514 meters and a flow of 64 m³/sec, and will have an installed capacity of 300 MW consisting of 5 generating units of 60 MW each. The mean annual generation initially envisaged was approximately 1,650 GWh for a normal hydrological year; at present provision is made for a mean annual generation of 1,710 GWh. The final capacity of 300 MW will be installed in the first and only stage of the project.
- 2.02 The project consists basically of the following:
- (i) A rockfill dam with an impermeable clay core, 130 m high from the rock foundation, and 250 m long at the crest, with a total volume of fill of 3,200,000 m³. It will create a reservoir of 460 Hm³, 14 m² in area and 50 km long, on the basis of a planned maximum level of 800 m above sea level. Provision has been made for a dead storage volume of 140 Hm³.
 - (ii) A concrete spillway, at the back of the dam, for a maximum flow of 3,880 m³/sec (10,000 year flood).
 - (iii) Intake structure with trash racks, slide gate, emergency gates and guard gate.
 - (iv) Pressure tunnel, 26 km long, and with a final internal diameter of 4.93 m, circular section, lined throughout its length with plain concrete and/or reinforced concrete. One tunnel is 7,660 m long and the other 18,100 m long and they are joined by an aqueduct bridge on pillars that crosses the Chixoy River in the neighborhood of Agua Blanca. At that place, and at the end of the tunnel that leads into the penstock, steel armor will be placed.

1/ In addition to these loans, the Bank granted loan 81/OC-GU in the amount of US\$3,150,000 in December 1966 for the construction of the Los Esclavos hydroelectric plant. The plant is in operation and the IDB loan is being regularly amortized.

2/ The institutional and financial aspects of the Executing Agency are discussed in Chapter VI of this report.

- (v) Upper and lower surge chambers at the end of the tunnel connected to it by a sloping shaft (which connects the tunnel to the lower chamber) and a vertical shaft (which connects the lower chamber to the upper chamber).
- (vi) A steel penstock, 3.65 m in diameter, laid in a trench, embedded in concrete and with 5 additional support blocks. At the head of the penstock is a mechanically activated butterfly valve.
- (vii) An outside powerhouse, with 5 vertical axis turbine generating units. The turbines are of the single impulse wheel type, with 6 jets each, and are rated at 69,000 HP. They are coupled to synchronous generators, each rated at 60 MW - 360 RPM - 13.8 kV.
- (viii) A two-circuit transmission line, rated at 230 kV and 123 km in length, connects the switching yard at Quixal to the Guatemala Norte substation, which will be part of the future 230 kV ring around the capital city of Guatemala.

2.03 Other auxiliary works of the project are:

- (i) The 70 km of road it was necessary to construct and/or improve in order to give access to the work sites.
- (ii) Camps and corresponding facilities at Pueblo Viejo (dam); Agua Blanca; Upper Quixal; Lower Quixal; Li-Chinatzul (San Cristóbal, INDE camp); Santa Cruz (COGEFAR camp); Venecia (HOCHTIEF camp); offices and warehouses in Pampur.
- (iii) Two diversion tunnels, 480 m and 495 m in length, at Pueblo Viejo, final diameter 7.10 m, for constructing the dam. Tunnel II will be provided with an intake and valves since the LAMI consortium is of the opinion that those structures, as planned, will provide limited control of the reservoir.
- (iv) A bypass and subsequent pressure tunnel for the flows of the cataracts at Pampur, for the dual purpose of reducing the flow towards the tunnel during its construction and subsequently increasing the flow available for generation.
- (v) Finally, at Quixal, the river of that name was diverted by a canal in order to gain more room for constructing the powerhouse and the switching yard.

2.04 As originally estimated for the project, the total cost was the equivalent of US\$340,874,000 (1975 prices). The current budget, approved by the Bank in December 1980, is for US\$446,547,000 (at prices updated to December 1979); the most recent estimate of INDE and of its consultant, LAMI, puts the final foreseeable cost (prices and yardage updated to December 1980) at US\$598,598,000. As stated in Chapter IV of this report, according to the estimates of the Bank at July 1981 (at January 1981

prices) the total cost of the project at its conclusion would amount to US\$630,000,000 equivalent).

(b) Of the loans

2.05 The basic data of the IDB loans are as follows:

- (i) Purpose: To cooperate in the financing of the construction of a hydroelectric plant on the Chixoy River.
- (ii) Borrower: The Republic of Guatemala.
- (iii) Date of approval: December 18, 1975, by the following resolutions of the Board of Executive Directors of the Bank: DE-246/75, DE-247/75, DE-248/75 and DE-249/75.
- (iv) Date of signature of contract: The four contracts were signed on February 15, 1976.
- (v) Amounts and currencies (figures in US\$ thousands or equivalent):

	<u>Amount</u>	<u>Currencies</u>
301/OC-GU	10,000	US dollars
302/OC-GU	15,000	US dollars
454/SF-GU	45,000	US dollars
6/VF-GU	<u>35,000</u>	US dollars 30,000 and 5,000 U.S. dollars
Total IDB loans	<u>105,000</u> =====	equivalent in bolivars

(vi) Execution deadlines (first and final disbursements) 1/

	<u>First disbursement</u>	<u>Final disbursement</u>
301/OC-GU and		
302/OC-GU	6/3/77	3/3/83
454/SF-GU	6/3/77	3/3/83
6/VF-GU	6/3/77	9/3/82

1/ The original deadlines have not been changed, and all the funds will be used within the current deadlines.

B. Project Execution

1. Technical aspects

(a) Physical and financial advance

2.06 At March 31, 1981 (date of the evaluation made by the Field Office) the physical advance of the project was estimated at 62%. According to the Initial Report of the Executing Agency, the physical advance at that date should have been about 92%. At June 30, 1981 (date of the completion of this report) the physical advance was 68%, which implies a lag of 7 months. The aggregate investment at December 31, 1980 amounted to the equivalent of US\$280,253,000 or 82%, 63% and 47% of the total original, current, and updated cost respectively. The Initial Report envisaged that 86% of the total investment would be made by December 31, 1980. According to the figures and percentages given above, it would appear that although the investment at the date of the evaluation (in current dollars) approximately the same as that envisaged, it is not keeping pace with the physical advance of the project, since its present total cost, according to the current official budget, is 31% higher than that originally planned. 1/

(b) Fulfillment of plans, specifications and technical standards

2.07 Generally speaking, construction has been carried out in accordance with the original specifications and technical standards, but substantial changes have been made in several parts of the project, as described briefly in the following section.

(c) Important changes in the project

2.08 The principal changes in each lot of civil engineering works, in relation to what was provided for in the feasibility study (and/or bidding documents) that served as the basis for the Project Report prepared in 1975, are described below.

(i) Lot 1 (dam, spillway and bypass works)

2.09 The height of the crest was raised from 812 to 815 meters above sea level and the volume of fill was increased from 2,680,000 m³ to 3,200,000 m³ (19%). Accordingly, the maximum height of the sill of the spillway was increased from 797.7 to 800 meters above sea level. In addition, the three spillway sluice ways were increased from 11.80 m to 15.00 m and thus the discharge flow was increased from 1,968 m³/sec to 3,880 m³/sec, all in accordance with a recommendation of the Board of Special Consultants.

1/ In this regard, see the pertinent table in paragraph 5.07, which shows that the physical advance is consistent with the investments made and those that should be made in the years ahead.

- 2.10 The project originally envisaged using a substantial portion of the rock from the excavation of the spillway as rockfill material for the dam. Because of the high proportion of fines in the rock excavated for the spillway, it was necessary to provide part of that material from a more distant quarry that was opened for that purpose, as well as to change the volumetric relationship between the different areas of which the fill of the dam is composed. In addition, to ensure the stability of the excavation of the spillway - during construction and subsequently during the operation of the facilities - it was necessary to adopt measures for the protection and drainage of the excavated slopes and berms.
- 2.11 Apart from some protection at the entrance to the diversion tunnels and the need for 12,000 m³ of concrete fill for a large limestone cavern encountered in the last 80 m of diversion tunnel II, no other important change was made in the design of the diversion tunnels except the modification of the permanent intake works within the reservoir for diversion tunnel II, which LAMI consultants planned as a bottom drain. ^{1/} This inlet was changed for one of the covered morning glory type. Other minor changes were made in the chamber of the bottom gate.
- 2.12 Originally provision was made for the middle part of the inclined plane of the spillway to be supported, on both sides, on the rock of the trench excavated for that structure. Because of the poor quality of the rock in that section the edge corresponding to the external slope had to be eliminated and consequently the walls of that side of the spillway will have to be strengthened and possibly anchored.
- (ii) Lot 2 (intake structure; pressure tunnels; crossing at Agua Blanca; surge tank)
- 2.13 The lower threshold of the intake structure was raised about 5 m (747 to 752 m above sea level). This change was made in order to separate the intake from the sediment that is deposited over time in the reservoir and to the extent the maximum and minimum operating levels of the reservoir increase. The final diameter of the pressure tunnel (completely lined) was changed from 4.90 m to 4.93 m.
- 2.14 The crossing of the Chixoy River at Agua Blanca, originally planned in the form of an inverted steel siphon, was changed to a structure consisting in an aqueduct bridge supported by 5 pillars fixed in the bed of the river; this was done because of possible vertical and horizontal displacements between the two banks of the Chixoy River at that place due to the activation of a fault longitudinal to the channel of the river.

^{1/} Karst formations are of volcanic origin and are characterized by their porosity, which results in the formation of caverns and caves in unexpected places.

- 2.15 The project originally provided for contact grouting (between the lining and the rock) throughout the length of the tunnel and consolidation grouting sporadically along the tunnel. At present a program of systematic consolidation grouting is being undertaken throughout the length of the pressure tunnels. To give an idea of the order of magnitude of the change, the length in meters of the drillings for the grouting and the volume of grouting material, planned and actual, are compared below:

	<u>Originally planned</u>	<u>Actual</u>
Length of drillings (meters)	15,000	122,000
Grouting material tons	2,100	16,000

- 2.16 This means a substantial change in the original conception of the geotechnical (and geomechanical) conditions of the rock and the real situation, as shown by the excavation already made of the tunnels. In this regard, it should be explained that although there has been a good correspondence (similarity between formation and type of rock forecast in the geological Report and that actually excavated, the geomechanical conditions (quality of the rock) have dictated - during the construction phase - intensive use of steel bracing and lining plates, that is, the geotechnical conditions have differed from those envisaged. This explains the substantial cost overrun due to geotechnical (not geological) contingencies. The soil studies were adequate and were carried to a level of detail that is normal and acceptable for this type of works.

- 2.17 Other changes worthy of mention in this lot are:

- (1) The structures for the collection of the springs (cataracts) at Pampur were substantially changed, from the original idea of a tunnel 2.00 m in diameter and 1,100 m in length to, finally, a diversion channel 1,746 m in length for 30 m³/sec and another headrace channel 450 m in length for 5 m³/sec.
- (2) A completely lined drainage gallery 540 m in length was added and runs under station 1,650 m of the pressure tunnel being excavated from Quixal. The purpose was to have a better outlet for the seepage that was expected to occur between stations 2,000 m and 2,500 m on the front being excavated from Quixal. To reach the frontage for this drainage gallery, it was necessary to construct a motorable access road 2,300 m in length.
- (3) In the lower chamber of the surge tank, provision was made for a plain concrete lining 0.50 m thick in case solid rock like that excavated was encountered. To ensure better seismic safety, the lining has been executed in reinforced concrete.

- (4) The final diameter of the vertical shaft connecting the lower with the upper chamber of the surge tank was increased from 5.95 m to 7.50 m, in accordance with the findings of the studies of possible hydraulic fluctuations during the operation of the plant.
- (5) For the reasons indicated in the foregoing paragraph, the internal diameter of the upper chamber of the surge tank was increased from 35.00 to 43.00 m and the circular walls were constructed with pre-stressed concrete in order to reduce their thickness since, contrary to what was planned in the preliminary project, the walls remained above the maximum ground level.

(iii) Lot 3. Diversion channel, powerhouse and penstocks

- 2.18 In the excavation phase of the diversion channel, the rock expected to be found at 5.00 m, on average, of the excavation was not discovered. Therefore it was necessary to deepen the excavation and increase the hydraulic section of the channel. The slopes were stabilized in some sections with reinforced concrete walls and in others with anchored mesh and gunite.
- 2.19 In addition, the working design incorporated a steep reinforced concrete slope and a stilling pool as an energy dissipator at an intermediate point in the total length. At the bottom of the stilling pool, dentated blocks were constructed to trap the material carried by the Quixal River.
- 2.20 During the excavation of the powerhouse a fault was found; it ran approximately along the channel of the Quixal River and cut across the longitudinal axis of the powerhouse (and of the substation). In the preliminary project, these buildings had been located exactly above the bed of the Quixal River, which was to be permanently diverted by the above-mentioned channel. This fault was known from the feasibility study, but the possibility that it might be active led to a recommendation by the Special Consultants (October 1978) that the axis of the powerhouse be turned approximately 90° and the powerhouse be located on the left bank of the Quixal River. Accordingly, the slope on that bank had to be excavated to gain sufficient room. The excavation of the slope and its permanent stability necessitated protection with reinforced (meshed) gunite and anchors and the respective drains.
- 2.21 The original design of the penstock, in accordance with the bidding documents, provided for a pipe, 3.65 m in diameter, embedded in a trench filled with concrete and a single anchor block at elevation 366 m above sea level. Now the working design provides for 5 anchor blocks, in addition to embedding in the above-mentioned trench. The anchor blocks will also be fixed to the ground by means of pre-stressed cables.

(d) Conclusions regarding changes in the works

- 2.22 In general, it should be pointed out that an important variation in the basic premises of the designs of all the structures of the project is

the increase in the seismicity factor used. Thus, while the bidding documents considered an acceleration of 0.1 g, the working designs took into account horizontal accelerations of 0.65 g following investigations subsequent to the feasibility study on earthquake activity in the project area and its possible magnitude. These additional investigations were necessary because of the devastating earthquake of February 1976, which occurred one month after the loan contracts were signed with the IDB. This variation has led to major changes in the design of the following structures:

- (1) Change in the grade of the slopes of the rockfill dam and in the disposition of the materials in the areas in which the impermeable core, the filters, the drains, and the various types of rockfill are distributed.
- (2) In the aqueduct bridge that crosses the Chixoy River at Agua Blanca.
- (3) In the design of the upper chamber of the surge tank.
- (4) In the number and reinforcements of the anchors of the penstock.
- (5) In the reinforcement of the structure of the powerhouse building.

2.23 The effect of these changes in terms of time, cost and economic return, as well as the corresponding updating of the cost-benefit ratio, has been calculated as part of the analysis of the new loan that is the subject matter of this report. The increases in cost and in time for each change in the works are summarized below.

(i) Costs

2.24 The table in paragraph 2.45 contains a comparison of the costs estimated in Appendix B of the original Project Report (at mid-1975 prices) and the costs included in the official budget at present in force. ^{1/} The table presented as Appendix II-1 of this report shows the distribution of the increases in the budgets: from US\$340,847,000 to US\$446,547,000 and from US\$446,547,000 to US\$630,000,000 for each one of the lots of civil works and supplies.

(ii) Deadlines

2.25 According to this Project Report, the generating units were expected to enter into service in the second quarter of 1982. Despite the fact that the excavation of the tunnels did not begin until April 1978, that is to

^{1/} It was approved in December 1980 and, as stated in Chapter IV of this report, the necessary financing is available. This does not apply to the new budget (in the amount of US\$630 million); the difference between them (US\$183 million) is precisely the financing gap that is analyzed in this report.

say, almost 15 months later than envisaged in the Project Report, the first unit may begin its test run in November 1982, that is to say, five months later than originally planned. ^{1/} In this regard it should be noted that the Project Report estimated the time required for the excavation of the tunnels at 52 months and the time for lining them, following excavation, at 13 months. Because mechanical (nonconventional excavation with a cutter was adopted on three fronts; a fourth front was opened from Pueblo Viejo (first acceleration); and the lining and grouting work were carried out jointly with the advance of the excavation, the critical path of the project - apart from the pressure tunnel - will be completed in 48 months, that is to say, in 76% of the time originally estimated in the Project Report.

- 2.26 The status of Lot 1, in particular the rockfill dam, is different. Primarily because of the lack of definition, at the date of evaluation, of the extent of the grout curtain, drains, and related underground works for ensuring that the reservoir will be watertight and the need to control seepage in the area of the Pueblo Viejo dam, it was not possible to ensure that the priming of the reservoir would begin in February 1982 and end within the first half of 1982.

(e) Quality of the specific goals achieved

- 2.27 Although this evaluation was made when the physical advance of the project was 62% of the total, it may be said that, by and large, the quality of the works being executed by the contractors is excellent. This applies particularly to the back fill of the dam and the quality of the concrete of the outdoor structures of Lots 2 and 3.
- 2.28 Generally speaking, the contractors of the civil works have been satisfactorily complying with their obligations; the only negative aspects that warrant mention are the loss of the excavation front of the tunnel at Agua Blanca South by the contractor of Lot 2 and a certain initial lack of construction equipment in the case of the contractor of Lot 3.
- 2.29 In the case of suppliers, the manufacturing, supplies (transportation) and erection programs are being satisfactorily carried out except in the case of the supplier and contractor of Lot 6 (mechanical structures, penstock, butterfly valve and gates), the firm of SOREFAME, which has missed several deadlines and therefore the penstock remains on the critical path of the work.

(f) Important technical problems that have arisen during the execution of the project

- 2.30 The technical problems of major importance were dealt with in greater detail earlier; they are: (i) change in the seismicity factor for all

^{1/} Provided no major problems occur in the remaining excavation of the Agua Blanca Norte-Quixal tunnel and that the grout curtain in the dam is sufficient to retain the impoundment.

the structures of the project; (ii) raising of the crest of the dam and increase in the discharge capacity of the spillway; (iii) change in the structure crossing the Chixoy River at Agua Blanca; (iv) increase and strengthening of the anchors of the penstock; (v) change in the position of the powerhouse and of the substation at Quixal; (vi) increase in the grouting pattern of the foundation of the dam, and (vii) systematic consolidation grouting in the tunnels.

- 2.31 The steps taken by the Bank with respect to these matters have been supported by the recommendations of the Board of Special Consultants of the project, which the Bank asked for as one of the requirements for the better supervision of the works. Up to the time of the evaluation, 13 meetings of the Consultants Board had been held, and its advice had been useful in improving the preparation of the designs and construction. Since this is a complex work, the role of the Bank has consisted in collaborating in the search for solutions geared to the problems presented in terms of costs and execution time and obtaining timely decisions from the Executing Agency. Solutions have already been found for items (i), (ii), (iii), (iv), (v) and (vii) mentioned above. For item (vi) and, to some extent, for item (vii), further consideration might be necessary in the future, in particular as the result of the respective tests, that is to say, control of the priming of the reservoir and the pressure testing of the tunnels. The solutions adopted have led to some substantial but necessary increases in the cost of the project, but do not greatly affect the generating capacity or the time for the entry into service of the project.

(g) Supervision by the Executing Agency and/or consultants

- 2.32 The supervision of the execution of the project is the responsibility of the specific Executive Directorate known as the Executing Unit of the Pueblo Viejo-Quixal Hydroelectric Project. The Executing Unit comes under the authority of the Office of the Deputy Manager of Construction Works and Production and that, in turn, under the Office of General Manager of the institute. The personnel assigned to the Executing Unit are shown below by location and level:

	Guatemala City	+	Site	=	Total
Professional personnel	9	+	45	=	54
Technical personnel	16	+	151	=	167
Auxiliary personnel	21	+	184	=	205
Total	46	+	380	=	426
	==		===		===

- 2.33 In addition, the Executing Unit is receiving technical advice from the LAMI consortium made up by the association, for the project, of the following consulting firms: Lahmeyer International GmbH (Frankfurt-am-Main, Federal Republic of Germany), Motor Columbus, S.S. (Baden, Switzerland) and International Engineering Co. Inc. (San Francisco, USA).

- 2.34 The basic engineering services contracted by INDE with the LAMI consortium are covered by a typical engineering and supervision contract with the following special features: (i) the designs are prepared exclusively at the head offices of the consulting firms that make up the consortium and (ii) orders to the contractors at the site are given directly by the resident engineers of INDE for each Lot into which the works and supplies have been divided.
- 2.35 For the purposes of on-site supervision and coordination of the project between Guatemala City and the head offices, the LAMI consortium now has - when the works are peaking - 15 foreign engineers and technicians, as listed below:

(i) Civil works and geneal coordination

One Project Director and Chief Resident Engineer; one Deputy Resident Engineer; one Supervising Engineer of Lot 2 (pressure tunnel); one Supervising Engineer of Lot 1 (dam and spillway); one Supervising Engineer of Lot 3 (penstock and powerhouse); one Tunnel Engineer; one Engineer specializing in grout injections in the dam; two Geologists; one Technician specializing in grout injections in the tunnels; and one Chief Surveyor.

(ii) Electro-mechanical equipment

One Supervising Engineer of the erection of Lot 4 (turbines, regulators, spherical valves and cranes); one Supervising Engineer of the erection of Lot 5 (generators, transformers and auxiliary electrical equipment); one Supervising Engineer of the erection of Lot 6 (penstock and other mechanical equipment such as gates, valves, and armor) and one Supervising Engineer of erection of Lot 7 (transmission lines and substation).

- 2.36 In addition to the above-mentioned personnel, who are on the site, the Technical Supervision Council composed of 6 directors (2 from each firm) of the head offices of the members of the consortium sometimes participate, as do 7 advisors and/or special experts and technical support personnel such as design engineers and designers in the head offices of the consulting firms that make up the LAMI consortium. The consortium is also responsible for inspecting the manufacture of the electro-mechanical equipment in the workshops of the suppliers and the in-factory testing of that equipment, where applicable.
- 2.37 Engineering and supervision contract 33-77, entered into by and between INDE and the LAMI consortium on June 28, 1977, was for the equivalent of US\$10,020,800 with a possible 60% increase. At the date of this evaluation, the amount of the contract, plus its expansions, totaled the equivalent of US\$14,542,600 (without escalation), that is to say, 45.1% more than the amount originally contracted.

- 2.38 The on-site personnel of the Executing Unit of INDE and of the LAMI consulting firm is more than sufficient for proper supervision of the civil works and the erection. A lack of inspectors was noted only in the case of the supervision of the detail of the grouting of the foundation of the dam, which is due to a larger number of work sites than originally envisaged.
- 2.39 The most significant difficulties in supervision have arisen from the lack of a design engineer's office (of the LAMI consortium) at the site of the works. In complex works like those of the project, so far removed from the design offices of the head offices, it would have been very useful to have an on-site design office responsible for adjusting and revising the plans prepared at the head offices and even of producing them to the extent and at the time required, in accordance with the advance of the works, and as the real soil conditions become known as a result of the excavations being made to support the various structures of the works.
- 2.40 With respect to the quality of the supervision by the Executing Unit, it should be noted that situations have arisen that are common in institutions which, like INDE, are tackling complex projects never before undertaken in the country. Although INDE has filled its professional supervisory posts with local personnel with substantial experience (recruiting engineers that have previously worked on tunnels, for example), in other aspects (such as in the rockfill and the clay core and specialized matters such as geology, foundation treatment and grouting) the experience of the local personnel is rather limited or is being gained in this project. The technical advice on those aspects given to the supervisors by the LAMI consortium has been valuable and the wise decisions of the manager of INDE and of the Executive Director of the project have enabled the LAMI consortium to find methods, and obtain the special advisory services and investigations it has requested whenever it has been faced by a specific problem of importance, and the costs have been satisfactorily covered.
- 2.41 Finally, the Director of the project, who, as far as the technical aspects are concerned, has been the Chief Resident Engineer of LAMI, has mapped out and cooperated in taking the steps involved in the most important decisions, thus solving the most serious problems that have occurred.

(h) Degree of fulfillment of special technical conditions stipulated in the loan contracts

- 2.42 Clause 1(g)(i) of Chapter III and clause 9 of Chapter V of loan contract 454/SF-GU (and similar clauses in contracts 301/OC and 6/VF-GU) stipulate that INDE shall select and contract - in agreement with and to the satisfaction of the Bank and in accordance with the procedure described in those contracts - a firm of supervising engineers for the project and the members of the Board of Special Consultants. These obligations were

fulfilled by INDE by contracting the LAMI consortium (INDE-LAMI contract 33-77 of June 28, 1977) and concluding the individual contracts to which reference was made in earlier paragraphs. In addition, the substantial changes in the budgets, investment schedules, plans and specifications of the project and in the contract for engineering and supervision services have been submitted to the Bank for approval.

- 2.43 Finally, the Executing Agency has submitted evidence that it owns most of the sites on which the corresponding works are being constructed, with the exception of the easements for some sections of the Quixal-Guatemala transmission line, but they are being gradually obtained. This is a common practice for this type of facility that involves a number of sites.

(i) Quality of the reports of the Executing Agency

- 2.44 Up to December 31, 1980 INDE punctually presented in accordance with the schedule of the initial report nine progress reports for each semiannual period that had elapsed. All those reports have adequately described the status and problems of the various parts of the project, their physical advance, the investments made and the sources of the funds used; therefore they have been extremely useful for monitoring the execution of the project. INDE has also provided each quarter a Report on the local contributions to the project. For its part, the LAMI consulting firm has issued 48 monthly Reports up to May 1981, describing the activities of each Lot in the period.

2. Financial aspects

(a) Fulfillment of the financing plan originally envisaged

- 2.45 The current official financing plan for the project, ^{1/} compared with the original financing plan, is presented below by investment categories, currencies of use and currencies of origin:

^{1/} Approved by the IDB in December 1980. It has been revised, as stated in Chapter IV of this Report, which presents the estimate prepared jointly by INDE and the IDB Analysis Mission in April 1981.

(in US\$ thousands equivalent)

Investment category	Original Financing				Current Financing			
	IDB 1/	Repub- lic	Other sources	Total	IDB	Repub- lic	Other sources	Total
Engineering and administration	10,282	7,608	-	17,890	8,995	22,612	-	31,607
Direct construction costs	49,895	59,334	62,832	172,061	95,105	146,851	135,645	377,601
Finance charges	12,624	11,185	13,552	37,361	900	25,639	10,800	37,339
Unallocated	32,199	51,985	29,378	113,562	-	-	-	-
Total	105,000	130,112	105,762	340,874	105,000	195,102	146,445	446,547
	=====	=====	=====	=====	=====	=====	=====	=====
Currencies of use								
Direct foreign exchange	105,000	29,654	105,762	240,416	105,000	77,830	146,445	254,575
Indirect foreign exchange	-	-	-	-	-	-	-	-
Foreign exchange for local outlays	-	-	-	-	-	-	-	-
Local currency (quetzals)	-	100,458	-	100,458	-	117,272	-	117,272
Total	105,000	130,112	105,762	340,874	105,000	195,102	146,445	446,547
	=====	=====	=====	=====	=====	=====	=====	=====
Currencies of origin								
U.S. dollar	100,000	29,654	105,762	235,416	100,000	77,830	71,700	249,530
Bolivar B.N.S. Eq.	5,000	-	-	5,000	5,000	-	74,745	79,745
Quetzal	-	100,458	-	100,458	-	117,272	-	117,272
Total	105,000	130,112	105,762	340,874	105,000	195,102	146,445	446,547
	=====	=====	=====	=====	=====	=====	=====	=====
Percentage	30.8	38.2	31.0	100.0	23.5	43.7	32.8	100.0

1/ Includes loans 301/OC-GU, 302/OC-GU, 454/OC-GU, 454/SF-GU and 6/VF-GU.

- 2.46 As the foregoing table shows, the original cost of the project was US\$340.9 million (at March 1975 prices) and the cost approved by the Bank in December 1980 was US\$446.5 million, which represents an increase of US\$105.6 million or 31% in the originally estimated cost. 1/

(b) Origin and use of currencies, pari passu

- 2.47 The currencies of use and currencies of origin originally envisaged in the loan contracts were not changed; however, the amounts originally assigned by investment category were changed as a result of the re-costing of the project. As a consequence of the above-mentioned updating, the amounts originally assigned in the Engineering and Supervision category were increased by US\$13.7 million and those in the Direct Construction Cost category, by US\$205.5 million. In addition, an adjustment was made in the Finance Charges category, and the amounts included in the Unallocated category were redistributed.
- 2.48 On September 25, 1980 the Government of Guatemala requested the Bank to approve the transfer of US\$11,319,000 from the Finance Charges-Interest and Commissions category to the Construction Cost category so that only US\$0.9 million was budgeted for paying the Inspection and Supervision fees. In requesting this transfer of funds, the borrower pointed out that the originally estimated cost of the project had increased at that date by US\$105.6 million because of various factors including exchange fluctuations in the dollar, which affected the payment of hard currency contracts, and escalation in the prices of fuel, labor, materials, machinery, transportation, etc. The Bank approved that request and is of the opinion that the technical and financial reasons for the increase in the cost of the project are justified and are due to circumstances beyond the control of the Executing Agency.

1/ The amount of US\$446.5 million is already financed: consequently, the additional funding requested by INDE, which is analyzed in other parts of this report, is solely for the US\$183,453,000 necessary for completing the project.

(c) Fulfillment of special financial conditions stipulated in loan contracts 1/

(i) Provision of the local contribution

2.49 A summary of the cumulative annual investments over the last four years chargeable to the local contribution, other sources, and the IDB loans is presented below:

(In US\$ thousands or equivalent)

Year	IDB resources	Cumulative investments by year			IDB	Percentage	
		Counter part funds	Other sources	Total		Counter part	Other sources
1977	29,230	37,686	4,992	71,908	40.6	52.5	6.9
1978	32,122	19,871	12,650	64,643	49.7	30.7	19.6
1979	10,100	42,318	7,226	59,644	16.9	70.9	12.2
1980	11,760	61,959	12,341	86,058	13.7	72.0	14.4
	<u>83,212</u>	<u>161,832</u>	<u>37,209</u>	<u>282,253</u>	<u>29.5</u>	<u>57.3</u>	<u>13.2</u>
	=====	=====	=====	=====	=====	=====	=====

2.50 As may be seen from the foregoing table, the provision of the local contribution in absolute terms has been satisfactory. It is important to note that Annex B of the loan contract stipulates a pari passu of IDB 30.8%, other sources 30.0% and local contribution 38.2%, which has been duly complied with by the borrower in accordance with the needs that have arisen in the execution of the project.

(ii) Servicing of the loans

2.51 In accordance with its contractual obligation, the borrower, through the Ministry of Public Finance, has been paying the commissions and interest on the loans fully and on a timely basis.

1/ Comments on the financial conditions of the contract are based on loan contract 454/SF-GU since the same clauses are included in the other contracts signed with the IDB. Chapter VI of this report states that INDE has fulfilled the clauses relating to rates (Chapter V, clause 6), maximum limit of the debt/equity ratio (Chapter V, clause 7), internal audit unit (Chapter V, clause 8), and with the stipulations relating to financial records and the hiring of external auditors. In addition, it reports that INDE has not implemented the plan for reducing the collection period and suggests measures for remedying that situation. In this chapter - in the context of the physical execution of the project - the analysis is limited to the provision of the local contribution and the servicing of the loans (which includes contributions to the general accounts of the Bank for inspection and supervision).

3. Operating aspects

(a) Fulfillment of conditions precedent to the first disbursement

- 2.52 The loan contracts were signed on January 15, 1976. They were ratified by the Congress of the Republic of Guatemala on August 10, 1976 (almost seven months later) and their effective date, the day following the publication of Decree 34-76, was September 3, 1976 (almost eight months after signature). This period is considered reasonably short and is that which has been used for the schedules for the use of the additional funding presented in other parts of this report.
- 2.53 The loans were declared fully eligible for disbursement by memorandum OP1-GU-500/77 of March 30, 1977, after the Bank had approved an extension of 90 days - from December 2, 1976 to March 2, 1977 - for fulfillment of the conditions precedent to the first disbursement.

(b) Major changes in investment categories

- 2.54 The first change of importance was approved on December 20, 1977 and increased the total cost of the project from the equivalent of US\$340,874,000 to US\$365,569,000 (difference = US\$24,695,000) and substantially reduced the forecasts of Annex B for unallocated expenditures. The breakdown of these reductions was as follows:

(In US\$ thousands)

-	General contingencies:	from	22,084
		to	<u>5,690</u>
	Reduction		16,394
-	Provision for escalation:	from	91,478
		to	<u>38,590</u>
	Reduction		52,888

- 2.55 It therefore follows that the total reduction was US\$69,282,000 and, as will be seen below, it was used to cover the increased amounts stemming from the international public biddings for the lots of the civil works. In addition, it is concluded that the Direct Construction Cost category increased from the equivalent of US\$172,061,000 to US\$256,712,000 (by US\$84,651,000) and that of Engineering and Administration also increased from the equivalent of US\$17,890,000 to US\$27,238,000 (by US\$9,348,000) while the estimate for the Finance Charge category remained virtually unchanged (US\$37,261,000 as opposed to US\$37,339,000). With respect to the financing, the amount of the Bank's contribution remained at its original figure of US\$105,000,000 equivalent. The contributions of "Other Sources" decreased from the equivalent of US\$105,762,000 to US\$88,090,000 (by US\$17,672,000) since there was a decrease in their

contribution to General Contingencies (US\$4,793,000 was eliminated) and to the provision for Escalation (from US\$24,585,000 to US\$10,355,000 or a reduction of US\$14,230,000 as well as the elimination of US\$13,552,000 from the provision for Interest and Commissions. The contribution of Other Sources increased solely in the Direct Construction Cost category, from US\$62,832,000 to US\$77,735,000, so that the reduction in that contribution was US\$17,672,000, as indicated above. The local contribution was increased by the equivalent of US\$42,367,000 (from US\$130,112,000 to US\$172,479,000).

(c) Tenders and contracts 1/

- 2.56 During the tendering, no complaints that required attention by headquarters were presented nor was it necessary to authorize exceptions of any kind. In the application of the contract for Lot 2, the Executing Agency and HOCHTIEF, A.G., the contractor, agreed in January of this year to amend clause 5 of Contract 96-77, which they entered into on August 11, 1977, by increasing from 20% to 40% the possible variation in the contract price of US\$126,248,100. The reason for this amendment was the increase in the construction works covered by Lot 2 (in particular increased consolidation grouting; a number of design changes due to a different seismicity factor; overruns due to the geotechnical conditions of the rock being different from those envisaged and excessive water being present during the excavation of the tunnels).
- 2.57 INDE is taking steps to have the first generating unit enter in service during the first three months of 1982, as scheduled, because of the substantial fuel cost savings that would result. Consequently, it has entered into extra work contracts with the three civil works contractors on two occasions; in the first instance, through acceleration agreements whose purpose was really to make up the delays due to various causes and to cover the respective costs; in the second instance, through partial updatings of the schedules for each lot. In the first case INDE submitted its reasons to the Bank which made no substantive observations on them. Even so it was clear that the resources of the IDB loans would not be used even partially to cover those extra costs in the case of Lots 2 and 3. The agreements concerning updated schedules have been entered into by and between INDE and the three civil works contractors directly and the Bank has been kept informed of them. The intention is to ensure the entry into commercial service of the first generating unit in June 1982, which is now not considered feasible by the IDB. The cost of the accelerations was the equivalent of US\$11,371,000 and that of the updated schedules, the equivalent of US\$9,291,000, or a total of US\$20,662,000.

1/ The contracts denominated in whole or in part in foreign currency are: i) Lot 2 (tunnel) more than 40% of which is payable in German marks; this contract was executed and more than 70% of it was paid before the U.S. dollar began its recent recovery; ii) the contract for Lot 5 (turbines) and Lot 6 (generating equipment), a high percentage of which are denominated in Swiss francs and yens and of which smaller percentages have been paid because of the later date of delivery of the equipment.

(d) Disbursements

- 2.58 The disbursements of the four loans all began at the same time on June 3, 1977. Up to March 31, 1981, a total of 31 disbursement requests had been processed; this means, when the inspection and supervision fee is added to them, that US\$81,027,000 of the loan resources has been used, i.e., 77.2% of the total of US\$105,000,000 ^{1/}. The local contribution/IDB contribution ratio is at present 2.60/1.00 and compares favorably with that established in the loan contracts (Annex B), which was 1.23/1.00. The disbursement requests have been submitted and processed in accordance with the procedures established by the Bank. In the case of Loan 302/OC-GU (which consisted in a complementary line of credit), the final disbursement was made on December 6, 1977, whereas the final deadline for it was March 31, 1978. The other three loans have still not used up the periods for their disbursements. (The shorter period is that for Loan 6/VF-GU, which is September 3, 1982 and Loans 301/OC-GU and 454/SF-GU have up to March 3, 1983).
- 2.59 In 1981 INDE wishes to use the entire balance of the above-mentioned three loans (US\$16,336,704 as of June 30, 1981) whereas the forecast of disbursements by IDB for 1981 is US\$14,150,000. (Between January 1, 1981, and June 30, 1981, an amount of US\$9,836,000 was disbursed). According to this forecast, US\$12,022,704 would remain to be disbursed in 1982; however, it is to be noted that in the first half of 1981 the disbursements were about 125% of the forecast.

4. Economic and social aspects

- 2.60 Although the above-mentioned loan contract did not expressly provide for the execution of economic and/or social studies, it is to be noted that, simultaneously with these loan operations, the Board of Executive Directors of the Bank approved a technical cooperation (ATCN/CD(PP)/SF-1521-GU) entitled Program for the Development of the Chixoy Basin.
- 2.61 This technical cooperation is being satisfactorily carried out in two stages by independent consultants contracted by INDE, in accordance with procedures approved by the Bank. The results of that technical cooperation are outside the scope of this evaluation.
- 2.62 With respect to the social aspect, mention should be made of the efforts of INDE to relocate the few inhabitants that will be affected by the reservoir. Resettlement in the places requested by the inhabitants affected, which have the facilities requested by them, is nearing completion. (In this last-mentioned regard see Chapter V of this report).

^{1/} At June 30, 1981, the disbursements of IDB loans amounted to US\$88,663,296.

C. Conclusions

- 2.63 At the completion of this report (July 30, 1981): (a) the advance of the Pueblo Viejo-Quixal (Chixoy) Hydroelectric Project was 68%; (b) in agreement with the Bank, the earliest date for the entry into service of the first 60,000 KW generating unit would be November 1982; (c) with respect to the cost of the project, INDE now accepts the estimate of the Analysis Mission, namely the equivalent of US\$630,000,000; (d) the overruns of the project have been due to (i) changes in the working designs; (ii) larger amount of construction work; (iii) price escalations between March 1975, the date of the calculations that appear in Project Report PR-676-A of December 2, 1975, and mid-1976, when bids for the civil works were invited; (iv) the escalations that may occur up to the time of completion of the work; (v) the differences in the exchange rate between the dollar and other currencies that were revaluated, and (vi) technical contingencies in all the structures (dam, water conveyance works, and plant).
- 2.64 The design changes are in part due to having had to adopt, in the construction phase, a seismicity factor for all the works that was higher than the original (0.1 g instead of 0.65 g) as well as of having had to redesign and construct the spillway with sufficient capacity to handle a flood caused by an earthquake that could occur once in 10,000 years (instead of 1,000 years). These factors were revised in the light of the findings of investigations on seismicity in the area as the result of the devastating earthquake that occurred in Guatemala in February 1976. The design changes are also partly the consequence of the construction work which, as can now be appreciated, was necessitated by the conditions encountered and which, in a complex project like this (whose tunnels are longer than those of any other project so far constructed in the area), could not be foreseen at the time the original feasibility study was prepared.
- 2.65 The lack of an on-site engineering design office of the consulting firm may be mentioned as a negative technical feature of this project. On the other hand, the project has received and continues to receive the strongest support from the borrower from the banks (IDB, International Bank for Reconstruction and Development - IBRD, Central American Bank for Economic Integration (CABEI), Venezuelan Trust Fund (VTF) and the Venezuelan Investment Fund (VIF)) and the Executing Agency has assigned it the highest priority. Finally, the senior management of INDE and of the project have not spared any monetary effort to ensure the best possible technical result within the period originally established.
- 2.66 A large number of competitors took part in the international biddings for works and supplies, which were conducted in accordance with the standards and procedures of the Bank in particular the provisions of the Bidding Regulations that form part of the loan contracts. The works and supplies were awarded to contractors of recognized capacity that presented the best bids evaluated.

- 2.67 The general contractual clauses have been complied with, and the conditions precedent to the first disbursement have been fulfilled on a timely basis. Chapter VI of this report discusses in detail how INDE has been complying with the clauses relating to financial Reports, rates, and rate of return. The clauses relating the rates and rate of return will be applicable once the project enters into service in accordance with the IDB contracts.
- 2.68 As of June 30, 1981, 77% of the amount of the loans has been disbursed and, for all of them, the procedures stipulated by the Bank have been followed. The national counterpart contribution has been made available on a timely basis despite the substantial increases that have had to be covered by the government and INDE.
- 2.69 On the basis of experience with the project so far, a realistic schedule and updated costs were necessary in order to ensure the conclusion of the project as set forth in Chapters IV and V of this report.

III. FRAME OF REFERENCE

A. Recent Economic Development and Outlook

- 3.01 In 1980 the Gross Domestic Product (GDP) grew at a rate of 4% in real terms, compared to 4.5% in 1979 and an average of 6.7% in 1976-78. This performance represents the continuation for the third consecutive year of the downward trend in the rate of economic growth, which is attributed to the negative impact on private investment from political factors in Central America as well as the recessionary and inflationary status of the world economy. That performance, however, could have been much worse were it not for the considerable dynamism shown by public expenditures.
- 3.02 Gross private capital formation dropped 4.3% in 1980, after having declined 11.1% the year before. Furthermore, inventory was more than two times less than in 1979. In contrast, public investment increased substantially by 33% compared to the growth of 7.9% the year before and the decline of 2.6% in 1978, reflecting the more dynamic role of the public sector to offset in part the decline noted in private investment.
1. Fiscal and financial situation
- 3.03 The financial situation, both of the central government and the rest of the public sector as a whole, deteriorated considerably during 1980, as the result of a higher level of expenditures (particularly capital costs) to offset in part the decline in private activity. As to the finances of the central government, the accelerated growth in current expenditures and capital costs together with the slow increase in revenue caused an unprecedented fiscal deficit which represented 4.9% of GDP compared to 2.6% in 1979 and an average of 1.9% in 1976-78. About 71% of that deficit was financed through internal resources, primarily by means of the placement of bonds, and the rest through external official loans.
- 3.04 In 1980 the monetary panorama was characterized by the drastic decline in net international assets of the financial system stemming primarily from the outflow of short-term capital. To offset the monetary decline the authorities provided credit to the public sector, which increased by 200% over the year before. In addition, foreign exchange control was established in April of 1980 to prevent additional flight of capital. Furthermore, advanced payments and rediscounts were made available to the banking system to meet the various activities of the productive sector and the level of reserves was reduced to offset the deficiency between supply and demand of credit of the banking system to the private sector. In effect, the credit to the private sector grew in nominal terms by 20.2%, almost equal to the average annual rate prevailing in the period 1976-79.
- 3.05 Traditionally, the growth in the level of prices in Guatemala has been closely linked to external inflation. The consumer price index of the

urban area increased by 10.9% in 1980 compared to the growth of 11.5% a year before and the average of 10.4% in 1976-78. External inflationary pressure was felt in the increase in the prices of fuels and imported goods and services as well as in the increase that occurred in some products that are exported.

- 3.06 In March of 1980, the minimum wages established by the state for some workers in productive branches were modified. The activities that experienced the greatest changes in terms of average wages were industry with 18.2%, mining and quarrying with 14% and construction with 13.4%. Despite this, almost half of the workers did not recover the gradual loss in purchasing power caused by inflation.

2. Balance of payments

- 3.07 In 1980, as the result of a massive outflow of private capital, the balance of payments recorded an unfavorable balance and net international reserves experienced an unprecedented decline of \$250 million. Nevertheless, later on in that year the trade balance became once again positive, reversing the negative balance situation of the past two years.
- 3.08 In 1980 exports of merchandise reached US\$1,522 million, equivalent to a growth of 24.6% vis-à-vis the increase of 11.8% recorded in 1979 and the average of 19.5% between 1976 and 1978. Among the traditional products, the exported value of coffee reached \$462 million, 6.9% more than the year before, whereas the volume was 9.8% less. The value of cotton declined 6.8% to \$175 million (owing to less cotton available because of the poor harvest) whereas sugar sales abroad doubled to \$71.5 million (because of the combined effect of the increase of 45% in prices and 51% in volume). A somewhat similar situation occurred in the case of bananas owing to the greater supply for export. In contrast, external sales of meat experienced a drop of 35% in terms of value, owing to the difficulties that occurred in the United States market.
- 3.09 Imports of merchandise (F.O.B.) reached \$1,490 million, an increase of 6.8% compared to 1979, when merchandise imports grew by 8.6%. The categories that experienced the greatest increases were raw materials and intermediate goods, the value of which (\$535 million) showed an increase of 16.8% in 1980 compared to 7% in 1979. The purchase of fuel (which totaled \$322 million) represented an increase of 37.5% over the year before, which reflected the higher world prices for petroleum. In contrast, imports of capital goods declined, primarily because of the reduction in private investment of 13% (reaching \$295 million) and imports of consumer goods remained at the level of 1979.

3. Public external debt

- 3.10 At the end of 1979, total external public debt contracted for a period of more than one year reached \$836.4 million, that is three times more

than in 1975. The total amount disbursed was \$484.3 million. Debt service covered 2.2% of exports of non-factor goods and services. It should be pointed out that Guatemala is one of the countries that has the lowest ratio of total debt disbursed (7% of GDP) and debt service. Preliminary estimates indicate that total debt contracted increased 14% in 1980 to about \$950 million and that debt service amounted to close to 3.3%.

4. Petroleum and outlook

- 3.11 On this matter, it should be pointed out that Guatemala recently began to produce petroleum on a commercial scale, extracting 5,050 barrels daily in 1980 coming from the wells of Rubelsanto and Chinajá in the region of Alta Verapaz. About 60% of that production was exported and the rest was consumed locally as fuel for a cement factory and the GEESA, representing a savings of approximately 15% of the volume of petroleum and petroleum by-product imports. In January of 1981 the well of Yalpe-mech came on stream with an average of 1,000 barrels per day and 5 foreign companies are now actively exploring.
- 3.12 It is estimated that by 1981 the growth in real GDP will be less than in 1980, in view of the worsening of the deficits on current account of the balance of payments and of the finances of the Central Government, as well as the continuation of the stagnation in private investment. The external sector would reflect the effects of the downward trend in coffee price which would offset favorable effects such as the improvement in the prices of sugar and cotton, as well as the slight increase in the volume of petroleum exports.
- 3.13 The most important factor in determining the rate of growth of GDP in 1981 and subsequent years would be the level of total gross investment attained. As indicated earlier, in the case of private investment its future level will depend upon the effort made by the government to improve and expand the tax base and upon the adoption of a monetary and credit policy consistent with the absorption capacity and the development objectives of the country.

B. Analysis of the Electric Energy Sector

1. Current status and recent developments

- 3.14 Presented ahead are the figures on the installed generating capacity and the production of electric energy in Guatemala with the growth from 1965 to 1980. Also shown are the coefficients of capacity and production of energy per capita. The figures of the table only refer to the Public Service (including the Interconnected System and the Isolated Systems), excluding the self-supplied services (self-suppliers).

Year	Installed capacity	Annual 1/ generation	Population (000) 2/	Coefficients	
	MW	GWh		Inst. capacity KWh/per capita	Generation KWh/per capita
1965	102	402	483	0.022	88
1970	186	641	5,298	0.035	121
1975	227	971	6,081	0.037	160
1976	271	1,056	6,256	0.044	169
1977	327	1,225	6,436	0.051	190
1978	374	1,357	6,620	0.056	205
1979	388	1,441	6,810	0.057	212
1980	388	1,476	7,006	0.055	211
<u>Average annual growth rates</u>					
1965-1970	12.8%	9.8%	2.94%	9.7%	6.5%
1970-1975	4.1%	8.7%	2.95%	1.1%	5.7%
1975-1980	11.3%	8.7%	2.87%	8.2%	5.7%

- 3.15 The electric production of the Public Service has grown in an even manner in the past 15 years, at the rate of approximately 9.1% per annum, which when compared to the population increase yields an average annual increment of 5 to 6% of the coefficient of generation per capita. The latter at the present time reaches somewhat more than 211 KWh per year.
- 3.16 In total, the Public Service had in 1980 close to 390 MW of generating capacity, with a production of 1,480 GWh. As can be noted from the following table, the installed capacity of 161 MW in plants of self-producers in 1978 is significant, since it represents more than 30% of the power earmarked for the Public Service. Among the self-producers the most important installation is that of the EXMIBAL mining industry on the Atlantic Coast, with 58 MW in its steam plant and 11 MW in diesel units. That capacity did not grow in 1979, which seems to point to greater confidence in the operation of the public service.

1/ Includes 11 GWh annually of isolated municipal services beginning with 1975.

2/ Dirección General de Estadística, Guatemala, November 1977.

Year 1978

	<u>Installed Capacity - MW</u>				<u>Generation - GWh</u>			
	<u>Hydro</u>	<u>Thermal Steam</u>	<u>Turbo-Gas & Others</u>	<u>Total</u>	<u>Hydro</u>	<u>Thermal Steam</u>	<u>Turbo-Gas & Others</u>	<u>Total</u>
<u>Public Service</u>								
<u>Interconnected</u>								
<u>System</u>								
- INDE	97	86	76	259	277	359	284	920
- EEGSA	-	30	64	94	-	235	130	365
Total Inter-connected System	97	116	140	353	277	594	414	1,285
<u>Isolated Systems</u>								
- INDE and Others	5	-	16	21	10	-	14	24
Total Public Service	102	116	156	374	287	594	428	1,309
<u>Self-producers, Total</u>	18	79	64	161	s/d	s/d	s/d	s/d
	===	===	===	===	===	===	===	===

Year 1979

<u>Public Service-</u>								
<u>Interconnected</u>								
<u>System</u>								
- INDE	99	86	89	274	269	391	302	963
- EEGSA	-	30	64	94	-	253	199	451
Total Inter-connected System	99	116	153	368	269	644	501	1,414
<u>Isolated Systems</u>								
- INDE	4	-	16	20	10	-	17	27
- Municipal or Private Enterprises	4	-	3	7	-10	-	-	10
Total Public Service	103	116	169	388	279	644	518	1,441
	===	===	===	===	===	===	===	===
-Self-producers	18	79	64	161	43	187	151	381
Total for the Country	121	195	233	549	322	831	669	1,822
	===	===	===	===	===	===	===	===

1/ No significant changes occurred between 1979 and 1980 in the Public Service, nor in the installed capacity of the self-producers.

- 3.17 Approximately 22% of the installed capacity of the Public Service pertains to hydroelectric plants, which in 1979 produced 322 GWh, i.e. 18% of the total generated. Furthermore, close to half of the thermal generation pertained to diesel and gas turbine groups, with a very high fuel cost. This situation worsened in 1980 because of delay in the installation of the Aguacapa hydroelectric plant.
- 3.18 Almost all of the energy generated comes from the generating plants of INDE and the Empresa Eléctrica de Guatemala (EEGSA), both government entities. There are a few isolated plants privately owned or owned by municipalities, of very little importance. They represent 1.3% of the total capacity in 1979. INDE, with approximately 70% of the total generation is primarily a producing firm that sells energy in blocks to EEGSA and to other distributing systems of the National Interconnected System.
- 3.19 EEGSA, concessionary of the Public Service in the capital and neighboring areas, is the largest distributing firm in the country. At the present time approximately 60% of the energy distributed by EEGSA is purchased from INDE, a proportion that will increase in the future, since the development of generating sources has been entrusted exclusively to INDE.
- 3.20 The table presented as Appendix III-1 shows the development of the generation, consumption and maximum demand for power in the Interconnected System in the past 10 years. A continuous decline is noted in the transmission and distribution losses, from close to 16% in 1970 to less than 14% at the present time. Furthermore, the load factor of the system has remained around about 60%.
- 3.21 According to the figures of the table, Appendix III-2, the total consumption of energy in the Interconnected System, most of which pertain to EEGSA, reached 1,231 GWh in 1979, with 315,000 consumers or subscribers. 1/ The greatest proportion of consumption pertained to the industrial sector with 44% of the total, whereas residential consumption, with 257,000 subscribers, accounted for close to 25% of the total consumption. With the exception of the consumption of governments and others, the average revenue fluctuated between US\$0.078/KWh for the industrial category and US\$0.0901/KWh for the commercial category. As can be noted, the overall average sales price of the Interconnected System was US\$0.079/KWh. 2/ That table reveals that the average overall level of consumption per subscriber has varied very little in the last five years, remaining at around 4,000 KWh annually. In contrast, the average sales price increased by somewhat more than 70% between 1975 and 1979, reflecting to a large extent the rise in the price of fuels.

1/ It should be noted that there are differences between the figures of the Interconnected System according to the source of the information. For example, the Planning Department of INDE accepts the figure of 1,265 GWh of consumption in 1979, which differs from the one given above which comes from the Financial Department.

2/ This includes the total sales of the Interconnected System. Therefore, it includes not only the sales of INDE but also those of EEGSA.

- 3.22 Since there has been no change in the hydroelectric generating capacity in Guatemala (it remained at about 100 MW), all of the growth in the generating system in the past 10 years has been due to conventional steam and internal combustion thermal plants, so that at the present time 80% of the energy earmarked to the Public Service is produced in thermal plants. As the proportion of thermal energy has increased, the price paid by the electric industry in Guatemala for the fuel has increased between 1973 and January of 1981, as follows: Bunker C, 1,244%; diesel, 721% and crude, 312%. The impact of this rise in the operating cost structure of INDE is considerable. Whereas in 1973 fuel represented 36% of the direct operating costs (excluding depreciation), in 1979 it reached 77% and is expected to have been even somewhat higher in 1980. 1/

2. Existing installations of INDE

- 3.23 The Instituto Nacional de Electrificación (INDE) is responsible for the planning and development of the primary supply of electricity nationally. It is charged with the execution of the generating and transmission works. 2/ The generating and transmission facilities currently in service by INDE are presented in Appendix III-3, which also include the thermal plants of EEGSA. The largest generating installation of the system is the thermal steam plant of INDE in Esquintla, with a unit of 53 MW installed in 1977 and another of 33 MW dating back to 1972. As to the transmission system, in 1979 there were somewhat more than 1,000 kilometers of lines of 230, 138 and 69 KV and 450 MVA of transforming capacity in step-down substations in service, with primary voltages of 230, 138 and 69 KV.

3. Electric energy market

- 3.24 The historical growth in demand in the Interconnected System of Guatemala has experienced great deviations, owing to the instability faced by the society and economy of that country. In effect, considering the period 1965 to 1980, the arithmetic average of the annual growth rate in demand was 9.3%, with a standard deviation of 3.7. The next table presents the historical trend in the main components of the electric market.

1/ The rate schedule of INDE in effect since June of 1980 calls for an adjustment to offset a change in the price of fuel, both for retail distributors (for example EEGSA, which purchases 80% of the energy of INDE in blocks) and for final consumers.

2/ This includes the interconnection with El Salvador, the financing of which has been requested from the IDB.

Years	Demand (GWh)	Loss factor (%)	Generation (GWh)	Load factor (%)	Maximum demand (MW)
1965	327.7	16.4	392	53.6	83.5
1970	541.0	13.2	623	61.3	116.0
1975	828.8	12.8	950	58.6	185.0
1976	892.9	13.6	1,033	59.3	199.0
1977	1,023.5	14.8	1,201	57.8	237.0
1978	1,135.8	14.8	1,333	61.4	248.0
1979	1,264.9	10.5	1,414	60.9	265.0
1980 ^{1/}	1,246.5	13.7	1,444	60.4	273.0

Annual Growth Rate (%)

1965-70	10.5	9.7	6.8
1970-75	8.9	8.8	9.8
1975-80	8.5	8.7	8.1

Source: INDE

3.25 The technicians of INDE have reported great unsatisfied demand in the system because of inadequate supply. This means that the present demand is restricted. Industrial users requesting new loads have been refused in the past for that reason. As can be seen in the preceding table, the demand grew by an average annual rate of 9.3% during the period 1965-1980. Nevertheless, the rates of growth in the periods 1965-70, 1970-75 and 1975-80 have been going down. That decline can be explained in part by the unsatisfied demand, but it appears that the basic explanation is the performance of the economy of the country. In effect, regression analysis of the demand vis-à-vis real GDP has shown significant adjustments (high correlation ratios). Therefore, the projections took into account first of all the high degree of correlation with GDP and secondly a certain restriction of demand, which would be satisfied in the period 1983-90.

3.26 The demand projections were prepared in the following manner: first of all several macroeconomic regressions of the demand were made (see Table A in Appendix VI-4), selecting the curve of best fit and with more reasonable projections. Secondly, assumptions were adopted on the macroeconomic indicators and the demand was estimated for the period 1981-95. Thirdly, the new loads anticipated up to 1990 were taken into account, ^{2/} weighting them according to their entry into the system and level of feasibility. The table ahead summarizes the demand and supply projections for the Interconnected System during the period 1980-1995. For greater information, see Tables B, C and D of Appendix VI-4.

^{1/} Preliminary data.

^{2/} New loads anticipated according to the official development plans (CORFINA) which include a matrix of Industrial, Mining and Tourism Projects.

<u>Years</u>	<u>Demand (GWh)</u>	<u>Losses (%)</u>	<u>Generation (GWh)</u>	<u>Load factor (%)</u>	<u>Maximum demand (MW)</u>
1980	1,246.5	13.60	1,442.7	60.30	273.0
1985	2,327.6	13.00	2,675.4	61.29	498.3
1990	4,306.3	12.25	4,907.5	62.10	902.1
1995	7,162.3	12.00	8,139.0	62.42	1,488.5

Growth rates (%):

1980-85	13.3	13.1	12.8
1985-90	13.1	12.9	12.6
1990-95	10.7	10.6	10.5

- 3.27 Some of the main assumptions pertaining to the projections are: (i) the GDP would grow at 5.3% per year up to 1983, increasing by 6% from that year on; (ii) the loss factor would gradually decline from the level of 13.6% noted in 1980 to 12% in 1992, remaining constant from that year on, and; (iii) the load factor of the System would increase gradually from 60.30% to 62.42% in 1992, remaining constant from 1992 on.

4. Electric system expansion program

- 3.28 The generating works currently being built are the hydroelectric plant of Aguacapa with 90 MW, expected to begin operating by November 1981 and the Pueblo Viejo (Chixoy) hydroelectric plant with 300 MW that would come on stream in November, 1982, with its installation being completed in 1983. When these two plants begin to operate, with an average production of 2,090 GWh per year, thermal generation will decline drastically, with the resulting savings in fuel in thermal generation equivalent to about US\$91 million annually.
- 3.29 After the installation of Aguacapa and Pueblo Viejo, the equipping program of INDE includes the hydroelectric plant of Santa María II (with 68 MW) in 1984, the geothermal plant of Zunil (33 MW) in 1985, the Chulac hydroelectric plant (440 MW) in 1988 and Xalalá hydroelectric plant (360 MW) in 1989. The last two are currently in the preliminary study stage, so that their installation dates should be considered as tentative. In total, the program of additions to generating capacity in the next ten years (Appendix III-4) represents an increase of 1,291 MW, that is 3.3 times the installed power currently in public service in the country and 2.4 times the total installed capacity including self-producers. ^{1/} Besides the generating works, that appendix indicates that it would be necessary to construct about 2,900 kilometers of transmission lines of 230 KV and 69 KV, including about 600 kilometers connected to the execution of the hydroelectric power plants. Furthermore, in the primary system it will be necessary to install approximately 1,400 MVA in step-down transformer substations of 230/69 KV.

^{1/} It should be taken into account that the values indicated do not take into consideration the withdrawal from service of thermal plants that would occur.

- 3.30 According to the financial projections of INDE, the development of the expansion program up to and including 1990 represents a total investment of about US\$2,200 million, of which about US\$1,720 million pertains to the generating works and the rest to the transmission, distribution, general installations and miscellaneous.
- 3.31 Lastly, it should be pointed out that the equipping program of INDE must be updated once again based on a revision of the demand in view of the energy and power estimates that are indicated in paragraphs 3.24 to 3.27 and 3.33 to 3.35 of this report. This is done periodically by every electric power enterprise as part of the routine needed to operate rationally. On the other hand, given the magnitude of the investment program, the national authorities will have to review the demand projections before undertaking the works subsequent to the Pueblo Viejo project. It should be pointed out that a new equipping plan will surely affect the date of entry into service and other characteristics of the other plants now anticipated, but not of those in an advanced stage of execution such as in the case of Aguacapa and the Pueblo Viejo-Quixal hydroelectric plant, as can be verified in chapter VII of this report.
- 3.32 Therefore, a recommendation is made in this respect, since INDE in any event is updating its master equipping plant and since it has had for this purpose, besides the staff of its Planning Department, the consulting services of an advisory mission from the Federal Republic of Germany since 1975. The consulting period of those advisors was extended in June of 1981 by 65 additional man/months.

5. Energy and power balances

- 3.33 To establish the energy and power balances of the National Interconnected System it is necessary first of all to prepare the pertinent demand projections and later to determine the pertinent availability of generation throughout the analysis period, which extends up to 1992. The power and energy availability of the Guatemalan system for each year of the period 1980-1992 is shown in tables F, G and H of Appendix VI-4. The power values refer to the actual capacity available during peak demand hours, generally less than the rated capacity or the plate capacity of the equipment. As to the availability of energy, the hydroelectric production is distinguished by average hydrological year and by critical year.
- 3.34 The energy balance which appears in table G of Appendix VI-4 shows that the firm energy that can be generated in a critical hydro year would only cover the generation demand in 1987 and 1992, with relatively small deficits of about 2% and 0.1%, respectively, of the generation required in those years. Furthermore, owing to the interconnection to El Salvador it will be possible to import surplus energy from the latter system to meet potential deficits in Guatemala. Table F of this appendix notes the possibility of generating surpluses of secondary energy, which could be transferred to the Salvadoran system to replace thermal generation. Furthermore, it is also noted that in the average hydro years the thermal energy of the conventional steam, turbo gas and diesel plants, even

though it does not disappear, declines in importance. With the inter-connection to the El Salvador system it will be necessary to determine what part of that thermal generation can be substituted by surplus hydro-geothermal energy or even by lower-cost thermal energy of the Salvadoran system, through optimum load dispatch in the combined electric system of both countries.

- 3.35 Tables H and I of Appendix VI-4 show the power balance in the Guatemalan national system, and it can be noted that in general in the period 1980-1992 there will be a high margin of reserve capacity, not only in terms of the total installed capacity but also in terms of the maximum demand. This appears to suggest that the expansion plan should be revised.

IV. THE PROJECT AND THE ADDITIONAL FINANCING NEEDED
TO COMPLETE THE PROJECT

A. Purposes and Description of the Project

- 4.01 The purpose of the project is to expand the generating capacity of the Guatemala Interconnected System by completing the Pueblo Viejo Quixal hydroelectric power plant along the Chixoy River, construction of which began in 1977. This power station shall provide for replacing generation from expensive fossil-fuel fired generating plants, thus reducing the unfavorable effect of this practice on the current account of Guatemala's balance of international payments. The generating units are scheduled to become operational in November 1982, at which time two 60 MW units shall be commissioned, and in April 1983, when another three units of the same capacity shall become operational.
- 4.02 The Pueblo Viejo project is the first stage in the integrated development of the Chixoy River basin, for which purpose the government received from the Bank nonreimbursable technical assistance as mentioned in Chapter II herein. The purpose of this assistance is to identify possibilities for development of the river basin making use of part of the hydraulic structures to be located along the middle section of the river, thus providing for the improvement of the whole service area by installing the projects identified. For this purpose an integrated regional development program has been drawn up on the basis of the use of the water resources of the river basin. It includes a study of the agriculture, industry, manpower and services aspects of the area as well as a definition of the necessary infrastructure facilities.
- 4.03 The Pueblo Viejo project is located in central Guatemala about 80 km distant, as the crow flies, from Guatemala City. It is a region of mountains with elevations from 300 to 3,000 meters. Its service area is predominantly rural and its population has scarce economic means and is virtually lacking in social services. Appendixes IV-1 and IV-2 contain location maps of the project and of the principal works.
- 4.04 As noted, the hydroelectric project now under construction is designed to expand the INDE generating system by providing for the construction of the hydroelectric plant at a point midway along the Chixoy River, with an installed capacity of 300 MGW and a mean energy generation of 1,710 GWh a year. It consists of: i) a rockfill dam at the place named Pueblo Viejo; ii) a spillway; iii) a power tunnel (headrace) about 26km long; iv) a plant located at Quixal with a powerhouse of 300 MW capacity; and v) a transmission line, about 120 km long, from the power plant to Guatemala City.
- 4.05 In the project area itself, the course of the Chixoy River is a large S-shaped meander about 50 km long, grading downward about 400 meters. This drop is to be utilized by a dam that will provide multi-year

storage ^{1/} of 460 million cubic meters of water, to be located at the upstream and of this double curve at the place named Pueblo Viejo; and a generating plant to be located at the downstream end at the place named Quixal. The power tunnel would be constructed between both structures.

4.06 The scheme described would consist of the following work-measures:

- i) Intake and reservoir: These will comprise a rockfill dam with an impermeable core. The dam will be about 109 meters high and the volume will be about 3,200,000 cubic meters. It will have an open spillway, though allowance will be made in its construction for the subsequent installation of gates; an intake structure will be installed. Also planned is the construction of two diversion tunnels 976 meters long with 7.10 meters inside diameter, one of which shall operate as an undersluice with corresponding inlet valve.
- ii) Headrace works: These comprise the construction of a power tunnel made up of three sections: the first section is between the Pueblo Viejo Dam and the Aguas Blancas work site, and measures 7,700 meters; the second is at the crossing of the Quixal River at the above-mentioned point and consists of a siphon about 400 meters long; the third is between Aguas Blancas and the powerhouse at Quixal and is 17,900 meters long. The section of tunnel between the intake and the surge tank will be concrete-lined along its entire length and have an inside diameter of 4.93 meters. The surge tank structure shall consist of two chambers, an upper and a lower, connected by a vertical shaft. The tunnel section between the surge tank and the outlet shall be armored in steel and its diameter will be reduced to about 3.65 meters. The Pampur depression - where there is a waterfall with a head of as much as 25 cubic meters of water per second - located close to the bearing of the power tunnel is a karst region. In order to reduce the danger of infiltration during the work of tunnel excavation, the Pampur water source shall be impounded and drained by means of a diversion channel. Water from the Pampur basin shall be used in the operational phase for additional energy generation. Therefore, as much as 5 cubic meters shall be added by means of a well shaft to the power tunnel. In order to prevent infiltration during the work of excavating the tunnel leading to the area near the Quixal portal, an infiltration gallery was excavated under the power tunnel itself for purposes of drainage. The length of this gallery is 550 meters.
- iii) Pressure pipe (penstock): This shall be buried over a distance of about 1,250 meters and have a diameter of 3.65 meters, ending in a distributor leading into the powerhouse.

^{1/} This reservoir shall provide for regulating 90% of the streamflow of the river, likely to be necessary 98% of the time.

iv) Powerhouse and step-Up substation: Includes the following main equipment:

- 5 Pelton turbines of 69,000 horsepower each.
- 5 Generators rated at 60 MW each - 13.8 KV - 60 Hz.
- 16 Single-phase transformers of 20 MVA each - 13.8 KV.
- The 230 KV double busbar switchyard will contain two output modules for 230 KV lines, a busbar coupling, and a metering module. The location of the power plant and the substation requires a permanent diversion of the course of the Quixal River by means of a canal 400 meters long and 14 meters sill width, shortening a bend in the river, with a difference in elevation of about 7 meters. To reduce water velocity a stilling pool about 100 meters long was constructed in the center of the diversion channel.

v) Transmission system: This shall consist of a two-circuit line rated at 230 KV, with steel reinforced aluminum conductors supported by metallic structures. The approximate length of this line between the Quixal substation and Guatemala City is 120 km. A step-down substation (230/69 KV) shall be installed in Guatemala City with associated transformer modules and feeder lines into the city.

vi) Auxiliary works: About 70 kms of access roads to the different work fronts have been constructed and improved, and a campsite for project management has been installed.

B. Total Cost of the Project and Financing Plan

1. Cost of table

4.07 The total cost of the project is broken down as shown below:

<u>Investment Category</u>		(Equivalent in thousands of US\$)	
1.	<u>Engineering and Management</u>		
	1.1 Engineering and supervision	22,310	
	1.2 Administration	<u>21,390</u>	
	Total Category 1	<u>43,700</u>	6.9
2.	<u>Direct Construction Cost</u>		
	2.1 Lot A, Complementary Works	20,921	
	2.2 Lot 1, Dam, diversion, spillway	126,323	
	2.3 Lot 2, Headrace	256,043	
	2.4 Lot 3, Powerhouse	28,400	
	2.5 Lot 4, Hydraulic equipment	18,238	
	2.6 Lot 5, Electrical equipment	20,600	
	2.7 Lot 6, Steel structures	8,849	
	2.8 Lot 7, Quixal substation and transmission line	19,786	
	2.9 Purchase of land and resettlement	<u>3,800</u>	
	Total Category 2	<u>502,960</u>	79.9
3.	<u>Finance Charges</u>		
	3.1 Interests and fees on IDB loan	17,782	
	3.2 Interests and fees on IBRD loan	14,538	
	3.3 Interests on CABEL loan	324	
	3.4 Interests and fees, other	3,596	
	3.5 Inspection and supervision fee	<u>1,100</u>	
	Total Category 3	<u>37,340</u>	5.9
4.	<u>Unallocable Expenses</u>		
	4.1 General contingencies	17,500	
	4.2 Allowance for escalation	<u>28,500</u>	
	Total Category 4	<u>46,000</u>	7.3
	TOTAL COST	<u>630,000</u>	
		=====	

- 4.08 It is important to note that this project, one of the largest in Central America, has a cost of US\$2,100 per kilowatt of installed capacity, which is high for facilities of this kind. However, the generation of 1,710 gigawatt hours with a high proportion of firm energy compares favorably as regards production costs with the cost of thermal-electric generation, which at this time would be the only generating equipment alternative able to meet demand in 1982, the year in which the Pueblo Viejo project is scheduled for completion.

2. Bases of the calculation

- 4.09 Project costs were determined at January 1981 prices with an undertaking that is in full progress and makes it possible to obtain up-to-date information on distances and unit costs. Taken into account in making the final estimate of the total cost given herein was the matter of the

geologic region of karst rock on which the dam is supported and through which three kilometers of tunnel must still be excavated. No invitations for bids are pending award; therefore, the level of accuracy of the calculations given herein is high.

- 4.10 At the time the IDB appraisal mission visited Guatemala, a review of costs was done and it was found that, generally speaking, the costs were reasonable and consistent with those reported in similar projects. However, the latest IDB cost calculations show amounts larger than those in the official budget in effect since December 1980. The reason is that account has been taken in the latest calculations of: (i) increases which occurred since March 1980 when the INDE drew up the budget that was approved in December 1980; (ii) increases in the contingencies and cost escalation items that may occur up until completion of the works.
- 4.11 The special study of the increase in costs between the 1975 estimate and the present-day 1981 estimate, may be summarized as follows: 1/
- (a) Design changes in the total amount of US\$19,771,000. These were suggested by the LAMI project consultant and by the Board of Consultants. The main modifications were: (i) the locations of the powerhouse and substation were changed because they were found to be located over a potentially active geologic fault; (ii) the Quixal River diversion channel; and (iii) the associated engineering and management costs. 2/
 - (b) The effect of the February 1976 earthquake in Guatemala amounted to US\$6,196,000. This disaster, which cost more than 22,000 lives, led to the revision of some design parameters of the dam, spillway, headrace, and others.
 - (c) Difficulties costing US\$35,330,000 on account of geologic structures. The karst geologic region of the project contained more caverns and sinkholes than expected as well as faults which caused several landslides in the tunnel excavation, one of which caused the loss by burial of a boring machine which cost about US\$5 million. In the tunnel alone - for the reasons stated previously and on account of the increase in the quantity and depth of the grouting - a cost increase of US\$26,400,000 was estimated. On the left bank of the dam a cavern appeared with a volume on the order of 100,000 cubic meters which caused considerable expenditure and which, together with smaller caverns and sinkholes, which appeared in the river bed and on the abutment, entailed an additional cost of US\$7,140,000.
 - (d) Difference in distances in the amount of US\$29,512,000, as itemized below:

1/ See Appendix II-I

2/ See Appendix IV-3 and IV-4.

Access roads	US\$1,600,000
Dam (increase in height)	US\$8,800,000
Spillway (reinforced concrete and excavation)	US\$2,810,000
Equipment	US\$4,580,000
Headrace	US\$6,410,000
Engineering management and the like	US\$5,312,000

- (e) Various additional jobs in the amount of US\$7,188,000. These include additional work on the access roads, technical supervision by LAMI, and management of the INDE executing agency, as well as several kinds of additional work on the dam and spillway.
- (f) Additional contingencies in the amount of US\$40,149,000. Most of these were the result of: (i) landslides, and the need for making new access roads to the work sites at a cost of US\$5,600,000; (ii) work on the headrace in the amount of US\$18,409,000; (iii) increase in underdrains in the dam, and equipment for measuring cavities in the rock, changes in fill materials for the dam, all in the amount of US\$11,600,000; and (iv) protection against landslides near the powerhouse, cofferdam, and repairs to the diversion channel of the Quixal River, and the like, in the amount of US\$4,530,000.
- (g) Acceleration of work in the amount of US\$20,662,000. The reason: delays in awarding the principal construction contracts, the effect of the 1976 earthquake, changes in design and delays in work caused by unforeseeable events, and the karst geology. The December 1981 scheduled date for setting the first generating unit in operation would have probably been delayed more than two years had these work accelerations not been undertaken. ^{1/} This would have brought on serious disruptions in the supply of electric energy in Guatemala inasmuch as the other large hydroelectric project, Aguacapa (90 megawatts), first scheduled to become operational at the end of 1978, shall enter service probably at the end of 1981, that is, three years later. INDE exerted pressure on all contractors to reduce the delay at Pueblo Viejo-Quixal to the lowest possible level, that is, to no more than one year, inasmuch as it was estimated that the first generating unit shall become operational in November 1982. Therefore, the contractors had to speed up the pace of work, hire more technicians and additional staff, and increase the size of their teams, thus raising costs as follows:

Lot 1, Dam	US\$8,300,000
Lot 2, Tunnels	US\$6,802,000
Lot 3, Power plant	US\$5,560,000

^{1/} As noted in Chapter III herein, the cost of fuel used by INDE thermal-electric plants (it would be reduced to a minimum once the Pueblo Viejo project becomes operational) is US\$40 million a year.

(h) Additional escalation of US\$86,497,000, broken down as follows:

Engineering and Management	US\$4,500,000
Lot 1, Dam	US\$33,907,000
Lot 2, Tunnels	US\$35,090,000
Lot 3, Power plant	US\$13,000,000

(i) The exchange rate differential of US\$43,830,000. Owing to the gradual weakening of the United States dollar over against the currencies of Japan, Federal Republic of Germany and Switzerland in the years 1977 up until 1980, the costs of contracts continued to increase and had to be paid mainly in those currencies, as follows:

Engineering and supervision	
LAMI (Germany and Switzerland)	US\$3,280,000
Lot 2 Tunnel (Germany)	US\$31,550,000
Lot 4 Turbines (Switzerland)	US\$5,500,000
Lot 5 Generators (Japan)	US\$3,500,000

C. Financing of Additional Costs

- 4.12 As noted, construction of the project is being financed in cooperation with the IDB, the IBRD, the CABEI, the VTF and with local funds allotted by the government and INDE. The following table shows a breakdown by source of financing on the date of the signing of the original loan contracts (US\$340,874,000), on the date of the budget in effect since December 1980 (US\$446,547,000), and the scheme of financing proposed for increasing this last-named (US\$183,453,000), according to the present-day estimate of the total cost which is US\$630 million.

(In thousands of US\$)

SOURCE OF FINANCING	According to Original Loan Contracts (Jan. 1976)		Budget in Effect in Dec. 1980		Final Estimate (July 1981)		Additional Financing Proposed	
		%		%		%		%
EXTERNAL	210,762	61.8	251,502	56.3	321,502	51.0	70,000	38.2
IDB	55,000	16.1	55,000	12.3	75,000	11.9	20,000	10.9
CLC	15,000	4.4	15,000	3.4	65,000	10.3	50,000	27.3
PVF	35,000	10.3	35,000	7.8	35,000	5.5	-	-
Total IDB	(105,000)	(30.8)	(105,000)	(23.5)	(175,000)	(27.7)	(70,000)	(38.2)
BRD	65,000	19.0	58,800	13.2	58,800	9.3	-	-
CABEI	5,400	1.6	12,900	2.9	12,900	2.1	-	-
VTF	-	-	74,802 ^{2/}	16.7	74,802	11.9	-	-
Suppliers	35,362	10.4	- ^{3/}	-	-	-	-	-
DOMESTIC	130,112	38.2	195,045	43.7	308,498	49.0	113,453	61.8
Government	(-) ^{1/}	(-)	(182,240)	(40.8)	(230,186)	(36.6)	(47,946)	26.1
INDE	(-) ^{1/}	(-)	(12,805)	(2.9)	(78,312)	(12.4)	(65,507)	(35.7)
TOTALS	340,874	100.0	446,547	100.0	630,000	100.0	183,453	100.0
	=====	=====	=====	=====	=====	=====	=====	=====

^{1/} At first the local contribution was not broken down by domestic source between the government and the INDE.

^{2/} Includes Q32,000,000 and Q42,000,000 in additional loans made by the Venezuelan Investment Bank for the local contribution and cost overrun.

^{3/} The government did not use supplier financing and issued treasury bonds instead.

D. Source and Application of Funds

- 4.13 The following table shows the source and application of funds of the additional financing and would be the same as that shown in Annex A of the loan contract which the Government of Guatemala would enter into with the IDB:

(Equivalent of thousands of US\$)

	<u>Additional Bank Financing</u>	<u>Additional Counterpart Financing</u>	<u>Total</u>	<u>%</u>
1. <u>Engineering and Management</u>				
1.1 Engineering and Supervision	3,900	4,947	8,847	4.8
1.2 Administration	-	4,980	4,980	2.7
Total Category 1	<u>3,900</u>	<u>9,927</u>	<u>13,827</u>	<u>7.5</u>
2. <u>Direct Construction Cost</u>				
2.1 Complementary Works	-	1,270	1,270	0.7
2.2 Lot 1 - Dam	-	53,717	53,717	29.3
2.3 Lot 2 - Tunnel	56,000	20,500	76,500	41.7
2.4 Lot 3 - Power house	<u>2,000</u>	<u>-</u>	<u>2,000</u>	<u>1.1</u>
Total Category 2	<u>58,000</u>	<u>75,487</u>	<u>133,487</u>	<u>72.8</u>
3. <u>Finance Charges</u>				
3.1 Interest and fees	-	17,782	17,782	9.7
3.2 Inspection and supervision	<u>200</u>	<u>-</u>	<u>200</u>	<u>0.1</u>
Total Category 3	<u>200</u>	<u>17,782</u>	<u>17,982</u>	<u>9.8</u>
4. <u>Unallocable Expenses</u>				
4.1 Contingencies	3,500	4,800	8,300	4.5
4.2 Allowance for cost escalation	<u>4,400</u>	<u>5,457</u>	<u>9,857</u>	<u>5.4</u>
Total Category 4	<u>7,900</u>	<u>10,257</u>	<u>18,157</u>	<u>9.9</u>
TOTAL	<u>70,000</u>	<u>113,453</u>	<u>183,453</u>	<u>100.0</u>
Percentages	(38.1%)	(61.9%)	100.0	

E. Terms and Conditions and Utilization of the Resources of the Additional IDB Financing

- 4.14 The additional IDB financing, in the amount of US\$70 million equivalent, would be granted on the following terms and conditions:

(i) A loan of US\$20 million equivalent, of which: US\$18 million would be in foreign exchange drawn on the ordinary capital resources, bearing interest at 9.25%, with a grace period of three and a half

years, a credit fee of 1.25%, and a term of amortization of 20 years, included in the grace period; and the amount of US\$2 million equivalent in local currency, chargeable to the ordinary capital, bearing interest at 4%, with a grace period of three and a half years and a term of amortization of 20 years.

(ii) A loan of US\$50 million equivalent in foreign exchange chargeable to the complementary credit line, which would be granted on such terms and conditions as may be negotiated with the participating banks.

4.15 The IDB loan component in foreign exchange (US\$18 million) chargeable to the ordinary capital would be used to partly defray only the cost of the new engineering works, the construction of these new facilities, the additional finance charges, and the contingencies and cost escalation that may occur up until the completion of the project. The IDB loan component in local currency in the amount of US\$2 million would be applied to the same investment categories. Therefore, this new IDB loan would not be used to finance cost overruns on such facilities as were called for in the original analysis done in 1975. The complementary credit line might be used to finance cost overruns, preferably in the investment categories shown in the foregoing table under the column Additional Bank Financing.

F. Additional Counterpart Contribution

4.16 The additional local contribution for financing the increase in costs would be US\$113,453,000. Of this amount, US\$47,946,000 equivalent would be financed with the Government of Guatemala's own resources; the amount of US\$65,507,000 equivalent would be financed with the INDE's own resources, using for the purpose part of the bond issue authorized by the Government of Guatemala. ^{1/} The local allotment of funds would be allocable to financing the remaining amounts of the categories partly financed from other sources, as well as the full amount of the categories for which no other source of financing was available.

^{1/} In this respect, see Chapter VI, paragraph 6.15 herein.

V. COMPLETION OF THE PROJECT

A. Executing Agency and Consulting Services

- 5.01 As noted previously, the executing agency INDE shall continue to coordinate, manage and supervise all activities necessary to complete the project with the advisory assistance of the LAMI consultants.
- 5.02 The executing agency shall be temporary in character, its functions expected to last as long as needed to complete the project, that is, up until the last of the five generating units becomes operational. This is expected to take place in the year 1983. Thereafter, INDE would leave in the project area the organization required to perform the necessary duties to provide for system operation and maintenance. The system shall become an organization unit of the Office of the Deputy Manager for Operations.

B. Designs and Documents for Inviting Bids

- 5.03 No invitations for bids are pending, and designs of the new facilities or suggested modifications are for the most part finished and the complementary works are in progress. The design modifications to provide greater protection against earthquakes; the new designs for the tunnel, dam, spillway and powerhouse are now finished, and the problems brought about by the karst rock which initially hampered the tunnel excavation have been overcome and what lies ahead is predictable.

C. Present-day Status of the Works

- 5.04 Generally speaking, work advance is 68% as of June 30, 1981 and work on most of the fronts is proceeding normally.
- a. At Lot 1, Dam, the diversion tunnels and dam excavation are finished; the fill is at elevation 765, that is, 80 meters above the supporting plane of the dam. There are still 50 meters of height fill up to the crest of the dam. Owing to the karst topography of the region, various caves, caverns and sinkholes have appeared along the abutments and in the bed of the dam. This made it necessary to make new designs for the galleries and to use special metering equipment and much care in filling the dam was required to control water losses likely to occur. At the same time, work is proceeding on the design of a small diversion tunnel on the right bank which, equipped with gates, shall assist in more securely and rapidly controlling the level of the reservoir, above all if heavy rainfall makes it necessary to lower the level of the reservoir quickly to prevent problems associated with major infiltration of water through the dam structure. Consequently, it is necessary for the executing agency to supply the Bank with detailed information about the design of this new tunnel, the justification for it, its cost and the time

schedule for its installation, so as to be able to determine its influence on the term allowed for project completion. In the time schedule in Appendix V-1, an estimate was given of the time needed for such work. The contract to be entered into for the additional financing from the IDB shall set forth that the executing agency must submit the relevant documentation within three months of the effective date thereof.

- b. About Lot 2, headrace, surge tank, Campur impoundment and intake it is noteworthy that of the 26 kilometers total length of the tunnel, 23 kilometers have been excavated; the remaining three kilometers are located in the central part of the Agua Blanca Norte - Quixal section, where excavation is being done with a borer and with traditional equipment from both ends in order to finish more quickly. Owing to its position (which requires a long run of nearly 10 kilometers for carrying excavated materials, reinforced concrete, air for ventilation, and the like, as well as owing to the property of the rock) it is expected that there shall be certain difficulties and delays, particularly in the excavation itself. But the great experience of the Hochtief Company and the work done so far suggests that there should be no serious difficulties.
- c. Lot 3, powerhouse, substation, canal for diversion of the Quixal River, are proceeding according to schedule and no delays or complications are expected. However, it is still necessary for the INDE to supply the Bank with (i) the final designs of the Quixal River diversion canal, as regards the cofferdam yet to be built; (ii) a report on how repairs to the reinforced concrete spillway sill, which was damaged during flooding of the Quixal River, shall be carried out; and (iii) a plan for maintenance of the canal. The new contract to be entered into for the additional financing proposed herein shall set forth the obligation of INDE to submit the necessary documentation within three months of the effective date of the agreement.

5.05 As regards the other equipment lots, Nos. 4, 5 and 6, activities are proceeding in normal fashion and this is also true of Lot 7 corresponding to the substation at Quixal and the transmission line leading to Guatemala City.

D. Project Completion Plan

5.06 Works execution has been controlled by a computerized BKN program run by the LAMI consulting firm and adjusted periodically as necessary. According to the program (and with some adjustments by the Bank), the first generation would be completed by November 30, 1982, with only finishing touches and slope paving on the dam and minor details on the powerhouse pending at that time.

E. Term of Execution and Time Schedule for Disbursement

- 5.07 If work on the access roads and workers' campsites is not included, all of which are the responsibility of the INDE and a requirement for initiating the project civil works, the period of time for executing the project would be six years and two months - the period between June 1977 and August 1983. The tentative disbursement schedule of IDB loan proceeds as well as funds from other sources, including the IBRD, CABEI and local contributions, based on the new work-schedule, is shown on page 50.

F. Procurement and Acquisition of Goods

- 5.08 All contracts for all civil works and project equipment purchases have been awarded and the contracts entered into; the works are now in progress and estimated work advance is 68% as of 30 June 1981. Only the obligation of letting invitations for bids under the prospective contract shall be included so as to allow for the possibility that some present-day contractor might terminate its contract for some reason, making it necessary to let the invitation for bids on the rest of the work. This is not expected to occur. 1/

G. Construction Materials

- 5.09 The construction materials needed for the project works were obtained as provided for in the project design and, in the time transpired, there was neither difficulty nor delay on this account. In the period of time up until completion of the work, no problems are anticipated and, what is more important, the necessary material for filling the dam is 90% excavated and deposited at the work site.

H. Manpower

- 5.10 Management staff as well as semi-technical personnel, foremen, skilled workers and day laborers, are available in Guatemala and have acquired additional experience which shall prove most useful in the period of project completion and for future hydroelectric projects in Guatemala.

I. Operation and Maintenance of the Facilities

- 5.11 The work of operating and maintaining this hydroelectric power station shall be the responsibility of the Office of the Deputy Manager for Operations of the INDE and shall be the direct responsibility of the Generation Section.

1/ The only work-measure that might require an additional invitation for bids is the small diversion tunnel in Lot 1, which is being financed by the IBRD. To this end the IBRD has its own procedure for inviting bids. It is more likely, however, that this construction work shall be the object of an amendatory contract inasmuch as - as has happened with the other project works - the contractor has its own equipment and staff at the work site, and to once again invite bids for the works would only entail greater expenses and a longer period of time for completion.

	EXISTING FINANCING				ADDITIONAL FINANCING				Grand total
	Expended up to XII/31/80	Additional amount of investment up until XII/31/81	Investment as to XII/31/82	Investment as to XII/31/82	Additional Investment up until XII/31/83	Additional Investment up until XII/31/84	Sub-total addit. financ.		
IDB	68,212	21,788	-	6,700	5,800	7,500	20,000		110,000
CLC	15,000	-	-	25,000	25,000	-	50,000		65,000
Other sources	199,041	111,792	30,714	51,300	49,200	12,953	113,453		455,000
Total	282,253	133,580	30,714	83,000	80,000	20,453	183,453		630,000
IDB investment as a share of total cost	10.8%	3.5%	-	1.1%	0.9%	1.2%	3.2%		17.5%
CLC investment as a share of final total cost	2.4%	-	-	3.9%	3.9%	-	7.9%		10.3%
Investment other sources as a share of total final cost	31.5%	17.8%	4.9%	8.1%	7.8%	2.1%	18.0%		72.2%
Total investment as a share of total final cost	44.8%	21.2%	4.9%	13.2%	12.7%	3.2%	29.1%		100.0%

J. Resettlement of Farmers

- 5.12 In the area affected either directly or indirectly by the reservoir there live 443 families. A total of 3,445 settlers shall be affected, the average being 8 members per family. 1/ As much as 65% of the population is Amerindian of Maya-Quiché origin; 35% is mixed. The population is located in four villages, five hamlets and 14 settlements. As much as 78% of the population is under 34 year of age; 79% is economically active.
- 5.13 The economic base of the inhabitants is precarious farming and farming for personal use. Top soil has little depth and is on broken terrain unsuitable for permanent crops, where rock outcroppings are commonplace. Nevertheless, landholding is of the utmost significance to the inhabitants not only for economic considerations (family security and minimal production) but on account of the sociological and traditional aspects. The Chixoy River basin, affected by construction of the project, comprises 50 archaeological sites and places described in the Popol Vuh mythology (the equivalent of the Bible for the Maya people). This explains why the people who live in the place are so greatly attached to it.
- 5.14 INDE has completed construction of a town to settle part of the peasants who, affected by the project construction, must leave the area to be flooded by the reservoir and other areas of the work site as well. In fact, at the Pacux farm, in Rabinal, housing, schools, a community center and church were constructed for 150 families. There are other settlements for the rest of the families, whose homes the INDE is now constructing and preparing at the Finca Primavera (Alta Verapaz). 2/
- 5.15 At first the settlers cooperated with the INDE authorities in choosing suitable sites and the type of homes to be built. Later on, however, they wished to have temporary housing at the work sites as well as permanent housing in the towns INDE built for them. INDE has adopted this new solution in order to settle the problem. As for payment of compensation for the land or crops affected, according to the information obtained INDE is meeting this requirement. Furthermore, INDE is acquiring new farmland for some groups of resettled farmers.

1/ The national average generally used is 6 persons per family. The population in the area was surveyed exhaustively and the arithmetic average of one of these 443 families is 8 members.

2/ The contract for loan IBRD-1605/GU and subsequent agreements for the performance thereof established that the INDE must supply housing and other services to the resettled farmers on better conditions than were available; the earlier IDB contracts did not contain similar provisions inasmuch as the people who must be displaced are for the most part located in the area near the dam, which was financed by the IBRD. Therefore, inasmuch as this important matter was covered in the contract with the IBRD, the new IDB contract shall not contain a similar clause.

- 5.16 Furthermore, the INDE has decided to build a road 6 km long between the town along the reservoir in order that the settlers may use the INDE-supplied boats to reach the lands they are now farming.
- 5.17 There is a program designed to salvage the cultural patrimony of the settlers along the Quixoy River basin ^{1/}, for which greater support might be given so as to benefit the cultural patrimony and tourism in the area. With the birth of the reservoir and given the attraction of the archaeological sites, tourism might be developed as an additional source of income. In the view of some experts a greater effort must be made in connection with the work of saving the heritage, not only on account of its cultural importance but on account of its tourism potential.

K. Protection of the River Bed

- 5.18 INDE, in cooperation with INAFOR and other state organizations, has undertaken a partial reforestation of the areas near the dam, planting a total of 30,000 trees as part of a study being prepared by INDE which includes treatment of the eroded areas, embankment for channeling streams, maintenance of existing roads, orientation of crops now being cultivated, and recovery of the forest cover of the watershed. Furthermore, the first stage of technical cooperation (ATCN/CD(PP)SF-1521) for development of the Quixoy River Basin has been completed and the report suggests possibilities for several projects along the basin up to the dam site at Pueblo Viejo.

L. Inspection and Supervision

- 5.19 The Field Office in Guatemala shall continue with the inspection and supervision of the project up until completion.

M. Ex-post Evaluation

- 5.20 The consultants for technical cooperation (ATCN(PP)/SF-1521) prepared a methodology for ex-post evaluation of the impact of the Pueblo Viejo-Quixal power station. The purely economic aspects were accepted by the Bank in 1981; however, it would be necessary to enlarge the redistributive effects of the project for which purpose the consultants now have at their disposal the IDB's methodology. Therefore, the inclusion of contract clauses as regards the preparation and presentation of a methodology for evaluating the project impact are not recommended inasmuch as this would be achieved through the technical cooperation noted. However, it is recommended that the new contract signed stipulate INDE's obligation to submit to the Bank a report on the socioeconomic impact of the project five years after the final disbursement of IDB loan resources.

^{1/} A Ichon, "Rescate Arqueológico en la Cuenca del Río Chixoy", preliminary report, (Guatemala: French-Guatemalan scientific mission, Editorial Piedra Santa, 1979).

VI. INSTITUTIONAL AND FINANCIAL ANALYSIS

A. Legal and Organizational Status of the Executing Agency

- 6.01 As in the case of loans 301/OC-GU, 302/OC-GU, 454/SF-GU and 6/VF-GU, the borrower would be the Republic of Guatemala and the executing agency the Instituto Nacional de Electrificación (INDE). The legal and institutional status of INDE was duly analyzed in document PR-676-2-A, dated December 2, 1975, in connection with the review of the operation that gave rise to those loans. The present chapter of this new report is limited to an examination of what has happened in the interim.
- 6.02 The above statement notwithstanding, it should be noted that INDE is a decentralized state agency which enjoys operating autonomy, legal status, its own funding and full authority to acquire rights and contract obligations within the area of its competence. Its liaison with the Executive Branch is the Ministry of Communications and Public Works (MCOP). Its purpose is the production and sale of electric power, to which end it has full faculties and authority.

B. Evaluation of the Administrative Structure

- 6.03 The professional consulting firm of Ingeniero Ricardo Alvarado recently conducted an evaluation of INDE's organizational structure. That report, presented in November 1980, contains a diagnosis of the organization and the personnel department, a performance evaluation and specific studies on every aspect of INDE personnel administration.
- 6.04 The consultants examined the flow of information processing in order to determine what measures could help streamline the internal movement of the documents on which the institution's accounting records and statistics are based. They also made an analysis of the optimal location for certain administrative units in terms of coordination with the rest of the organization and with decision-making centers. Lastly, the consultants examined the area of programming, coordinated preparation of budgets, and monitoring of execution.
- 6.05 In their conclusions to the study, the consultants recommend a group of organizational adjustments which would entail changes in the distribution of duties, affecting various sectors of the agency. INDE has appointed an executive committee to study the consultants' report and to advise the Board of Directors on implementation of those recommendations within a reasonable period. Consequently, it is recommended that INDE submit to the IDB, within six months after the contracts are signed for the new financing under review here, a plan for implementation of the recommendations and the corresponding execution schedule, together with a commitment to follow that schedule to the Bank's satisfaction.

C. Internal Control

- 6.06 The Internal Auditing Unit, which reports to the Board of Directors, consists of 38 auditors and is divided into three working sections: constant auditing, special auditing and periodic auditing. In general, the work performed by the department encompasses the traditional duties of internal auditing. The consulting firm of Arturo Morales Palencia y Asociados made a study entitled Evaluation and Reorganization of INDE Internal Auditing. It was approved by INDE's Board of Directors and approximately 50% of the recommendations were put into effect during the last fiscal year. The remaining recommendations made by the external auditors will also be subject to an implementation plan and execution schedule, with a similar commitment to that described in the preceding paragraph.
- 6.07 There are still some weaknesses, however, in the INDE control mechanism. They were noted by the external auditors and constituted the object of reservations in the auditors' reports for the last few fiscal years. They consist mainly of the impossibility of reconciling central control accounts with the balances of auxiliary records for such diverse items as construction and maintenance materials and supplies, imported materials in transit, and suppliers of materials and equipment. In the opinion of the independent accountants, these differences have accumulated over the years. At present, an effort is being made to clarify all such balances.

D. External Control

- 6.08 From the standpoint of external control, INDE management is subject to inspection by the Office of the Controllers of National Accounts, through a permanent delegation of controllers consisting of a chief and five individual controllers. INDE is also required to submit a quarterly report on its activities to the Ministry of Finance (Technical Budget Directorate). The INDE Board of Directors engages the services of an independent firm of public accountants each year to audit its financial statements and review supplementary financial information and the degree of compliance with the accounting and financial clauses appearing in loan contracts with international financing agencies. Presentation of these financial statements has generally been the subject of extensions of up to an additional three months after April 30 of each year i.e. until July of the following fiscal year.
- 6.09 External auditing of the institution and the IDB project for fiscal years 1977-79 was entrusted to the auditing firm of Lizarralde, Ayestas y Asociados. The opinion of the auditors was issued with reservations concerning substantial differences in accounts receivable, the inventory of materials and supplies, accounts payable and users' deposits. Generally speaking, the work of the auditors may be considered acceptable. However, the supplementary information might well be expanded in regard to INDE operating indicators and statistics.

- 6.10 External auditing for the 1980 fiscal year is being conducted by the same firm and it is anticipated at this time that an extension of at least two months will be needed for its presentation. In regard to the new financing under review here, it will not be necessary for the contract to contain a provision requiring the executing agency to present its financial statements and those of the project, since that financial information has to be supplied, pursuant to the provisions of contract 454/SF-GU, throughout the life of this loan, which has an amortization period of 40 years.

E. Human Resources

- 6.11 As of December 31, 1980, the Instituto Nacional de Electrificación had a total of 6,825 employees. Changes in the staff over the past three years are shown below:

	<u>1978</u>	<u>1979</u>	<u>1980 1/</u>
Administration	647	650	659
Engineering and construction	3,060	4,131	4,208
Operation and maintenance	1,748	1,754	1,751
Marketing and services	202	205	207
	<u>5,657</u>	<u>6,740</u>	<u>6,825</u>

- 6.12 As of December 31 1980, the following staff members were assigned to the most important works in progress:

<u>Works</u>	<u>Personnel</u>
69 KV line	979
Pueblo Viejo plant (Chixoy)	931
Transmission lines	718
Escuintla plant	400
Aguacapa plant	398
Western system	342
Eastern system	231
	<u>4,009</u>

F. Historical Financial Analysis

(a) Introduction

- 6.13 Article 37 of the law creating INDE exempts it from all taxes, assessments, customs duties and existing or future levies. Article 31 states that one of the Instituto's financial policies will be to capitalize its net profits, using them to finance and execute national electrification

1/ On December 31, 1980, INDE staff included 136 permanent professionals, mostly electric, civil and mechanical engineers. An additional 41 professionals in various specialized areas work under temporary contracts.

plans. Article 32 further provides that INDE shall not transfer any part of its profits to the general income of the state. INDE's accounts are kept in quetzals, the official currency of the Republic of Guatemala, which has maintained a stable rate of exchange in regard to the United States dollar for many years (one quetzal is equal to one dollar).

- 6.14 The financial analysis of the Instituto Nacional de Electrificación was conducted by the IDB based on December 31 financial statements for the years 1977, 1978, 1979 and 1980. ^{1/} In order to provide the most recent information available on the situation of INDE, the IDB analysis used the December 31, 1980 financial statements, although external auditing had not been completed by May 1981, at the time of the analysis mission's visit.

(b) Profitability

- 6.15 A comparative statement of INDE annual results for the period from 1977 through 1980 appears below, showing that profits were obtained in each of those years:

(In US\$ thousands equivalent)

	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
Operating revenue	36,301	44,021	64,765	83,811
Operating expenses	(34,157)	(38,125)	(52,212)	(76,660)
Net operating revenue	2,144	5,896	12,553	7,151
Overhead	(405)	(413)	(1,876)	(671)
Net operating revenue	1,739	5,483	10,677	6,480
Other expenditures	(133)	(562)	(118)	(472)
Financing charges	<u>(1,119)</u>	<u>(1,500)</u>	<u>(1,727)</u>	<u>(1,862)</u>
Net profits	<u>487</u>	<u>3,421</u>	<u>8,832</u>	<u>4,146</u>
	=====	=====	=====	=====

- 6.16 Revenue from INDE electric power sales increased constantly over the period analyzed, rising from the equivalent of US\$36 million in 1977 to that of US\$83 million in 1980. This represents an increase of approximately 130% over the three-year period, mainly due to periodic utility rate hikes. It should be noted that INDE's average rate has risen from the equivalent of US\$0.04223 per Kwh in 1977 to that of US\$0.0778 per Kwh in 1980. The volume of INDE electric power sales fluctuated only slightly over the period: 916 Kwh in 1977 and 959 Kwh in 1980.

^{1/} Independent auditors Lizarralde, Ayestas y Asociados reported that the December 31, 1979 financial statements reflected INDE's financial position and the results of its operations, taking into account the reservations expressed in their opinion.

6.17 Operating expenses - which amounted to US\$34 million equivalent in 1977 - rose US\$42.5 million equivalent, or approximately 124%, over the period, amounting to US\$76.7 million equivalent as of December 31, 1980. Approximately 80% of that increase was due to the higher cost of fuel used for thermal generation of electricity. During the period analyzed, INDE financing charges went up steadily, from US\$1.1 million equivalent in 1977 to US\$1.9 million in 1980.

6.18 Average profitability in proportion to the amount of sales fluctuated during the period, reaching the following amounts for the years indicated:

<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
1.34%	7.77%	13.6%	4.95%

(c) Financial position

6.19 A comparative chart of the December 31 statements of INDE's financial position for the years 1977, 1978, 1979 and 1980 appears below:

(In US\$ thousands)

	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
<u>Assets</u>				
Plant in service	118,463	138,026	153,149	164,440
Less depreciation	(23,380)	(28,326)	(34,402)	(41,062)
	<u>95,083</u>	<u>109,700</u>	<u>118,747</u>	<u>123,378</u>
Construction in progress	81,506	177,420	309,606	481,656
Net fixed assets	176,589	287,120	428,353	605,034
Current assets	38,184	41,755	65,708	80,472
Other assets	86,197	67,199	61,166	51,690
Total assets	<u>300,970</u>	<u>396,074</u>	<u>555,227</u>	<u>737,196</u>
<u>Net Worth</u>				
Capital	173,511	225,140	309,431	431,462
Profits	305	3,328	8,935	1,925
	<u>173,816</u>	<u>228,468</u>	<u>318,366</u>	<u>433,387</u>
<u>Liabilities</u>				
Long-term liabilities	75,372	116,221	171,818	198,530
Short-term liabilities	51,598	50,202	64,779	105,016
Other liabilities	184	1,183	264	263
Total liabilities	<u>127,154</u>	<u>167,606</u>	<u>236,861</u>	<u>303,809</u>
Total liabilities and net worth	<u>300,970</u>	<u>396,074</u>	<u>555,227</u>	<u>737,196</u>
	=====	=====	=====	=====

6.20 The foregoing data show that INDE assets have experienced important growth over the period analyzed. Most of the increase is for construction in progress under the heading of fixed assets. This includes the Chixoy River and Aguacapa hydroelectric plants plus the new substations, transmission lines and distribution grids for the central, eastern and western systems. ^{1/}

6.21 The foregoing comparative statement is the source of the following ratios showing the evolution of INDE's financial position:

	1977	1978	1979	1980
Current assets	38,184	41,755	65,708	80,472
Current liabilities	51,598	50,202	64,779	105,016
Working capital	(13,414)	(8,447)	929	(24,544)
Long-term liabilities	75,372	116,221	171,818	198,530
Net Worth	173,816	228,468	318,366	433,387
Ratios:				
Current ratio	0.74	0.83	1.01	0.77
Debt/equity	0.43	0.51	0.54	0.45
Short-term liabilities/ long-term liabilities	0.68	0.43	0.38	0.53

6.22 The above summary indicates first of all that INDE coverage of short-term liabilities over the period from 1977 to 1980 was inadequate. Even though its long-term liabilities have increased sharply in absolute terms (rising from US\$75 million equivalent in 1977 to that of US\$198 million in 1980), as a percentage of the net worth has remained substantially unchanged, since the long-term debt/equity ratio remained at 0.43 and 0.45 at the close of 1977 and 1980, respectively.

6.23 In regard to the debt structure, the proportion of short-term commitments to total liabilities is relatively high for the period, despite the slight downward trend.

6.24 INDE's net worth, which amounted to US\$174 million equivalent in 1977, shows an increase of US\$259 million equivalent over the period, reaching US\$433 million equivalent. The increase, representing approximately 149%, was largely due to capital contributions from the Guatemalan government.

6.25 According to the financial statements, the balance outstanding of INDE receivables on December 31, 1980 amounted to US\$28 million equivalent. A breakdown appears below of the composition of receivables, by sector, at the close of the fiscal year, showing the accounts by year and the collection indices.

^{1/} INDE is now working on a major investment program to expand Guatemala's electric power generation capacity.

	<u>US\$</u>	<u>%</u>	<u>Days of sale</u>
Residential	2,560.6	9.1	128
Commercial	1,195.0	4.6	189
Industrial	4,013.7	14.3	150
Government	1,735.1	6.2	369
Municipal	481.7	1.7	450
Public lighting	1,077.8	3.9	487
Electric companies	3,372.1	12.0	247
Sub-total	14,536.9	51.9	-
EEGSA	13,472.6	48.1	88
Total	28,010.5	100.0	123
	=====	=====	=====

COLLECTION INDEX

<u>Year</u>	<u>Receivables</u> (in thousands of Q)	<u>Sales</u> (in thousands of Q)	<u>%</u>	<u>Days of sale</u>
1971	1,453.1	7,308.3	19.9	73
1972	1,835.9	8,480.0	21.6	79
1973	1,956.0	9,985.2	19.6	72
1974	3,976.8	16,985.0	23.5	86
1975	2,899.3	19,155.0	15.1	55
1976	4,252.2	25,200.7	16.9	62
1977	8,410.6	36,300.7	23.2	85
1978	11,824.8	44,020.9	26.9	98
1979	19,333.0	64,764.9	29.9	109
1980	28,010.5	83,811.0	33.4	123

- 6.26 The foregoing information shows that collections for energy sales are lagging in all sectors served by the INDE. Collection indices fell from 55 days of sales in 1975 to 123 days in 1980. Unpaid balances from the residential and commercial sector represent receivables of 128 and 189 days of sale respectively, although the General Electric Service Regulations stipulate that after 120 days have elapsed without payment, service is to be disconnected. In analyzing the accounts classified under the industrial sector, it should be remembered that these include substantial balances from suppliers of cement to INDE construction sites, to whom INDE also owes payments.
- 6.27 Government agency accounts: the information supplied to the Bank indicates that INDE has made arrangements for the Ministry of Finance to work out a mechanism that will allow collection of these debts and provide for automatic payment starting in 1981. The municipal sector provides public services that cannot be interrupted without causing serious social problems. Furthermore, some of the municipalities are in straitened financial conditions. For these reasons, and to expedite collection of balances due, INDE has had to ask the Ministry of Finance to increase

budgetary allocations to the municipalities to enable them to pay their bills. Payment for public lighting in most towns is made from municipal taxes that have not been increased enough to cover costs. INDE is conducting a study as a basis for proposing that the government issue a decree authorizing municipalities to incorporate the increased cost into the established taxes. It should be stressed that the greatest arrearage is found in government agency accounts. But the impact on INDE finances is slight since the amounts involved are relatively small (particularly in the case of the municipalities). Nevertheless, this situation must be remedied and, as noted, measures are now being taken for that purpose.

- 6.28 The table above also shows that the Empresa Eléctrica de Guatemala (EEGSA) has a balance outstanding equivalent to US\$13.4 million, representing 48% of all receivables. Information supplied to the Bank indicates that INDE has held a series of meetings with EEGSA authorities to try to bring the account up to date and that the necessary measures are being taken to reduce the payment period to a maximum 30 days. The arrearage from all sources (public and private sectors and the electric companies, including EEGSA) must be remedied within a prudent amount of time. To this end, it is recommended that INDE submit evidence to the Bank, within 120 days of the close of each fiscal year, starting with the one ending December 31 1983, that it has collected no less than 85% of receivables due for the corresponding year, including the amount due for collection at the start of the year.

d) Source and application of INDE funds

- 6.29 The comparative statement of the source and application of funds for the 1977-1980 period appears below:

STATEMENT OF SOURCE AND APPLICATION OF FUNDS
(in thousands of quetzals)

	<u>1977</u>	<u>%</u>	<u>1978</u>	<u>%</u>	<u>1979</u>	<u>%</u>	<u>1980</u>	<u>%</u>
SOURCE OF FUNDS								
Net operating income	487	0.6	3,422	3.5	8,832	6.4	4,145	2.6
Depreciation and amortization	<u>4,542</u>	5.4	<u>4,947</u>	5.0	<u>6,076</u>	4.4	<u>6,660</u>	4.2
Total internal sources	5,029	6.0	8,369	8.5	14,908	10.8	10,805	6.9
Capital contributions (net)	52,072	61.4	42,983	43.8	62,462	45.0	113,095	72.0
Loans obtained	27,680	32.6	46,783	47.7	61,410	44.2	35,330	22.5
Other sources	<u>64</u>	-	<u>42</u>	-	<u>170</u>	-	<u>(2,160)</u>	(1.4)
	79,816	94.0	89,808	91.5	124,042	89.2	146,265	93.1
All sources	<u>84,845</u>	100.0	<u>98,177</u>	100.0	<u>138,950</u>	100.0	<u>157,070</u>	100.0
APPLICATION OF FUNDS								
Loan amortization	1,745	2.0	2,326	2.4	4,548	3.3	5,424	3.5
Internal debt amortization	<u>1,332</u>	1.6	<u>1,332</u>	1.4	<u>1,332</u>	1.0	<u>1,332</u>	0.8
Total debt service	3,077	3.6	3,658	3.8	5,880	4.3	6,756	4.3
Construction	66,672	78.6	122,637	124.9	159,264	114.6	197,416	125.7
Other applications	<u>284</u>	0.3	<u>186</u>	0.2	<u>2</u>	-	<u>-</u>	-
Total application	70,033	82.5	126,481	128.8	165,146	118.9	204,172	130.0
Increase (decrease)								
Working capital	14,812	17.5	(28,304)	(28.8)	(26,196)	(18.9)	(47,102)	(30.0)

- 6.30 Internal generation of funds averaged 8.05% during the period under review, representing 6% in 1977 and 6.9% in 1980. Funds of external origin have remained relatively constant, representing 94% in 1977; 93.1% in 1980; and an average of 91.95% for the period. The largest item was that of government contributions, which represented a total of 61.4% of all funds in 1977 and 72% in 1980. This shows that INDE is strongly dependent on government contributions. Expenditures were used primarily for the INDE construction program, which accounted for 78.6% of all sources in 1977, increasing to 125.7% in 1980.

e) Conclusions of historical financial analysis

- 6.31 (i) From 1977 to 1980, INDE's financial situation was characterized by substantial growth, financed by long-term loans, capital contributions from the government and internal generation of funds. (ii) Most of the resources handled by INDE were used for works in progress. (iii) The volume of electric power generation has fluctuated slightly. Nevertheless, income from operations has increased steadily due to periodic rate hikes. (iv) During the period analyzed, INDE's long-term debt has increased but has nevertheless remained in proportion to its net worth. INDE working capital, on the other hand, has been inadequate, as shown by the current index, which was less than one for the period (except in 1979 when for a short time it reached 1.01).
- 6.32 The foregoing information leads to the conclusion that although INDE liabilities include a relatively high proportion of short-term commitments, total indebtedness is reasonably in proportion to the Instituto's net worth. At present, INDE is concentrating its resources primarily on completion and start-up of the hydroelectric plant in order to improve general profitability of its operations by replacing thermal generation with lower cost hydroelectric power.

G. Rates

- 6.33 Article 56 A of the law that established INDE makes it responsible for the study, formulation, revision and surveillance of rate applications. The instrument governing INDE's relations with its customers is the General Electric Service Regulations approved by its Board of Directors in July 1967. The specific regulations applicable to utility rates were approved on May 21, 1980. The categories established are: general (residential and commercial sectors); general (government and municipal sectors); intermediate consumption; high consumption; retail distributors; farm irrigation pumping; temporary service; water supply and municipal services; general rural electrification and general public lighting. 1/

1/ The rates for farm irrigation pumping and water supply and municipal services are based on peak demand load, according to the volume of consumption.

6.34 There are no legal requirements defining the tariff base used to measure the profitability obtained by operation of electric service. Nevertheless, loan contract 454/SF-GU included the following conditions: "Chapter V, Clause 6 - Rates. (a) The borrower shall take appropriate measures acceptable to the Bank in order that the rates for the sale of energy from the systems of INDE: (i) produce revenues at least sufficient to cover all operating expenses of the electric energy system, including those related to administration, operation and maintenance, billing and collections and depreciation; (ii) yield a reasonable return on the net utility investment in the electric energy system; and (iii) if the flow of funds available from the foregoing is not sufficient to cover the timely servicing of all the obligations of INDE, generate such additional sums as shall be needed for this purpose. (b) The borrower undertakes to ensure that INDE will implement a complete rate adjustment to the Bank's satisfaction starting in 1976 that will represent an increase of at least 35% in its current average rates."

6.35 INDE operating results for fiscal years 1977, 1978, 1979 and 1980 (all of which showed a profit) are evidence of compliance with subsection (a)(i) of the financial profitability clause. The following table shows profits obtained by INDE over the 1977-1980 period. Profitability on average fixed assets in service amounted to 2.09% in 1977. This increased to 9.35% in 1979, dropping back to 5.35% in 1980. The calculation methodology does not include working capital; if it did, estimating it as a percentage of sales, the profitability index would be slightly lower. The index for 1977 would become 1.95%, increasing to 8.54% in 1979 and dropping to 4.79% in 1980. The financial rate of return stipulated in section VII of Annex B to the contract calls for an index of 9% on the average value of fixed assets in service, although that index may be lower during the execution period. Accordingly, even though the minimum level of profitability is not achieved for 1980, a profitability rate of 5.35% for that year is acceptable since it is within the execution period.

INDE PROFITABILITY

As of Dec. 31	Gross Fixed Assets in Operation	Depre- ciation	Net Fixed Assets	Average Fixed Assets	Working Capital (1/6 sales)	Profit/ Fixed Investments	Average Profit on Fixed Assets
1976	89,918	18,954	70,964	-	-	-	-
1977	118,462	23,379	95,083	83,023	6,050	1.95%	2.09%
1978	138,026	28,326	109,700	102,391	7,336	4.99%	5.35%
1979	153,157	34,403	118,754	114,227	10,794	8.54%	9.35%
1980	164,440	41,062	123,378	121,066	13,969	4.79%	5.35%

- 6.36 According to statistics supplied by INDE, the average price per kilowatt/hour for all sectors (which was 0.032 cents in 1976) rose to 0.0778 cents in 1980. This represents an increase of about 143% in the average price of kilowatt/hour sold. Therefore INDE has complied with the stipulations of subsection (b) of the aforementioned clause. The evolution of average prices for electric power since 1975, by service category, is shown in the following table.

(In US\$ cents)

	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
Residential	6.39	8.33	9.37	10.29	11.45
Commercial	4.62	6.30	7.76	10.83	12.13
Small industry	3.02	5.62	8.35	9.60	10.75
Large industry	-	4.84	5.67	7.67	8.59
Government and municipalities	3.97	6.64	6.36	10.51	11.77
Public lighting	3.54	5.45	6.22	7.64	8.55
EEGSA (bulk)	3.07	3.84	4.42	7.02	7.15
Bulk sales to municipalities	2.66	4.96	5.61	6.25	7.00
Total average	3.20	4.22	4.92	7.49	7.78

- 6.37 Analysis of the above comparative statement shows that INDE has established annual increases in its rates over the period from 1976 to 1980. Most of that increase took place between 1976 and 1979, accounting for 134%. The foregoing information indicates that INDE electric power rates have now reached a relatively high level. It should be noted that expenditures for fuel represent a heavy burden on INDE finances. Start-up of the Aguacapa and Chixoy projects will make it possible to cut back substantially on fuels outlays when Aguacapa goes on stream in 1981 and even more so in June 1983 when the fifth (and last) unit of Pueblo Viejo goes on stream.

VII. JUSTIFICATION FOR THE ADDITIONAL FINANCING ANALYZED

A. Technical Viability

- 7.01 The technical analysis conducted shows that the project is well conceived and is being executed satisfactorily: physical progress amounts to 68%.
- 7.02 The project was properly planned and scaled by INDE and its consultants to meet the estimated demand of the interconnected system. Every attempt has been made to ensure that the delay on certain fronts, due to the reasons described, was as short as possible in accordance with the country's energy requirements.
- 7.03 We are given to understand that cost increases and the delays caused by the after effects of the 1976 earthquake, the design changes and the difficult geology of the rock at the construction site have been properly handled. Accelerated construction, escalated costs and exchange differences represented the equivalent of US\$150,990,000, that is to say, 52% of the total difference between the amount estimated in the loan contract (US\$340,874,000) and the current estimate of US\$630 million. The savings in fuel achieved by Guatemala as a result of curtailing by more than a year the total delay that would have occurred had construction not been accelerated, together with the country's increasing demand for energy, justify this expenditure.
- 7.04 The INDE executing agency has been strengthened by the experience accrued in five years of supervision, and, in addition, enjoys the technical advisory services of a consortium whose component companies are well regarded internationally. The Board of Special Consultants has collaborated effectively with LAMI and INDE on the advisory services for the project, with all elements constituting a harmonious technical team.
- 7.05 The terms for project execution were adjusted periodically by INDE consultants and reviewed during the visit of the analysis mission in the light of experience acquired in construction in the past four years. Appendix V-1, the construction timetable, pegs the start-up date for the first unit as November 1982 and the remaining units would go on stream by August 1983.
- 7.06 As a result, it may be concluded that the additional financing analyzed is justified, inasmuch as: the technical concept of the project was sound and its designs were carefully formulated to ensure satisfactory and safe construction; the new costs were recently checked and the new execution deadline is reasonable. Accordingly, the project is technically viable within the terms, costs and other parameters described earlier in this report.

B. Financial Viability

(a) Scope of financial analysis

- 7.07 The financial projections included in this analysis take into account the necessary investments for completion of the Aguacapa and Pueblo Viejo hydroelectric projects and the interconnection with El Salvador but exclude any additional resources needed for execution of INDE's other projects. Nevertheless, certain considerations appear in paragraph 7.34 and 7.35 regarding the government's capacity to supply the funds that will be needed to finance the entire INDE investment program.
- 7.08 The studies made indicate that Guatemala's demand for electric power will increase steadily between 1981 and 1990, reaching an annual 4,900 Gwh by the end of that period. The investments needed to satisfy that demand represent a considerable outlay, which is believed to exceed the possibilities INDE's internally generated resources. Therefore it must seek financing from the state or from financial markets, as in the past.
- 7.09 The projections were based on the initial assumption that INDE would continue with an investment program covering only the work currently in progress, for which financing is assured; interconnection with El Salvador (the financing of which is now under review by the IDB); and the works under review in this report. For purposes of consistency, it was assumed that INDE sales would increase exclusively in accordance with its installed capacity for power generation and that of the Aguacapa and Chixoy projects, reaching 2 million Kwh in 1985 and remaining at that level thereafter.
- 7.10 The studies indicate that execution of the entire investment program will be required to satisfy additional demand: the corresponding financing is explored in a second stage of this exercise.

(b) Projected INDE profitability

- 7.11 A summary appears below of the projected INDE comparative operating statements for the 1981/1990 period. 1/

1/ Appendix VI-1 contains projected statements of earnings for a period of 10 years.

(In US\$ million)

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>
Total sales (Gwh)	1,002	1,122	1,704	1,918	2,082	2,082	2,082	2,082	2,082	2,082
Energy sales	95.1	106.5	161.7	182.0	197.6	197.6	197.6	197.6	197.6	197.6
Operating costs	<u>94.6</u>	<u>80.5</u>	<u>75.7</u>	<u>82.4</u>	<u>104.2</u>	<u>106.6</u>	<u>107.1</u>	<u>107.6</u>	<u>108.1</u>	<u>108.6</u>
Net operating revenue	0.5	26.0	86.0	99.6	93.4	91.0	90.5	90.0	89.5	89.0
Other outlays	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Financing charges	<u>2.6</u>	<u>11.8</u>	<u>29.6</u>	<u>29.8</u>	<u>34.4</u>	<u>33.0</u>	<u>28.9</u>	<u>24.7</u>	<u>20.5</u>	<u>16.7</u>
Profit (net loss)	<u>(2.5)</u>	<u>(13.8)</u>	<u>56.0</u>	<u>69.4</u>	<u>58.6</u>	<u>57.6</u>	<u>61.2</u>	<u>64.9</u>	<u>68.6</u>	<u>71.9</u>
	=====	=====	=====	=====	=====	=====	=====	=====	=====	=====

7.12 An analysis of the comparative statements shows that, according to the projections, revenue from INDE sales would increase from the equivalent of US\$95 million in 1981 to that of US\$197 million in 1990, based on the increased volume of sales.

7.13 According to the projections, INDE operating expenses would increase from the equivalent of US\$94 million in 1981 to that of US\$108 million in 1990. It is important to note in this connection that the cost structure of INDE operations would be affected by the changes that will take place in the composition of power generation when the Aguacapa (1982) and Chixoy (1983) plants go on stream. As a result of the expanded hydrogeneration program, the consumption of fuels used for thermal generation would decline over that period, reaching its lowest point in 1984. Additional savings in fuel consumption may be possible until this item is completely eliminated between 1988 and 1989 upon completion of the new hydroelectric plants scheduled by INDE.

7.14 Consequently, if the assumptions used for INDE projections prove to be true, there would be a net loss (equivalent to US\$2.6 million) only in 1981, with increasing profits starting in 1982 and reaching US\$71 million equivalent at the end of 1990. 1/

(c) Projected statements of source and application of funds

7.15 Appendix VI-2 contains the projected statements of the source and application of INDE financial resources for the period from 1981 to 1990. That projection is summarized below:

1/ Losses in the first year would occur because net operating income would be inadequate to cover financing costs.

(In US\$ million)

	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>
Internal sources	6.4	35.7	108.3	131.7	127.3	126.8	126.3	125.8	125.3	124.8
External sources	<u>218.7</u>	<u>134.3</u>	<u>58.2</u>	<u>9.1</u>	-	-	-	-	-	-
Total source	225.1	170.0	166.5	140.8	127.3	126.8	126.3	125.8	125.3	124.8
Debt servicing	29.0	36.4	65.8	59.2	73.3	73.8	70.6	66.4	49.5	44.8
Construction	202.3	160.8	85.1	3.3	-	-	-	-	-	-
Other applica- tions	<u>(6.2)</u>	<u>(12.9)</u>	<u>5.3</u>	<u>3.6</u>	<u>3.9</u>	-	-	-	-	-
Total applica- tions	225.1	184.3	156.2	66.1	77.2	73.8	70.6	66.4	49.5	44.8
Annual surplus (deficit)	-	(14.3)	10.3	74.7	50.1	53.0	55.7	59.4	75.8	80.0

7.16 If the assumptions used in the projections prove to be true, the principal source of funds would be internal, representing between 21% and 93% of total sources during the period from 1982 to 1984. It is important to note that the projections do not include government capital contributions starting in 1982. The small deficit (US\$14.3 million) appearing in that year therefore indicates that government capital contribution will be necessary to carry out investment plans of the Aguacapa and Pueblo Viejo projects.

7.17 This figure represents a relatively small amount in comparison with the annual contributions that INDE has received from the government in recent fiscal years, which represent an annual average equivalent to US\$67 million from 1977 to 1980.

7.18 According to the financial projections, total internal sources of funding will increase constantly over the period, rising from the equivalent of US\$6 million in 1981 to that of US\$124 million in 1990.

7.19 According to the premises adopted in this study, INDE expects to receive a total equivalent to US\$420 million from external sources between 1981 and 1984. Most of the resources mentioned (US\$240 million) would come from the government or its agencies in the form of direct contributions in 1981 and as a result of bond issues that have already been approved.

7.20 It is believed that the IDB loans under review for financing of the Pueblo Viejo and interconnection projects would be used for the most part between 1982 and 1983.

- 7.21 The issuance of treasury bonds amounting to 150 million quetzals has been authorized to finance the local contribution for the final stage of the Pueblo Viejo project and that of the Aguacapa, Santa María II and Chulac hydroelectric plant projects. Those resources would be allocated as follows:

(In the equivalent of US\$ millions)

Pueblo Viejo hydroelectric plant	87
Aguacapa hydroelectric plant	25
Santa María II hydroelectric plant	<u>3</u>
	115
Chulac hydroelectric plant	<u>35</u>
Total bond issue	150
	===

- 7.22 Issuance of the treasury bonds was authorized by congressional decree 13-81, published on May 14, 1981. The following stipulations will apply: (i) they will be sold at face value, preferably within the Republic of Guatemala; (ii) bearer bonds maturing in 15 years will be issued on the dates specified by the regulations of this Decree; (iii) interest will be paid at the rate of 12% per annum when negotiated in the Republic of Guatemala or abroad and 1.5% when purchased by the Bank of Guatemala and so long as they remain in its possession; (iv) the sale, transfer or disposal of the bonds and accrued interest are exempt from taxes on stamped paper and fiscal stamps on legacies, bequests and donations; income tax; and any other taxes or assessments that may be established. The decree also provides that if the bonds cannot be sold in the internal or external private market, they will be acquired by the Central Bank.
- 7.23 The Bank of Guatemala will act as financial agent for the indebtedness incurred through issuance of those bonds and will receive a 5% for performing this task. The financial agent is authorized to set aside the necessary resources to cover payment of the principal amount of the debt, interest, commissions and other expenses derived from debt servicing. Nevertheless, the Instituto Nacional de Electrificación will be responsible for payment of Q.115 million of the debt, plus interest and commission fees, six months after the Pueblo Viejo hydroelectric plant goes on stream and in the terms agreed upon with the financial agent. In any event, the Government of the Republic will guarantee payment of any balance outstanding under this obligation. The aforementioned decree provides that the Executive Branch, through the Ministry of Finance, will be responsible for issuing the regulations governing this operation.
- 7.24 Debt servicing will absorb an increasing share of INDE resources, rising from the equivalent of US\$29 million in 1981 to that of US\$73 million in

1986. As of 1983, internally generated resources will suffice for debt servicing. Consequently, INDE will be in a position to meet its commitments satisfactorily while carrying out its investment program.

7.25 In conclusion, the projected statement of source and application of funds shows that, based on the premises adopted, which include loans and a bond issue, INDE will have sufficient resources to complete construction and start-up of the Pueblo Viejo and Aguacapa plants and interconnection with El Salvador, and that its operations will produce annual surpluses.

7.26 The following table is a comparison of the INDE estimated financial surpluses in accordance with the aforementioned projections and the investment program to be carried out by INDE in order to meet the demand for electric power in the period from 1982 to 1990.

	<u>INDE internal resources</u>	<u>Additional investments</u>	<u>Financial requirements (surpluses)</u>
1982	(14,385)	123,327	137,712
1983	10,257	78,624	68,367
1984	74,749	64,998	(9,751)
1985	50,119	56,503	6,384
1986	52,960	54,760	1,800
1987	55,696	122,068	66,372
1988	59,330	116,015	56,685
1989	75,775	129,089	53,314
1990	79,974	72,360	(7,614)

7.27 The preceding table shows how much INDE will be able to contribute to its own investment program. According to this information, internal generation in 1984, 1985 and 1990 would be more than adequate to cover the investment program. In the remaining years, additional contributions will be needed from the state or other external sources. It is estimated that such additional resources would be equivalent to US\$137 million in 1982 and US\$68 million in 1983.

7.28 It should however be noted that the premises adopted in the projections do not include sales resulting from projects for which financing has not yet been assured. If those sales were included, the amount of internal resources generated by INDE would increase and the Instituto would be in a position to finance an even greater proportion of its investment program with funding from that source.

(d) Projected statements of financial position

7.29 The projected statements of INDE's financial position for the 1981-1990 period are included in Appendix VI-3. The principal financial indicators calculated on the basis of the information contained in those statements are shown below:

<u>Year</u>	<u>Current Ratio</u>	<u>Indebtedness Index</u>	<u>Debt service coverage</u>	<u>Profitability/ Fixed investment</u>
1981	0.83	0.50	0.22	0.3%
1982	0.63	0.67	0.98	10.2%
1983	0.80	0.66	1.65	13.9%
1984	0.80	0.55	2.22	11.2%
1985	0.81	0.46	1.74	10.3%
1986	0.81	0.37	1.72	9.8%
1987	0.81	0.30	1.79	10.1%
1988	0.89	0.25	1.89	10.5%
1989	0.90	0.20	2.53	10.9%
1990	0.90	0.16	2.78	11.3%

- 7.30 The liquidity index remains at inadequate levels throughout the period covered by the projections. This is partially due to the fact that the projection does not include capital contributions from the government. The liquidity index would improve sharply if such contributions were made.
- 7.31 Similarly, the indebtedness index reaches high levels in the first years because the projection does not include capital contributions. If such contributions were made, the index would improve proportionately.
- 7.32 The debt service coverage index is rather high in 1981, i.e. 0.22 times. This would however be temporary, since that index would increase to 2.22 in 1984 and would continue to rise until 1990.
- 7.33 Profitability on fixed investments starting in 1983, when the Pueblo Viejo Chixoy River hydroelectric plant goes on stream, continues at adequate levels. No recommendations are made regarding maintenance of the liquidity, indebtedness and debt service coverage indices or obtaining a satisfactory minimum level of profitability, since the contracts for previous loans (301/OC-GU, 302/OC-GU, 454/SF-GU and 6/VF-GU) contain the necessary clauses for that purpose.

(e) Financing of investment programs

- 7.34 Figures in the table that appears in paragraph 7.26 show that INDE's entire investment program (exclusive of Aguacapa, Pueblo Viejo and the Interconnection) will require resources amounting to an aggregate US\$817.7 million. Of that amount, the equivalent of US\$444.5 million could be supplied by INDE internal sources. In other words, INDE would be in a position to finance 54% of its development program.
- 7.35 This proportion is considered very high in comparison with other regional electric sector agencies. Provision of the remaining funds, however, will require a stringent additional effort by the government, particularly in 1982, when investment in the electric sector development

program would represent nearly 34.7% of total 1980 government expenditures. But in view of the priority attached by the government to the Pueblo Viejo project and since it has always supplied the necessary resources in the past, it may be concluded that the government may continue to support this sector in the immediate future, using a combination of internal indebtedness (bonds issued by the treasury and/or INDE itself) and external indebtedness for this purpose. As indicated in paragraph 3.10 of this report, Guatemala is one of the countries with the lowest debt and debt servicing coefficients in Latin America, so that no problems are anticipated in this regard.

C. Socioeconomic Evaluation

a) Introduction

- 7.36 Economic analysis of this project does not address the traditional problem of whether or not the project should be continued, since it is nearing completion. We are therefore concerned with evaluating the consequences of financing the necessary additional investment resulting from increased costs. For purposes of analysis, project alternatives may be considered that involve different start-up dates. Accordingly, it does not behoove us to evaluate the project based on the premise that if it is not financed, its benefits will not materialize, but rather on the assumption that they will materialize, although at a later date.
- 7.37 Another aspect of the project that should be examined has to do with the change of design. Originally, the project was conceived to generate an average annual 1650 GWh. As a result of design changes made after work had started (during construction) in order to make better use of the volume of flow and difference of levels, it was decided to increase the average amount of energy to an annual 1710 GWh. Accordingly, the analysis is designed to ascertain whether the costs implied by the change of design are justified from an economic standpoint.
- 7.38 Finally, we must study the costs to Guatemala's economy entailed by delay in the project. The plant was originally scheduled to go on stream in September 1981; the date has now been postponed to November 1982.

(b) Expansion plans

- 7.39 The expansion plan currently being considered by INDE is shown in the table further on. It is based on INDE demand projections, which appear somewhat optimistic (see Table D in Appendix VI-5). The IDB prognoses (presented in paragraph 3.24 to 3.27) assume an average growth in the demand for energy and power over the 1980-95 period amounting to 12.2% and 12% per annum, respectively. The INDE estimated figures are 13.1% and 13%, respectively, suggesting a need for reoptimization of the equipment plan in regard to works subsequent to start-up of Pueblo Viejo.
- 7.40 To illustrate the need for adjusting the equipment plan, it should be pointed out that the margin of reserves during the 1981-92 planning horizon goes from a minimum of 13.2% (in 1981) to a maximum of 72.8% (in

1983). The average is 44.7%, which is quite high for a country with limited capital resources. For purposes of analysis of the Pueblo Viejo project, however, that program can be kept in effect without affecting the results, since the equipment plan remains unchanged in the four project alternatives.

<u>Plants</u>	<u>Type</u>	<u>Average Energy GWh</u>	<u>Start-up Date</u>
Pueblo Viejo	H	1,710	Nov. 1982
Sta. María II	H	254	Jun. 1984
Zunil	G	210	Dec. 1985
Chulac	H	1,716	Jan. 1988
Xalalá	H	1,474	Dec. 1989

H = Hydroelectric
G = Geothermal

- 7.41 The Pueblo Viejo project was originally scheduled to go on stream in September 1981 (Alternative I). For a number of reasons, this date was postponed to November 1982 (Alternative II). The question now arises of what might happen if the financing under review here is not granted. The most obvious effect would be to reduce the annual spending level and delay start-up of the plant to April 1983 (Alternative III), resulting in the processing of new loan applications and temporary reduction of investment funds available. The possibility of suspending the project is not considered. Finally, the project under review generates average energy of 1710 GWh-year, while the original plans called for only 1650 GWh-year (Alternative IV). The following table shows the principal features of those alternatives:

<u>ALTERNATIVES</u>	<u>Start-Up Dates</u>	<u>Average Energy (GWh)</u>
I	Sept. 1981	1,710
II	Nov. 1982	1,710
III	April 1983	1,710
IV	Nov. 1982	1,650

- 7.42 Economic analysis of the original project report envisaged an equipping sequence totally different from the present one. ^{1/} That sequence included the four Chixoy River development projects (Pueblo Viejo, Tapezcos, Jacotales and Palzajel), the Atitlán and Aguacapa projects and the Moyuta geothermal plant. The present expansion plan considers only two of the seven previous projects: Aguacapa and Pueblo Viejo.

^{1/} IDB, Guatemala: Pueblo Viejo Hydroelectric Project on the Chixoy River, Project Report, PR-676-2-A, December 2, 1975.

d) Costs

- 7.43 The total cost of the project amounts to US\$630 million equivalent. The economic cost of the project at January 1981 prices, equivalent to US\$525.72 million, is obtained by deducting financing charges, taxes, and provision for escalation from January 1981 to April 1983 (date of completion of final project works) and reevaluating the period from 1977 to January 1981 to cover inflation. The data on which this estimate is based correspond to expenditures made thus far (from 1977 to March 1981) and those yet to be made (from April 1981 to April 1983). In view of the degree of progress on the project, it is felt that the final cost would be very close to the estimated figure. The principal components of the investment amount (in Alternative II) are shown below:

	<u>(US\$ MM)</u>	<u>(%)</u>
Total Investment	525.7	100.0
A. Materials	210.3	40.0
B. Equipment	131.4	25.0
C. Labor	184.0	35.0
1) Skilled	(26.3)	(5.0)
2) Semi-skilled	(52.6)	(10.0)
3) Unskilled	(105.1)	(20.0)

- 7.44 Alternatives I and III cost the same as Alternative II, the only difference being in the disbursement schedule. Alternative IV costs less than the others since it does not include the expense of the design change required to increase the average amount of energy that can be generated by the project. This design change cost is estimated at US\$6.86 million at January 1981 prices, which results in an economic cost of US\$6.66 million when corrected for transfers. The investment table below shows the schedules and amounts of investments under the different alternatives:

<u>Investment Percentages</u>				
<u>Years</u>	<u>ALT. I</u>	<u>ALT. II</u>	<u>ALT. III</u>	<u>ALT. IV</u>
1977	10.0	10.4	10.4	10.4
1978	12.0	10.3	10.3	10.3
1979	13.0	9.1	9.1	9.1
1980	25.0	15.0	15.0	15.0
1981	25.0	21.2	20.0	21.2
1982	15.0	22.4	20.0	22.4
1983	-	11.7	10.0	11.7
1984	-	-	5.2	-
<u>Totals</u>				
<u>(%)</u>	100.0	100.0	100.0	100.0
<u>US\$MM</u>	<u>525.7</u>	<u>525.7</u>	<u>525.7</u>	<u>519.1</u>

- 7.45 Fuel costs at the thermal plants were estimated in accordance with the most recent figures for imported fuels. Those prices were weighted by the volume of imports. The results were in turn adjusted by transportation costs from the port of entry 1/ to the plant sites. The resulting prices are shown below:

(In the equivalent of 1981 US\$)

<u>Fuels</u>	<u>Barrel</u>
Bunker	33.43
Diesel	43.10
Crude	34.60

- 7.46 Operating and maintenance costs were estimated on the basis of data for Guatemala and other countries, and are shown in the following table.

(In the equivalent of January 1981 US\$)

<u>Plant and Type of Cost</u>	<u>Cost</u>
I. Hydro	
-Fixed (US\$MW)	0.007
-Variable (US\$GWh)	0.002
II. Thermal, gas turbines and geothermal	
-Fixed (US\$MW)	0.005
-Variable (US\$GWh)	0.003

e) Socioeconomic profitability

- 7.47 Economic evaluation of the Pueblo Viejo-Quixal hydroelectric project attempts to answer the following questions: i) what are the opportunity costs to Guatemala of delaying the project? ii) what would be the opportunity costs to the country if the financing under review here is not granted? iii) what are the benefits of increasing average generation from 1650 GWh-year to 1710 GWh-year?
- 7.48 The bases used for the economic analysis are: i) The demand forecasts considered in the analysis were prepared by the IDB. ii) The basic plan for the interconnected system will remain unchanged, with marginal changes in the start-up date and scale of the Pueblo Viejo-Quixal project. iii) Simultaneous operation of the interconnected system is simulated with the different alternatives for the Pueblo Viejo project, generating different cost flows for each plan considered. iv) The planning

1/ Some of the EGGSA plants use domestically produced crude, which was assigned the LAB export price.

horizon extends to 1992, assuming that demand subsequent to that time would be met in the same way. Naturally, this assumption favors Alternative IV, involving greater relative use of thermal capacity. v) The price base corresponds to January 1981, using real prices and eliminating tax, financial and accounting transfers. vi) International fuel prices were used, weighted for the various types of crude and adjusted for port-to-plant transportation costs.

- 7.49 The cost flows of the four project alternatives indexed at 12% are shown in the following table. As may be seen, the lowest updated cost is that of ALTERNATIVE I (original case, Pueblo Viejo-Quixal in September 1981). The difference between the cost of that alternative and the present one (II, Pueblo Viejo-Quixal in November 1982) shows how much the delay in the project has cost Guatemala: US\$34.8 million.

(In US\$ million equivalent)

Alternatives	Pueblo Viejo Start-up Date	Updated Cost <u>2/</u>	Difference in Regard to the Cost of the Base Case	
			(\$)	(%)
I	Sept. 1981	493.4	-34.8	6.6
II	Nov. 1982	528.2	-	-
III	April 1983	534.8	+6.6	+1.3
IV	Nov. 1982 <u>1/</u>	529.6	+1.4	+0.3

- 7.50 If the financing for the project is not granted, it would go on stream later. This would mean a cost overrun of US\$6.6 million for Guatemala in terms of present value, as a result of the prospective delay in the rate of construction. If the project goes on stream on the earliest date, that cost overrun would not occur, so that this may be considered as the net benefit of the project. The foregoing considerations determine that the financing under review here is to the country's advantage.
- 7.51 Finally, the change in project design whereby average power would be increased will prove economical. The project alternative with an average generation of 1650 GWh a year costs US\$1.4 million more than base alternative II.
- 7.52 The sensitivity analysis shows that for the highest rates of demand (two percentage points), the project benefit increases and for lower demand rates (two percentage points less), the benefit declines but continues to remain positive, with the ranking of the various alternatives remaining unchanged. Moreover, the same result was obtained in regard to fuel price changes. Consequently, the sensitivity analysis shows that neither project feasibility nor the start-up date would be affected, thus confirming the priority nature of the project.

1/ Featuring average power of 1,650 GWh-year.

2/ Discounted at 12% to 1977, date when the project started.

W-3716P

AUMENTO PROGRESIVO DE LOS COSTOS DEL PROYECTO

JULIO 1981

GUATEMALA: PROYECTO PUEBLO VIEJO - QUIXAL
(en miles de US\$)

	Contrato de Préstamo 1975	Aprobado		Diferencia		Diferencia
		BID Mar. 1980	Enero 1981	630.000 - 340.874	630.000 - 446.547	
Estudio y diseño		2.001	2.810	2.810	809	
Ingeniería y supervisión	12.703	8.653	19.500	6.797	10.847	
Administración	5.187	16.410	21.390	16.203	4.980	15.827
	17.890	25.063	40.890	23.000		
Caminos acceso y campamento	15.250	19.651	20.921	5.671	1.270	
Chixoy B. Presa	27.838	42.606	126.323	98.485	83.717	
Túnel Aducción	73.618	126.248	256.043	182.425	129.795	
Casa de máquinas	7.391	24.389	28.400	21.009	4.011	
Equipo hidrone-cánico	14.385	10.238	18.238	3.853	8.000	
Equipo electro-mecánico	13.800	12.594	20.600	6.800	8.006	
Estructuras acero	7.965	6.248	8.849	884	2.601	
S/E y Línea de transmisión	11.814	11.818	19.786	7.972	7.968	
Compra tierras y reubicación	172.061	2.500	3.800	3.800	1.300	246.668
		256.292	502.960	330.899		
Gastos financieros	37.361	37.339	37.340	(-21)		1
Imprevistos	22.084	40.302	17.500	(-4.584)	(-22.802)	
Escalamiento	91.478	85.550	28.500	(-62.978)	(-57.050)	(-79.852)
	113.562	125.852	46.000	(-67.562)		
TOTAL	340.874	446.547	630.000	289.126		183.453

W-2140a

GUATEMALA

SISTEMA INTERCONECTADO

GENERACION, CONSUMO Y DEMANDAS MAXIMAS

<u>Año</u>	<u>Generación</u>	<u>Consumo</u>	<u>Pérdidas</u>	<u>Demanda</u>	<u>Factor de</u>
	<u>Neta</u>		<u>T + D</u>	<u>Máxima</u>	<u>Carga Anual</u>
	<u>GWH</u>	<u>GWH</u>	<u>%</u>	<u>MW</u>	<u>%</u>
1970	623	541	13.2	116	61.3
1975	922	798	13.4	185	56.8
1976	1015	871	14.2	199	58.2
1977	1202	1044	13.1	237	57.8
1978	1309	1144	12.6	248	60.2
1979	1398	1239	11.3	265	60.2
1980	1431	1281	11.7	273	59.8

GUATEMALA

SISTEMA INTERCONECTADO AÑO 1979

CONSUMO, NUMERO DE ABONADOS E INGRESOS POR VENTA DE ENERGIA

Clase de Consumo	Consumo		No. de Abonados miles	Ingresos Miles US\$	Consumo Medio DWH/Abonado	Ingreso Medio UScts/KWH	Fa M Anu
	GWH	%					
Residencial	305	24.8	257	26764	1184	8.78	
Comercial	220	17.9	52	19810	4218	9.01	
Industrial	545	44.3	1.6	42507	341900	7.80	26
Gobierno y otros	161	13.1	4.3	8159	37400	5.07	1
Totales y Promedios	1231	100.0	315	97240	3902	7.90	

CONSUMO E INGRESO MEDIOS

	<u>Residencial</u>		<u>Comercial</u>		<u>Industrial</u>		<u>Gobiernos y Otros</u>		<u>Tot</u>
Año	KWH/Ab	UScts/KWH	KWH/Ab	UScts/KWH	KWH/Ab	UScts/KWH	KWH/Ab	UScts/KWH	KWH/Ab
1975	-	-	-	-	-	-	-	-	3680
1976	-	-	-	-	-	-	-	-	3752
1977	1271	6.49	4257	6.17	314060	4.97	29210	5.22	4129
1978	1118	7.45	4008	7.08	296260	5.79	37850	4.08	3873
1979	1184	8.78	4218	9.01	341900	7.80	37400	5.07	3902
	====	=====	====	=====	====	=====	====	=====	=====

INDE Y EEGSA

INSTALACIONES EXISTENTES 1979

Generación	Central Generadora Sistema Interconectado:	Año Instalación	No. Unidades	Capacidad Instalada - MW		
				Hi- dráulica	Térmica Vapor	Turbogas y Diesel
<u>INDE</u>						
	CH Jurún Marinalá	1969/70	3	61	-	-
	CH Los Esclavos	1966	2	13	-	-
	CH Varias menores			25	-	-
	CD Varias					2
	CT Escuintla	1972/77	2Vap. 5TG	-	862/	871/
<u>EEGSA</u>						
	CT Laguna	1961/77	4Vap. 3TG	-	30	59
	CT Diesel	1956	-	-	-	5
	Total Sistema Int.	-	-	99	116	153
<u>Sistemas Aislados INDE</u>						
	Total INDE y EEGSA	-	-	99	116	165

Transmisión

Líneas de Transmisión:

Voltajes - KV Longitud - KMS	
230	44
138	46
69	935

Subestaciones Reductoras	
Voltajes -	Capacidad en MVA

230/13.8	130
138/69	75
138/13.8	132
69/34.5/13.8	114

1/ Se incluye 12 MW de Turbina de Gas, alquilada temporalmente a México y ya devuelta en 1980.

2/ Incluye la máquina mayor del sistema TV 53 MW, y la siguiente TV 33 MW.

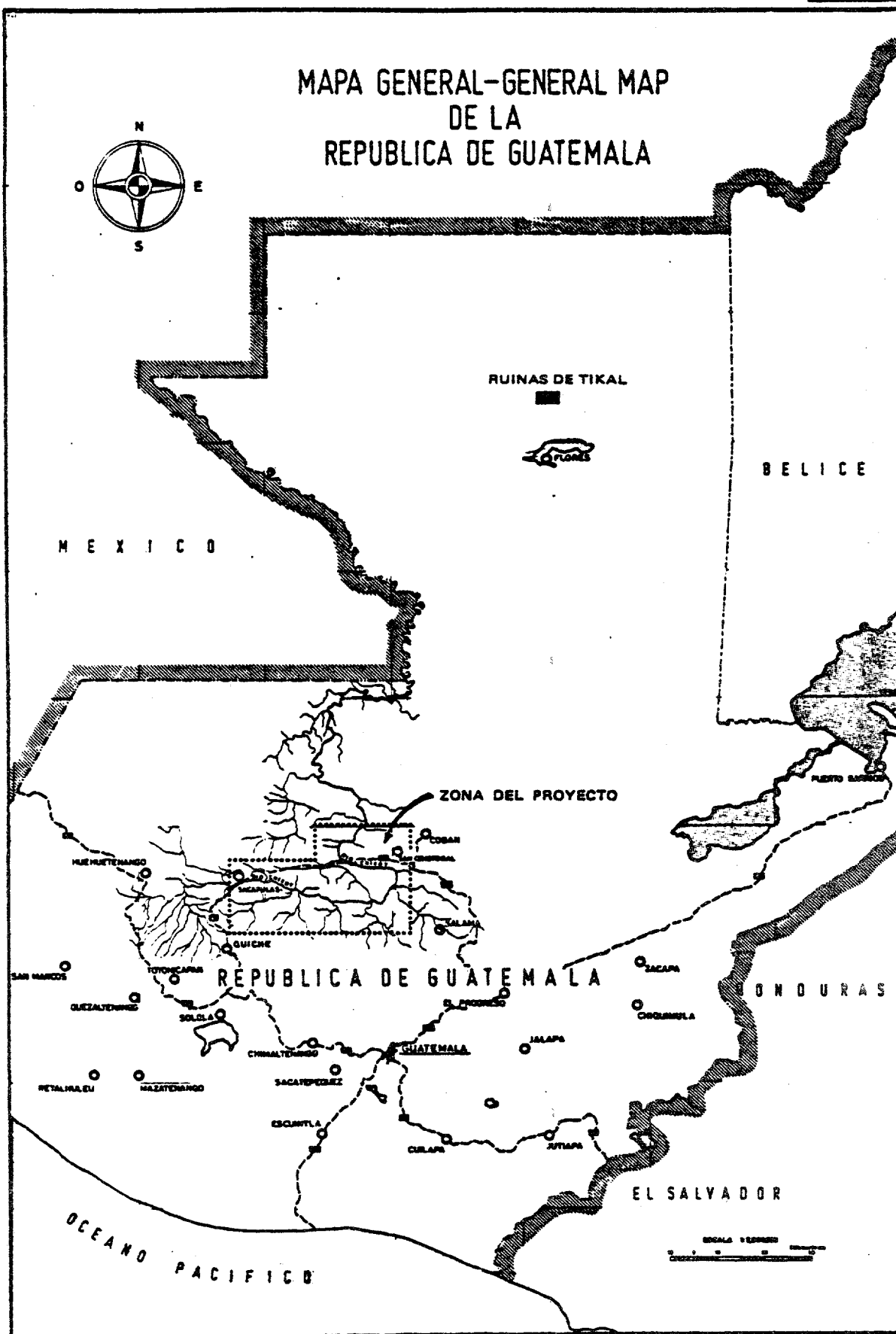
GUATEMALA

PROGRAMA DE EXPANSION 1980 - 1991

<u>Generación</u>		<u>Año de Instalación</u>	<u>Capacidad Instalada-MW</u>	
<u>Proyecto</u>			<u>Hidráulica</u>	<u>Térmica</u>
C.H. Aguacapa (3 unidades)		1981	90	-
C.H. Pueblo Viejo (5 unidades)		1982	300	-
C.H. Santa María II (2 unidades)		1984	68	-
C. Geotérmica Zunil (1 unidad)		1985	-	33
C.H. Chulac (6 unidades)		1988	440	-
C.H. Xalalá (4 unidades)		1989	360	-

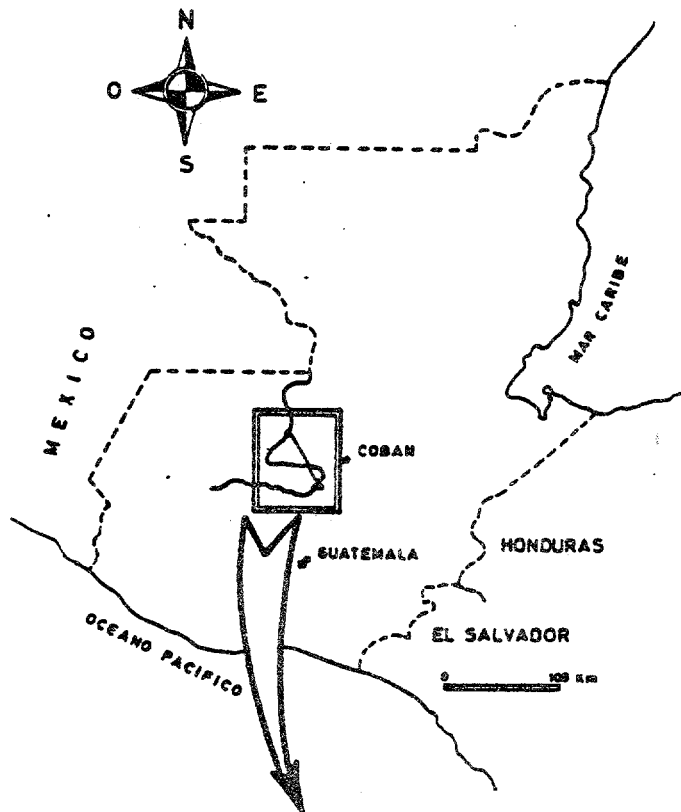
Sistema de Transmisión

<u>Líneas</u>	<u>Voltaje</u>	<u>Longitud Aprox.</u>
	230 KV	1055 Km
	69 KV	1800
<u>Subestaciones Reductoras</u>	<u>Voltajes</u>	<u>Capacidad Aprox.</u>
	230/69	1400 MVA



"UBICACION DE LAS OBRAS PRINCIPALES"

APENDICE IV-2



PRESA :

Altura max. : apr. 109 m
Longitud : apr. 250 m
Volumen total : apr. $3.2 \times 10^6 \text{ m}^3$

EMBALSE

Volumen max. : apr. $460 \times 10^6 \text{ m}^3$

TUNEL DE ADUCCION

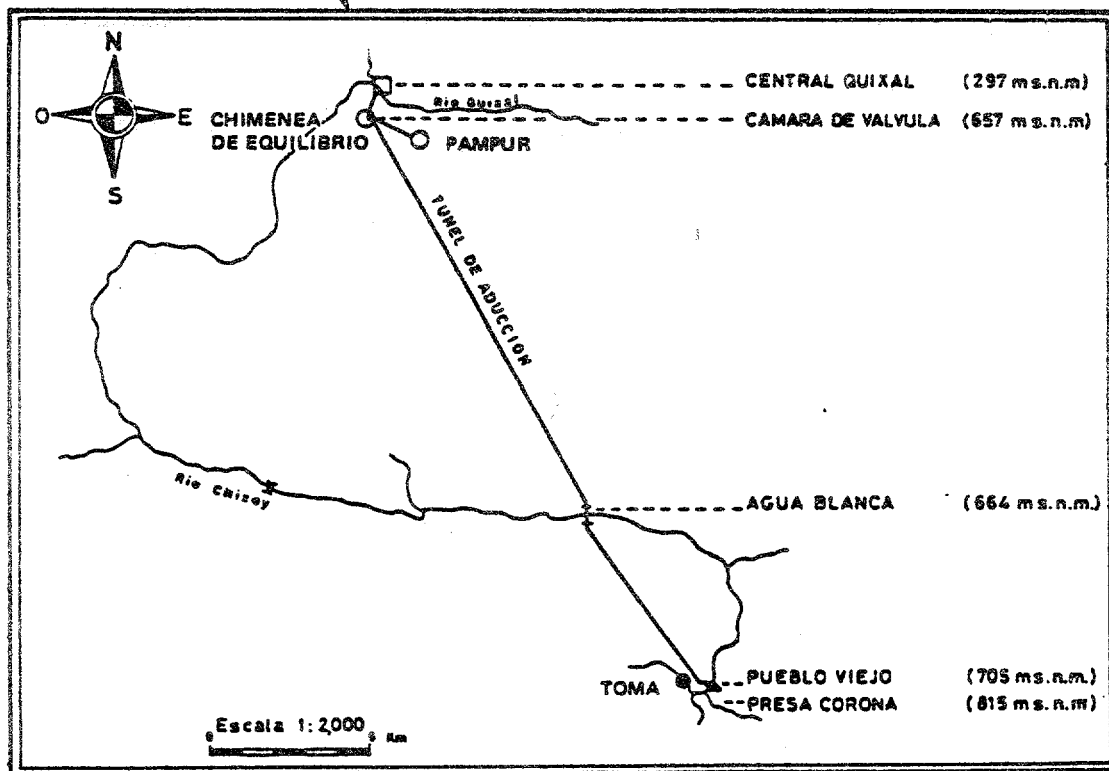
Longitud : apr. 26.014 Km
Diametro interior: 4.93 m
Caudal maximo: 75 m^3/s

CASA DE MAQUINAS

Caida bruta : apr. 520 m
Cap. nom. deturbinas: $5 \times 60 \text{ Mw}$

LINEA DE TRANSMISION

Longitud : apr. 123 km



"CLASIFICACION POR CATEGORIAS DE LOS AUMENTOS DE COSTOS"

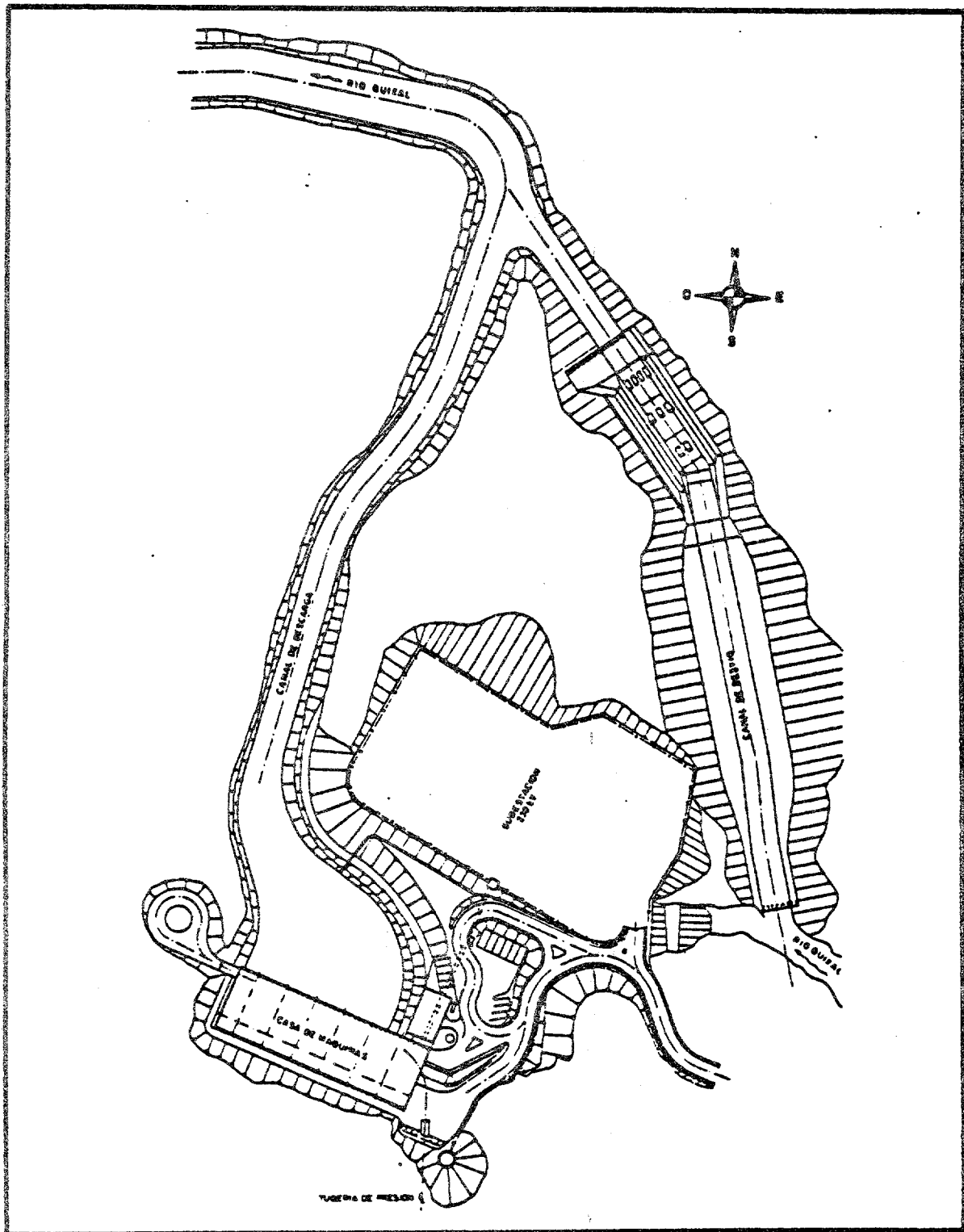
GUATEMALA: PROYECTO PUEBLO VIEJO - QUIXAL
AUMENTOS DE COSTOS EN MILES DE US\$

Categorías	Aumentos entre estimados de costos totales desde:		Total
	340.874	a 446.547	446.547 a 630.000
- Cambios de diseño	4.170	15.601	19.771
- Por terremoto 1976	2.709	3.487	6.196
- Dificultades geológicas	4.344	30.986	35.330
- Diferencia de metrajes	6.869	22.643	29.512
- Varios	(2.892)	10.080	7.188
- Imprevistos	24.209	15.930	40.139
- Aceleración	6.961	13.702	20.663
- Sobrecostos escalamiento	24.243	62.254	86.497
- Diferencial cambiario	35.060	8.770	43.830
	105.673	183.453	289.126

WANG 376P

CASA DE MAQUINAS QUIXAL, DISEÑO FINAL

APENDICE IV-4



CRONOGRAMA DE OBRAS

Items	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>
<u>LOTE A</u>							
Carreteras, compuertas							
<u>LOTE B</u>							
Bocatoma							
Túnel de carga							
Almenara							
Tubería de presión							
Casa de máquinas							
Canal de desvío río Quixal							
<u>LOTE C</u>							
Túneles de desvío							
Presa							
Vertedero							
<u>LOTE D1</u>							
Turbinas, válvulas, etc.							
<u>LOTE D2</u>							
Generadores, transforma- dores, etc.							
<u>LOTE D3</u>							
Tubería, válvulas, com- puertas							
<u>LOTE E</u>							
Línea 220 KV							
Subestaciones							
Primera generación							

*

APENDICE VI-1

SEPT.2,1981

PROYECCION ESTADO DE RESULTADOS
EN MILES DE US\$

CHIXOY-GUATEMALA

LINE NO	1980 REAL	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	TOTAL
DATOS DE OPERACION												
306.0 TOTAL GWH VENDIDOS	967	1002	1122	1704	1918	2082	2082	2082	2082	2082	2082	0
INGRESO MEDIO												
319.0 INGRESO MEDIO KWH TOTAL	0.087	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.
INGRESOS DE EXPLOTACION												
338.0 TOTAL INGRESOS EXPLOTACION	83811	95090	106478	161710	182018	197582	197582	197582	197582	197582	197582	1730786
GASTOS DE EXPLOTACION												
341.0 GENERACION Y MANTENIMIENTO	4369	9394	13810	25566	30833	31909	31909	31909	31909	31909	31909	271057
342.0 COMBUSTIBLES	57594	67396	43910	12775	2774	20784	20784	20784	20784	20784	20784	251559
343.0 TRANSMISION	787	2037	2728	4073	4964	5259	5259	5259	5259	5259	5259	45356
344.0 DISTRIBUCION	1353	1589	1863	2161	2480	2552	2552	2552	2552	2552	2552	23405
347.0 DEPRECIACION	5650	6313	10119	22741	32443	34333	36223	36223	36223	36223	36223	287062
352.0 GTOS. GEN. Y ADM.	7225	7500	7700	8000	8500	9000	9500	10000	10500	11000	11500	93200
358.0 OTROS GASTOS EXPLOTACION	353	400	400	400	400	400	400	400	400	400	400	4000
359.0 TOTAL GASTOS EXPLOTACION	77331	94629	80530	75716	82394	104237	106627	107127	107627	108127	108627	975639
360.0 INGRESO NETO EXPLOTACION	6480	460	25947	85994	99624	93345	90955	90455	89955	89455	88955	755147
INGRESOS(EGRESOS)AJENOS EXP.												
361.2 OTROS INGRESOS	1321	1400	1400	1400	1400	1400	1400	1400	1400	1400	1400	14000
361.6 OTROS EGRESOS	1793	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	18000
361.8 TOTAL ING(EGRES)AJ.EXP.	-472	-400	-400	-400	-400	-400	-400	-400	-400	-400	-400	-4000
362.0 UTILIDAD ANTE GTOS.FINANC.	6008	60	25547	85594	99224	92945	90535	90055	89555	89055	88555	751147
364.0 GTOS.FINANCIEROS(LGO.PLZO)	1862	2600	11777	29633	29751	34425	32999	28933	24709	20494	16695	232016
370.0 UTILIDAD(PERDIDA)NETA	4146	-2540	13770	55961	69473	58520	57536	61122	64846	68561	71860	519131

NOTA:

NO INCLUYE NUEVAS CENTRALES, LINEAS TRANSMISION Y DISTRIBUCION DESPUES DEL PROYECTO EN ESTUDIO E INTERCONEXION

UPREP3

SEP. 8, 1981

PROYECCION ESTADO ORIGEN Y APLICACION DE FONDOS
EN MILES DE US\$

CHIXOY-GUATEMALA

LINE NO	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	TOTAL
ORIGEN											
FUENTES INTERNAS											
360.0 INGRESO NETO EXPLOTACION	460	25947	85994	99624	93345	90955	90455	99955	89455	88955	755147
361.8 TOTAL ING(EGRES)AJ.EXP.	-400	-400	-400	-400	-400	-400	-400	-400	-400	-400	-4000
404.0 DEPREC.Y AMORT.DIFERIDOS	6313	10119	22741	32443	34333	36223	36223	36223	36223	36223	287062
406.0 TOTAL FUENTES INTERNAS	6374	35667	108335	131667	127278	126778	126278	125778	125278	124778	1038209
FUENTES EXTERNAS											
408.0 APORTES DE CAPITAL	125908	0	0	0	0	0	0	0	0	0	125908
412.0 EMISION BONOS	0	89770	25230	0	0	0	0	0	0	0	115000
11.0 PRESTAMO BID	0	6671	5525	7804	0	0	0	0	0	0	20000
12.0 FINANC. COMPLT.	0	25000	25000	0	0	0	0	0	0	0	50000
13.0 PTNO.BCIE.INTERCONEXION	0	7199	2401	1316	0	0	0	0	0	0	10916
414.0 PRESTAMOS OBTENIDOS	80601	5635	0	0	0	0	0	0	0	0	86236
416.0 PRESTAMOS A GESTIONAR	12227	0	0	0	0	0	0	0	0	0	12227
422.0 TOTAL FUENTES EXTERNAS	218736	134275	58156	9120	0	0	0	0	0	0	420287
426.0 TOTAL ORIGEN	225110	169942	166491	140787	127278	126778	126278	125778	125278	124778	1458496
APLICACIONES											
SERVICIOS DEUDAS											
364.0 GYOS.FINANCIEROS(LGO.PLZO)	2600	11777	29633	29751	34425	32999	28933	24709	20494	16695	232016
429.0 GYOS.FIN.CONSTR.NO FIN.*	14228	11020	8483	1515	0	0	0	0	0	0	35246
430.0 AMORT.PTHOS EN ESTUDIO	0	0	0	0	13106	13712	13712	13712	1212	1212	56666
431.0 AMORT.PTHOS.VIGENTES	12180	13610	27679	27949	25737	27107	27937	28027	27797	26897	244920
432.0 TOTAL SERVICIO DEUDA	29008	36407	65795	59215	73268	73818	70582	66448	49503	44804	568848
PROGRAMA CONSTRUCCION											
435.0 PROYECTO EN ESTUDIO	133430	140864	73453	0	0	0	0	0	0	0	347747
435.1 INTERCONEXION	933	8963	3178	1746	0	0	0	0	0	0	14820
436.0 GASTOS FINANC.CONSTRUCCION	14228	11020	8483	1515	0	0	0	0	0	0	35246
439.0 EJECUCION PROY.AGUACAPA	53748	0	0	0	0	0	0	0	0	0	53748
440.0 TOTAL CONSTRUCCION	202339	160847	85114	3261	0	0	0	0	0	0	451561
OTRAS APLICACIONES											
448.0 GYOS.FIN.CONSTR.NO FIN.	(14228)	(11020)	(8483)	(1515)	0	0	0	0	0	0	(35246)
450.0 INCREM(DISMIN)CAP.TRAB.	7991	-1907	13808	5077	3891	0	0	0	0	0	28859
452.0 TOTAL APLICACIONES	225110	104327	156234	66038	77159	73818	70582	66448	49503	44804	1014022
454.0 SUPERAVIT(DEFICIT)ANUAL	0	-14385	10257	74749	50119	32960	55696	59330	75775	79974	444474
460.0 SUPERAVIT(DEFICIT)ACUM.	0	-14385	-4128	70621	120740	173700	229395	289725	364500	444474	0

NOTA:

NO INCLUYE NUEVAS CENTRALES, LINEAS TRANSMISION Y DISTRIBUCION DESPUES DEL PROYECTO EN ESTUDIO E INTERCONEXION

*CUENTA MEMORIA

UPREP4

SEP. 8, 1981

PROYECCION ESTADO DE SITUACION
EN MILES DE US\$APENDICE VI-3
CHIXOY-GUATEMALA

LINE NO	1980 REAL	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
ACTIVO											

ACTIVO FIJO											
510.0 ACTIVO FIJO EN SERVICIO	144440	218188	395113	983113	983113	1097657	1097657	1097657	1097657	1097657	1097657
511.0 MENOS:DEPREC.ACUNULADA	41062	47375	57495	80236	112678	147011	183234	219456	255679	291902	328124
512.0 ACTIVO FIJO EN SERV.NETO	123378	170813	337618	902877	870435	950646	914423	878201	841978	805755	769533
513.0 ACTIVO FIJO CONSTRUCCION	481656	630247	614169	111283	114544	0	0	0	0	0	0
514.0 ACTIVO FIJO NETO TOTAL	605034	801060	951787	1014160	984979	950646	914423	878201	841978	805755	769533

ACTIVO CORRIENTE											
519.0 CAJA Y BANCOS	7946	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000
519.0 CUENTAS A COBRAR NETO	28010	28527	26619	40427	45505	49395	49395	49395	49395	49395	49395
520.0 INVENTARIOS	15959	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
521.0 ACTIVOS CTES. DIVERSOS	28557	29000	29000	29000	29000	29000	29000	29000	29000	29000	29000
522.0 TOTAL ACTIVO CORRIENTE	80472	85527	83619	97427	102505	106395	106395	106395	106395	106395	106395

OTROS ACTIVOS											
523.0 OTROS DISPONIBILIDADES	0	0	0	0	70621	120740	173700	229395	288725	344500	444474
525.0 ACTIVOS DIVERSOS	51690	51690	51690	51690	51690	51690	51690	51690	51690	51690	51690
526.0 TOTAL ACTIVO	737196	938277	1087097	1163278	1209794	1229471	1246208	1265681	1288789	1328341	1372092
=====											
PATRIMONIO Y PASIVO											

PATRIMONIO											
528.0 CAPITAL	431462	557370	557370	557370	557370	557370	557370	557370	557370	557370	557370
531.0 UTILIDAD(PERDIDA)RETENIDA	1925	-615	13156	69117	138590	197110	254666	315788	380635	449196	521056
532.0 TOTAL PATRIMONIO	433387	556755	570526	626487	695960	754480	812036	873158	938005	1006566	1078426

PASIVO											
534.0 DEUDA LARGO PLAZO	198794	277911	384507	414714	384991	344172	302523	260784	231775	203666	175557

PASIVO CORRIENTE											
536.0 PRESTAMOS CORTO PLAZO	0	0	14385	4128	0	0	0	0	0	0	0
538.0 PORCION CTE.LARGO PLAZO	12079	13610	27679	27949	38843	40819	41649	41739	29009	28109	28109
540.0 CUENTAS A PAGAR	92936	90000	90000	90000	90000	90000	90000	90000	90000	90000	90000
545.0 TOTAL PASIVO CORRIENTE	105015	103610	132664	122077	128843	130819	131649	131739	119009	118109	118109
548.0 TOTAL PASIVO	303809	381521	516571	536791	513834	474991	434172	392523	350784	321775	293666
550.0 TOTAL PATRIMONIO Y PASIVO	737196	938277	1087097	1163278	1209794	1229471	1246208	1265681	1288789	1328341	1372092
=====											

NOTA:

NO INCLUYE NUEVAS CENTRALES, LINEAS TRANSMISION Y DISTRIBUCION DESPUES DEL PROYECTO EN ESTUDIO E INTERCONEXION

UPREPS

APENDICE ECONOMICO

Cuadro A

Ajustes Macroeconómicos de la Demanda: 1965-80

<u>Forma de la Ecuación</u>	
$\ln De = -12.49 + 3.22 \ln (PIB/POB)$	0.995
$\ln De = -5.87 + 1.62 \ln (PIB)$	0.998
$De = -1\,548.62 + 6.19 (PIB/POB)$	0.980
$De = -437.18 + .54 (PIB)$	0.990
$\ln De = 3.26 + 0.01 (PIB/POB)$	0.995
$\ln De = 4.86 + 7.66 (10^{-4}) (PIB)$	0.985
$De = 9.71 - 1\,158.19 \, 1/\ln(PIB/POB)$	-0.985

De = Demanda de energía
PIB = Producto Interno Bruto
POB = Población.

W-2154a.

CUADRO B

INDICADORES MACROECONOMICOS Y DATOS DEL MERCADO ELECTRICO: 1965-80

AÑOS	PROD. INT. BRUTO		POBLACION		GENERACION		VENTAS ENER.		DEM. MAXIMA		PERDIDA CARGA	
	TOTAL	TASA	TOTAL	TASA	TOTAL	TASA	TOTAL	TASA	TOTAL	TASA	FACTOR	FACTOR
	(US\$ MM)	(%)	(M)	(%)	(GWH)	(%)	(GWH)	(%)	(MW)	(%)	(%)	(%)
1965	1355.2	.0	4580.3	.0	392.0	.0	327.7	.0	83.5	.0	16.4	63.6
1966	1429.9	5.8	4717.6	3.0	450.0	14.8	371.7	13.4	93.1	11.5	17.4	55.2
1967	1488.6	4.1	4859.1	3.0	473.0	5.1	402.0	8.2	97.0	4.2	15.0	55.7
1968	1619.2	8.8	5000.9	3.0	514.0	8.7	438.3	9.0	103.7	6.9	14.7	56.6
1969	1695.9	4.7	5128.8	2.5	578.0	12.5	489.3	11.6	116.2	12.1	15.3	58.8
1970	1792.8	5.7	5298.0	3.3	623.0	7.8	541.0	10.6	116.0	-2.2	13.2	61.3
1971	1892.8	5.6	5430.9	2.5	659.0	5.8	578.3	6.9	132.0	13.8	12.2	57.0
1972	2031.5	7.3	5656.4	4.2	687.0	4.2	649.9	12.4	135.0	2.3	5.4	58.1
1973	2169.4	6.8	5730.1	1.3	778.0	13.2	714.3	9.9	143.0	5.9	8.2	62.1
1974	2307.6	6.4	5985.8	4.5	842.0	8.2	768.0	7.5	163.0	14.0	8.8	59.0
1975	2352.7	2.0	6081.6	1.6	950.0	12.8	828.8	7.9	185.0	13.5	12.8	58.6
1976	2526.5	7.4	6256.2	2.9	1033.0	8.7	892.9	7.7	199.0	7.8	13.8	59.3
1977	2723.8	7.8	6435.7	2.9	1201.0	16.3	1023.5	14.6	237.0	19.1	14.8	57.8
1978	2859.9	5.0	6620.5	2.9	1333.0	11.0	1135.8	11.0	248.0	4.6	14.8	61.4
1979	2987.3	4.5	6610.5	2.9	1414.0	6.1	1264.9	11.4	265.0	6.9	10.5	60.9
1980	3045.8	2.0	7006.0	2.9	1444.0	2.1	1246.5	-1.5	273.0	3.0	13.7	60.4

**SISTEMA NACIONAL INTERCONECTADO: PRONOSTICOS
DE LA DEMANDA DE ENERGIA Y POTENCIA**

AÑO	DEMANDA DE ENERGIA (GWH)				PERDIDAS TC (%)	GENERACION BRUTA (GWH)	FACTOR CARGA (%)	DEMANDA DE POTENCIA	
	AJUSTE	CARGAS ESPECIALES	TOTAL	TC (%)				MW	(TC (%))
1980a/	1 246.5	---	1 246.5	13.60	1 442.7	60.30	273.0		
1981	1 357.2b/	---	1 357.2	8.88	1 570.8	60.70	295.4	8.21	
1982	1 475.7	---	1 475.7	6.7	1 705.0	60.80	320.1	8.37	
1983	1 604.6	99.2	1 703.8	15.46	1 965.2	61.00	367.8	16.32	
1984	1 744.6	246.8	1 991.4	16.88	2 292.9	61.13	428.2	16.42	
1985	1 896.9	430.7	2 327.6	16.88	2 675.4	61.29	498.3	16.37	
1986	2 084.8	635.8	2 720.6	16.88	3 121.7	61.45	579.9	16.38	
1987	2 291.3	760.3	3 051.6	12.17	3 495.5	61.62	647.6	11.67	
1988	2 518.2	904.8	3 423.0	12.17	3 914.2	61.78	723.3	11.69	
1989	2 767.6	1 071.7	3 839.3	12.16	4 382.8	61.94	807.7	11.67	
1990	3 041.6	1 264.7	4 306.3	12.16	4 907.5	62.10	902.1	11.69	
1991	---	---	4 767.6	10.71	5 423.9	62.26	994.5	10.24	
1992	---	---	5 278.2	10.71	5 998.0	62.42	1 096.9	10.30	
1993	---	---	5 843.5	10.71	6 640.3	62.42	1 214.4	10.71	
1994	---	---	6 469.4	10.71	7 351.6	62.42	1 344.5	10.71	
1995	---	---	7 162.3	10.71	8 139.0	62.42	1 488.5	10.71	

a/ Histórico

b/ Con base en la ecuación de regresión: $\ln y = -5.87 + 1.62 \ln (\text{PIB})$.

CUADRO D

PRONOSTICOS DE GENERACION Y DEMANDA MAXIMA: SISTEMA NACIONAL INTERCOMUNICADO

AÑO	B I D		INFORME INDE	
	Generación Bruta (GWH)	Demanda Máxima de Potencia (MW)	Generación Bruta (GWH)	Demanda Máxima de Potencia (MW)
1980	1.442.7	273.0	1.442.7	273.0
1981	1.570.8	295.4	1.570.8	295.4
1982	1.705.0	20.1	1.747.0	324.0
1983	1.965.2	367.8	2.340.0	434.0
1984	2.292.9	428.2	2.661.0	493.0
1985	2.675.4	498.3	3.018.0	558.0
1986	3.121.7	579.9	3.378.0	624.0
1987	3.495.5	647.6	3.845.0	709.0
1988	3.914.2	723.3	4.369.0	808.0
1989	4.382.8	807.7	4.913.0	907.0
1990	4.907.5	902.1	5.473.0	1.009.0
1991	5.423.9	994.5	6.069.6	1.118.0
1992	5.998.0	1.096.9	6.731.1	1.241.0
1993	6.640.3	1.214.4	7.464.18	1.378.0
1994	7.351.6	1.344.5	8.278.5	1.529.0
1995	8.139.0	1.488.5	9.180.9	1.698.0

CUADRO E
ENERGIA DE LAS CENTRALES HIDROELECTRICAS

Central	Fecha Operación	Capacidad Instalada MW	Capacidad Confiable MW	Energía Firme GWh/Año*	Energía Año Medio GWh/Año**
I. Centrales Exist.					
Jurún Marinalá		60.0	60	120	160
Los Esclavos		13.0	13	45	55
Michatoyas		11.6	5	12	17
Río Hondo		2.4	2	12	16
Santa María		6.6	5	30	35
El Porvenir		2.3	2	16	20
TOTALES		95.9	87	235	303
II. Centrales Futuras					
Aguacapa	Nov.81	90	90	296	380
Chixoy	Nov.82	120	120	1.234	1.710
	Ago.83	180	180		
Santa María II	Jun.84	68	60	188	254
Chulac	Ene.88	440	440	1.562	1.716
Xalalá	Dic.89	360	360	1.010	1.474
III. Central Geotérmica					
Zunil 1/	Dic.85	33	30	210	210

1/ Tiempo de uso 7.000 horas.
 * Energía firme s/INDE: Es aquella que puede producirse considerando una probabilidad de ocurrencia del 80% del caudal medio mensual que pasa por el punto presa.
 ** Energía Media: Para las centrales existentes se consideró una probabilidad de ocurrencia del 50% del caudal medio mensual que pasa por el punto de presa. Para los nuevos proyectos se utilizaron los datos correspondientes a los respectivos informes de factibilidad.

CUADRO F

APENDICE VI-4
Pág. 6 de 16

Alternativa II: CHIXOY ENTRA EN NOV/82
BALANCE DE ENERGIA (Energía Año Medio GWh)
SISTEMA NACIONAL INTERCONECTADO

	1985	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
DEMANDA	1 247	1 357	1 478	1 704	1 991	2 328	2 783	3 082	3 423	3 835	4 385	4 968	5 378
Pérdidas - Consumo Própio	195	214	227	241	257	271	285	294	291	284	282	284	270
GENERACION BRUTA	1 443	1 571	1 705	1 965	2 293	2 675	3 067	3 406	3 914	4 383	4 978	5 424	5 998
TERMOELECTRICAS													
Jordán Martínez	180	180	180	180	180	180	180	180	180	180	180	180	180
Los Esclavos	85	85	85	85	85	85	85	85	85	85	85	85	85
Michatayac	17	17	17	17	17	17	17	17	17	17	17	17	17
El Nardo	16	16	16	16	16	16	16	16	16	16	16	16	16
Santa María 1	25	25	25	25	25	25	25	25	25	25	25	25	25
El Porvenir	20	20	20	20	20	20	20	20	20	20	20	20	20
Quetzaco	--	45	180	180	180	180	180	180	180	180	180	180	180
Pueblo Viejo-Quetzal	--	--	186	1 282	1 610	1 710	1 785	1 720	1 630	1 720	1 720	1 630	1 720
Santa María 2	--	--	--	--	180	184	184	184	184	184	184	184	184
Quilac	--	--	--	--	--	--	--	--	1 716	1 716	1 716	1 716	1 716
Atlatz	--	--	--	--	--	--	--	--	--	--	20	1 678	1 678
SUBTOTAL NISRO	303	348	679	1 965	2 293	2 647	2 647	2 647	3 914	4 383	4 383	5 424	5 937
TERMOELECTRICAS													
Escuintla Vapor 1	224	224	42	0	0	0	0	0	0	0	0	0	0
Escuintla Vapor 2	371	371	371	0	0	18	0	228	0	0	0	0	0
Laguna Vapor	231	C.C	C.C	0	0	0	C.C	C.C	0	0	C.C	0	0
Escuintla Gas 1	0	0	0	F.S	--	--	--	--	--	--	--	--	--
Escuintla Gas 2	0	0	0	F.S	--	--	--	--	--	--	--	--	--
Escuintla Gas 3	125	125	0	0	0	0	0	0	0	0	0	0	0
Escuintla Gas 4	125	92	0	0	0	0	0	0	0	0	0	0	0
Laguna Gas 1	0	0	0	F.S	--	--	--	--	--	--	--	--	--
Laguna Gas 2	64	C.C	C.C	0	0	0	C.C	C.C	0	0	C.C	0	0
Laguna Gas 3	0	C.C	C.C	0	0	0	C.C	C.C	0	0	C.C	0	0
Cielo Combinado	--	411	411	--	--	--	285	411	--	--	215	--	--
Nuevo San Felipe	0	0	0	F.S	--	--	--	--	--	--	--	--	--
Nuevo EGSA	0	0	0	F.S	--	--	--	--	--	--	--	--	--
SUBTOTAL NISRO	1 340	1 223	826	--	--	18	285	630	--	--	60	--	--
OTRAS FUENTES													
Small 1	--	--	--	--	--	10	210	210	0	20	210	0	161
SUBTOTAL OTRAS FUENTES	--	--	--	--	--	10	210	210	0	20	210	0	161
TOTAL	1 443	1 571	1 705	1 965	2 293	2 675	3 067	3 406	3 914	4 383	4 978	5 424	5 998

Planta en Operación
Planta en Construcción
Planta en Proyecto

Energía Térmica: Plantas de Vapor - P.A.S. por Años
Planta de Energía eólica - P.A.S. por Años
Planta de Energía hidroeléctrica - P.A.S. por Años

CUADRO G

Alternativa II: CHIXOY ENTRA EN NOV./82

APENDICE VI-4
(Página 7 de 16)

**BALANCE DE ENERGIA (Energía Firme GWh)
SISTEMA NACIONAL INTERCONECTADO**

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
DEMANDA	1 247	1 357	1 478	1 704	1 991	2 328	2 721	3 052	3 423	3 839	4 356	4 768	5 278
Pérdidas + Consumo Propio	196	214	227	261	302	347	401	466	491	544	602	656	720
RETEENCIÓN BRUTA	1 443	1 571	1 705	1 965	2 293	2 675	3 122	3 518	3 914	4 383	4 958	5 424	5 998
HIDROELECTRICAS													
Juán Marínola	120	120	120	120	120	120	120	120	120	120	120	120	120
Los Esclavos	45	45	45	45	45	45	45	45	45	45	45	45	45
Micatasayas	12	12	12	12	12	12	12	12	12	12	12	12	12
Rio Hondo	12	12	12	12	12	12	12	12	12	12	12	12	12
Santa María 1	20	20	20	20	20	20	20	20	20	20	20	20	20
El Porvenir	16	16	16	16	16	16	16	16	16	16	16	16	16
Agucapá	--	45	296	296	296	296	296	296	296	296	296	296	296
Pueblo Viejo - Quisál	--	--	196	1 234	1 234	1 234	1 234	1 234	1 234	1 234	1 234	1 234	1 234
Santa María 2	--	--	--	--	180	180	180	180	180	180	180	180	180
Chulac	--	--	--	--	--	--	--	--	1 062	1 062	1 062	1 062	1 062
Xelalá	--	--	--	--	--	--	--	--	--	--	20	1 000	1 010
SUBTOTAL HIDRO	235	280	727	1 765	1 965	1 963	1 953	1 953	3 513	3 515	3 515	4 625	4 625
TERMOELECTRICAS													
Escuintla Vapor 1	224	224	196	R	17	R	177	224	R	R	224	R	224
Escuintla Vapor 2	371	371	371	R	R	381	371	371	R	347	371	378	371
Laguna Vapor	231	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C
Escuintla Gas 1	R	R	R	F.S	--	--	--	--	--	--	--	--	--
Escuintla Gas 2	R	35	R	F.S	--	--	--	--	--	--	--	--	--
Escuintla Gas 3	125	125	R	R	R	R	R	125	R	R	70	R	125
Escuintla Gas 4	125	125	R	R	R	R	R	125	R	R	70	R	125
Laguna Gas 1	R	R	R	F.S	--	--	--	--	--	--	--	--	--
Laguna Gas 2	90	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C
Laguna Gas 3	48	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C	C.C
Ciclo Combinado	--	411	411	209	411	411	411	411	411	411	411	411	411
Diesel San Felipe	R	R	R	F.S	--	--	--	--	--	--	--	--	--
Diesel EETSA	R	R	R	F.S	--	--	--	--	--	--	--	--	--
SUBTOTAL TERMO	1 208	1 291	978	200	428	712	959	1 256	140	613	1 252	660	1 256
RETEENCIÓN BRUTA	1 443	1 571	1 705	1 965	2 293	2 675	3 122	3 518	3 914	4 383	4 958	5 424	5 998
PERDIDAS	--	--	--	--	--	--	--	(77)	--	--	--	--	(7)

P = Planta en Operación
C.C = Ciclo Combinado
F.S = Planta en Espera
R = Reserva de Emergencia

Energía Térmica: Plantas de Vapor = 7,000 horas anuales
Plantas de Ciclo Combinado = 4,000 horas anuales
Turbinas de Gas y Diesel = 8,000 horas anuales

CUADRO N

ALTERNATIVA 27: CHIXOY EN MONTEBERR 1962
BALANCE DE POTENCIA - SISTEMA NACIONAL INTERCONECTADO
(MW)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
DEMANDA MAXIMA	395.0	320.0	368.0	428.0	498.0	380.0	648.0	725.0	808.0	902.0	994.0
CAPACIDAD DISPONIBLE:											
HIDROELECTRICAS											
Jardín Marínald	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Los Esclavos	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Michatoyas	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Rio Mondo	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Santa María 1	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
El Pervenir	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Aguaesapa	13.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
Chixoy	—	20.0	255.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
Santa María 2	—	—	—	40.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Chulac	—	—	—	—	—	—	—	440.0	440.0	440.0	440.0
Kalala	—	—	—	—	—	—	—	—	—	7.0	200.0
SUBTOTAL HIDROELECT.	102.0	397.0	432.0	517.0	537.0	537.0	537.0	97.7	97.7	984.0	1257.0
TERMoeLECTRICAS											
Escuintla Vapor 1	24.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0
Escuintla Vapor 2	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0
Laguna Vapor	33.0	33.0	33.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
Escuintla Gas 1	10.0	10.0	FSPA	—	—	—	—	—	—	—	—
Escuintla Gas 2	10.0	10.0	FSPA	—	—	—	—	—	—	—	—
Escuintla Gas 3	25.0	25.0	25.0	35.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Escuintla Gas 4	25.0	25.0	25.0	35.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Laguna Gas 1	10.0	10.0	FSPA	—	—	—	—	—	—	—	—
Laguna Gas 2	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
Laguna Gas 3	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
Diesel San Felipe	1.0	1.0	FSPA	—	—	—	—	—	—	—	—
Diesel ECEA	5.0	5.0	FSPA	—	—	—	—	—	—	—	—
SUBTOTAL TERMoeLECT.	232.0	240.0	204.0	198.0	197.0	197.0	197.0	197.0	197.0	197.0	197.0
GEOTERMICAS											
Bunil 1	—	—	—	—	—	30.0	30.0	30.0	30.0	30.0	30.0
SUBTOTAL GEOTERMICAS	—	—	—	—	—	30.0	30.0	30.0	30.0	30.0	30.0
TOTAL CAPACIDAD DISP.	334.0	437.0	636.0	714.0	734.0	764.0	764.0	1204.0	1204.0	1211.0	1584.0
Excedente (Déficit)	39.0	117.0	268.0	286.0	336.0	384.0	116.0	481.0	396.0	299.0	570.0
Reserva en % de la Demanda Máxima	15.2	36.6	72.0	66.8	47.4	31.7	17.9	66.5	49.0	34.3	57.3
Reserva en % de la Capacidad Disponible	11.7	36.8	42.1	46.1	32.1	24.1	13.2	40.0	32.9	23.5	36.6

FSPA: Fuera de servicio por mantenimiento.

Apéndice VI-4

Cuadro I

ALTERNATIVA II: CHIXOY EN NOVIEMBRE 1982
BALANCE DE POTENCIA EN MW - SISTEMA INTERCONECTADO

Año	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Demanda Máxima de Potencia	265	273	295	320	368	428	498	580	648	723	808	902	994	1097
Disponibilidad (Cap. Efectiva)														
- Hidráulica	88	88	102	197	478	517	537	537	537	977	977	984	1337	1337
- Térmicas														
Incluido Geotérmica Zunil)	252	246	232	240	204	197	197	327	227	227	227	227	227	227
TOTAL POTENCIA DISPONIBLE	340	332	334	437	636	714	734	764	764	1204	1204	1211	1564	1564
Excedente de Potencia	75	59	39	117	268	286	236	184	116	481	396	309	570	467
Excedente de Potencia x Demanda Máxima	28.3	21.6	13.2	36.6	72.8	66.8	47.4	31.7	17.9	66.5	49.0	34.3	57.3	42.6

Cuadro J

Alternativa II: CHIXOY ENTRA EN NOV./82
 ENERGIA MEDIA
 CONSUMO DE COMBUSTIBLES (Miles de Barriles)
 SISTEMA NACIONAL INTERCONECTADO

PLANTA	RENDIMIEN - TIPO DE		COMBUS- TIBLE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
	TO GWH	BARRILX10														
	I N D E															
Esc.Vapor 1	0.394	B	569	569	112											
Esc.Vapor 2	0.467	B	794	794	794				39		488					
TOTAL BUNKER INDE		B	1 363	1 363	906				39		488					
Esc.Gas 1	0.297	D														
Esc.Gas 2	0.258	D														
Esc.Gas 3	0.431	D	290	290												
Esc.Gas 4	0.434	D	288	212												
San Felipe	0.504	D														
TOTAL DIESEL INDE		D	578	502												
E E G S A																
Laguna Vapor	0.338	B	683													
TOTAL BUNKER EEGSA		B	683													
Laguna Gas 1	0.319	C														
Laguna Gas 2	0.381	C	168													
Laguna Gas 3	0.381	C														
Ciclo Combinado	0.588	C	699	699	699				451	699				536		
TOTAL CRUDO EEGSA			168	699	699				451	699				536		
TOTAL DIESEL EEGSA	0.504	D														
S E C T O R																
TOTAL BUNKER SECTOR		B	2 046	1 363	906				39		488					
TOTAL DIESEL SECTOR		D	578	502												
TOTAL CRUDO SECTOR		C	168	699	699				451	699				536		

B = Bunker "C"
 D = Diesel
 C = Crudo

BALANCE DE ENERGIA (Energia AÑO Medio GWh)
SISTEMA NACIONAL INTERCONECTADO

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
DEMANDA	1.247	1.357	1.478	1.704	1.991	2.328	2.721	3.052	3.423	3.839	4.306	4.768	5.278
Pérdidas + Consumo Propio	196	214	227	261	302	347	401	444	491	544	602	656	720
Generación Bruta	1.443	1.571	1.705	1.965	2.293	2.675	3.122	3.496	3.914	4.383	4.908	5.424	5.998
HIDROELECTRICAS													
Curón Marinala	160	160	160	160	160	160	160	160	100	160	160	100	160
Los Esclavos	55	55	55	55	55	55	55	55	55	55	55	55	55
Michetoyas	17	17	17	17	17	17	17	17	10	17	17	17	17
Rio Hondo	16	16	16	16	16	16	16	16	16	16	16	16	16
Santa María 1	35	35	35	35	35	35	35	35	35	35	35	35	35
El Porvenir	20	20	20	20	20	20	20	20	20	20	20	20	20
Aguscaps	-	45	380	380	300	380	380	380	200	380	380	200	380
Pueblo Viejo-Quixel	-	400	1.022	1.282	1.610	1.710	1.710	1.710	1.530	1.710	1.710	1.560	1.710
Santa María 2	-	-	-	-	100	254	254	254	254	254	254	254	254
Chulac	-	-	-	-	-	-	-	-	1.716	1.716	1.716	1.716	1.716
Kalala	-	-	-	-	-	-	-	-	-	-	20	1.474	1.474
SUBTOTAL HIDRO	303	748	1.705	1.965	2.293	2.647	2.647	2.647	3.914	4.363	4.383	5.424	5.837

TERMoeLECTRICAS

Escuintla Vapor 1	224	41	R	R	R	R	R	R	R	R	R	R	R
Escuintla Vapor 2	371	371	C.C.	R	R	R	R	228	R	R	R	R	R
Laguna Vapor	231	-	-	-	-	-	-	-	-	-	-	-	-
Escuintla Gas 1	R	R	R	P.S.	-	-	-	-	-	-	-	-	-
Escuintla Gas 2	R	R	R	P.S.	-	-	-	-	-	-	-	-	-
Escuintla Gas 3	125	R	R	R	-	-	-	-	-	-	-	-	-
Escuintla Gas 4	125	R	R	R	-	-	-	-	-	-	-	-	-
Laguna Gas 1	R	R	R	P.S.	-	-	-	-	-	-	-	-	-
Laguna Gas 2	R	R	R	P.S.	-	-	-	-	-	-	-	-	-
Laguna Gas 3	125	R	R	R	-	-	-	-	-	-	-	-	-
Laguna Gas 4	125	R	R	R	-	-	-	-	-	-	-	-	-
Laguna Gas 1	R	R	R	P.S.	-	-	-	-	-	-	-	-	-
Laguna Gas 2	R	R	R	P.S.	-	-	-	-	-	-	-	-	-
Laguna Gas 3	64	C.C.	R	R	-	-	-	-	-	-	-	-	-
Laguna Gas 4	R	C.C.	R	R	-	-	-	-	-	-	-	-	-
Ciclo Combinado	-	411	-	-	-	-	-	-	-	-	-	-	-
Ciesel San Felipe	R	R	R	P.S.	-	-	-	-	-	-	-	-	-
Ciesel EEGSA	R	R	R	P.S.	-	-	-	-	-	-	-	-	-
SUBTOTAL TERMO	1.140	823	-	-	-	18	265	639	-	-	315	-	-

GEOTERMICAS

Zunil 1	-	-	-	-	-	-	-	-	-	-	-	-	-
SUBTOTAL GEOTERMICO	-	-	-	-	-	10	210	210	210	20	210	161	-
TOTAL	1.443	1.571	1.705	1.965	2.293	2.675	3.122	3.496	3.914	4.383	4.908	5.424	5.998
Deficit	-	-	-	-	-	-	-	-	-	-	-	-	-

* = Planta de Reservas
CC = Ciclo Combinado
PS = Fuera de Servicio
DE = Deficit de Energia

Energia Térmica: Fuentes de Vapor = 7.000 horas Anuales
Plantas Geotérmicas = 7.000 horas Anuales.
Turbinas de Gas y Diesel = 5.000 horas Anuales.

Cuadro L

Alternativa III: CHIMY ENTRA EN ABRIL 1983
BALANCE DE ENERGIA (Energía Año Medio GMH)
SISTEMA NACIONAL INTERCONECTADO

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
DEMANDA													
Pérdidas + Consumo Propio	1 247	1 357	1 478	1 704	1 991	2 328	2 721	3 052	3 423	3 839	4 306	4 768	5 278
	196	214	227	261	302	347	401	444	491	544	602	656	720
GENERACION BRUTA	1 443	1 571	1 705	1 965	2 293	2 675	3 122	3 496	3 916	4 383	4 908	5 424	5 998
HIDROELECTRICAS													
Jurón Marinalá	160	160	160	160	160	160	160	160	100	160	160	100	160
Los Enclavos	55	55	55	55	55	55	55	55	55	55	55	55	55
Michetoys	17	17	17	17	17	17	17	17	17	17	17	17	17
Rio Mondo	16	16	16	16	16	16	16	16	16	16	16	16	16
San María 1	35	35	35	35	35	35	35	35	35	35	35	35	35
El Porvenir	20	20	20	20	20	20	20	20	20	20	20	20	20
Aquacapa	45	380	380	300	380	380	380	380	200	380	380	200	380
Pueblo Viejo - Quinal	---	---	---	1 282	1 610	1 710	1 710	1 710	1 530	1 710	1 710	1 560	1 710
Santa María 2	---	---	---	---	100	254	254	254	254	254	254	254	254
Chulec	---	---	---	---	---	---	---	---	1 716	1 716	1 716	1 716	1 716
Xalala	---	---	---	---	---	---	---	---	---	---	20	1 474	1 474
SUSTOTAL HIDRO	303	348	683	1 965	2 293	2 647	2 647	2 647	3 916	4 363	4 383	5 424	5 837
TERMOMOLECTRICAS													
Escuintla Vapor 1	224	224	224	R	R	R	R	R	R	R	R	R	R
Escuintla Vapor 2	371	371	371	R	R	R	R	R	R	R	R	R	R
Laguna Vapor	231	C.C	C.C	R	R	R	C.C	C.C	R	R	C.C	R	R
Escuintla Gas 1	R	R	R	P.B	---	---	---	---	---	---	---	---	---
Escuintla Gas 2	R	R	R	P.B	---	---	---	---	---	---	---	---	---
Escuintla Gas 3	125	125	16	R	R	R	R	R	R	R	R	R	R
Escuintla Gas 4	125	92	R	R	R	R	R	R	R	R	R	R	R
Laguna Gas 1	R	R	R	P.B	---	---	---	---	---	---	---	---	---
Laguna Gas 2	64	C.C	C.C	R	R	R	C.C	C.C	R	R	C.C	R	R
Laguna Gas 3	R	C.C	C.C	R	R	R	C.C	C.C	R	R	C.C	R	R
Ciclo Combinado	---	411	411	---	---	---	265	411	---	---	313	---	---
Diesel San Felipe	R	R	R	P.B	---	---	---	---	---	---	---	---	---
Diesel EGSA	R	R	R	P.B	---	---	---	---	---	---	---	---	---
SUSTOTAL TERMO	1 140	1 223	1 022	---	---	10	165	659	---	---	313	---	---
GEOTERMICAS													
Zunil	---	---	---	---	---	10	210	210	R	20	210	R	161
SUSTOTAL GEOTERMICO	---	---	---	---	---	10	210	210	R	20	210	R	161
TOTAL	1 44	1 571	1 705	1 965	2 293	2 675	3 122	3 496	3 916	4 383	4 908	5 424	5 998

Plantas de Reserva: C. Ciclo Combinado. S. Fuera de Servicio. D. Deficiente de Energía. Energía Térmica:
Plantas de Vapor: 7.000 Horas Anuales. Plantas Geotérmicas: 7.000 Horas Anuales. Turbinas de Gas y Diesel:
Sustentables Anuales.

Cuadro M

Flujos de Costos
(US \$ M de enero 1981)

Año	Inversión	Combustibles	Operación y Mantenimiento	Total
1	52572.00	0.00	0.00	52572.00
2	63087.00	0.00	0.00	63087.00
3	68344.00	0.00	0.00	68344.00
4	131431.00	0.00	0.00	131431.00
5	131431.00	54205.00	6329.00	191965.00
6	78858.00	0.00	7102.00	85 960.00
7	0.00	0.00	8289.00	8289.00
8	0.00	0.00	9190.00	9190.00
9	0.00	1289.00	10122.00	11411.00
10	0.00	15605.00	11613.00	27218.00
11	0.00	40499.00	12735.00	43234.00
12	0.00	0.00	15802.00	15802.00
13	0.00	0.00	16760.00	16760.00
14	0.00	18546.00	18364.00	36910.00
15	0.00	0.00	21342.00	21342.00
16	0.00	0.00	22651.00	22651.00

Nota: Año 1 corresponde a 1977

Cuadro M

Alternativa II

Flujo de Costos
(US \$ M de enero 1981)

Año	Inversión	Combustibles	Operación y Mantenimiento	Total
1	54807.00	0.00	0.00	54807.00
2	54174.00	0.00	0.00	54174.00
3	47706.00	0.00	0.00	47706.00
4	78848.00	0.00	0.00	78848.00
5	111345.00	91386.00	6239.00	208970.00
6	117548.00	54473.00	6815.00	178836.00
7	61295.00	0.00	7974.00	69269.00
8	0.00	0.00	9190.00	9190.00
9	0.00	1289.00	10122.00	11411.00
10	0.00	15605.00	11613.00	27218.00
11	0.00	40499.00	12735.00	53234.00
12	0.00	0.00	15802.00	15802.00
13	0.00	0.00	16760.00	16760.00
14	0.00	18546.00	18364.00	36910.00
15	0.00	0.00	21342.00	21342.00
16	0.00	0.00	22651.00	22651.00

Nota: Año 1 corresponde a 1977.

Alternativa III
Flujos de Costos
(US \$ M de enero 1981)

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<u>Año</u>	<u>Inversión</u>	<u>Combustibles</u>	<u>Operación y Mantenimiento</u>	<u>Total</u>
1	54807.00	0.00	0.00	54807.00
2	54174.00	0.00	0.00	54174.00
3	47706.00	0.00	0.00	47706.00
4	78848.00	0.00	0.00	78848.00
5	105145.00	91386.00	6239.00	202770.00
6	105145.00	71345.00	6871.00	183361.00
7	52572.00	0.00	7974.00	60546.00
8	27326.00	0.00	9190.00	36516.00
9	0.00	1289.00	10122.00	11411.00
10	0.00	15605.00	11613.00	27218.00
11	0.00	40499.00	12735.00	53234.00
12	0.00	0.00	15802.00	15802.00
13	0.00	0.00	16760.00	16760.00
14	0.00	18546.00	18364.00	36910.00
15	0.00	0.00	21342.00	21342.00
16	0.00	0.00	22651.00	22651.00

Nota: Año 1 corresponde a 1977

Cuadro P

Alternativa IV

Flujos de Costos
(US \$ M de enero 1981)

<u>Año</u>	<u>Inversión</u>	<u>Combustibles</u>	<u>Operación y Mantenimiento</u>	<u>Total</u>
1	54113.00	0.00	0.00	54113.00
2	53488.00	0.00	0.00	53488.00
3	47102.00	0.00	0.00	47102.00
4	77850.00	0.00	0.00	77850.00
5	109935.00	91386.00	6239.00	207560.00
6	116060.00	55056.00	6815.00	177931.00
7	60519.00	0.00	7918.00	68437.00
8	0.00	0.00	9120.00	9120.00
9	0.00	5584.00	10652.00	16236.00
10	0.00	19124.00	12143.00	31267.00
11	0.00	44801.00	13265.00	58066.00
12	0.00	0.00	15732.00	15732.00
13	0.00	0.00	16750.00	16750.00
14	0.00	22066.00	18334.00	40420.00
15	0.00	0.00	21272.00	21272.00
16	0.00	0.00	22641.00	22641.00

Nota: Año 1 corresponde a 1977.