PN. ABM-188
79148

United States Agency for International Development
Mission in El Salvador

INFRASTRUCTURE SECTOR ASSESSMENT

MDEO

Final Report

Volume IV
Electric Power and Telecomunnications

Tech International, Inc.
Louis Berger International, Inc.
Edificaciones Choussy, S.A. de C.V.

February 1990

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

MISSION IN EL SALVADOR

INFRASTRUCTURE SECTOR ASSESSMENT

FINAL REPORT

VOLUME IV

ELECTRIC POWER

TELECOMMUNICATIONS

TECH INTERNATIONAL, INC.

LOUIS BERGER INTERNATIONAL, INC.

EDIFICACIONES CHOUSSY, S.A. DE C.V.

INFRASTRUCTURE

SECTOR ASSESSMENT

VOLUMES

VOLUME I	SUMMARY REPORT
VOLUME II	TRANSPORTATION
VOLUME III	WATER SUPPLY & SANITATION
VOLUME IV	ELECTRIC POWER & TELECOMMUNICATIONS

- N'

This study is being prepared under contract between USAID/El Salvador and Tech International, Inc. under contract number 519-0177-C-00-9503-01.

The Consultants wish to thank the generous assistance and contributions provided by the staff of USAID/ Salvador, the Government of El Salvador, its agencies and private firms. They were extremely helpful in providing data and clear explanations of Salvador and its infrastructure sector. Nevertheless, the Consultants remain solely responsible for all data, opinions, conclusions and recommendations.

IV ELECTRIC POWER

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ELECTRIC POWER

SUMMARY AND RECOMMENDATIONS

1. Institutional Framework

The production and distribution of electricity is operated under the authority of the Ministry of the Economy. CEL is the autonomous institution in charge of generating and distributing electric power and although it faces numerous constraints, it is a generally efficient and professional company. The institutional framework of the power sector is sound.

2. Distribution

As a result of the GOES terminating distribution company concessions in 1986, minimal investments were made in the previous decade since then. Thus, the distribution system is overloaded.

Recommendation # 1

The GOES should seek a settlement and proceed to set up viable operating entities. If needed investments are not made, emergency measures may soon need to be implemented to avoid more rationing.

Also, there appears to be insufficient plans to manage the distribution system once this settlement is reached.

Recommendation # 2

Plans should begin now to set up such a system. One option under consideration is to set a country-wide distribution utility with the participation of private capital in financing and management. To become an attractive investment, it would have to be established on a sound institutional and financial basis. The GOES could nominate a committee to prepare a proposal on this matter. Investments in distribution could then proceed more effectively.

3. Finance

CEL is in a difficult financial situation. The company has been losing money since the 1986 devaluation. At that point, debt and debt service increased more than twofold without any compensating tariff adjustment or debt restructuring. To compound this problem, tariff adjustment procedures are complex and arrears are due from public entities.

Recommendation # 3

ISA Consultants have devised the following set of financial recommendations:

- There should either be a utility regulation agency to support needed adjustments or CEL should be given the authority to adjust tariffs to compensate for increases in operating costs and debt payments. This authorization should not be for a one time adjustment only. CEL needs to be allowed to continuously adjust its tariffs according to the specified financial criteria.

- There is a need for a comprehensive tariff study to analyze tariff adjustment requirements and deal with the above issue.

- ISA estimates that the minimum real rate increase needed is approximately 14 percent over the 1988 period. This should be phased in gradually to avoid a consumer price shock and keep a positive business climate.

- The number of tariffs should be reduced to six, one for each type of user. The number of blocks should also be limited. This will cut administrative costs.

- CEL's debt should be rescheduled given clear investment objectives. This will permit a gradual implementation of this increase.

- Arrears by State Enterprises should be paid to CEL.

4. Planned Energy Use

The present situation of low tariffs and lack of power directly limits investment and maintenance while increasing demand, thus jeopardizing the power supply situation. Also industry has little incentive to conserve energy, modernize energy use, and schedule energy use to reduce CEL's load factor. The demand charges on the current tariff schedule are insignificant. Thus, users have no incentive to reschedule energy consumption.

As a result, an expensive generation facility may soon be required to meet increased peak requirements.

Recommendation # 4

Implement an effective industrial demand charge to reduce CEL's heavy load factor.

5. Generation

The most serious generation problem is the rapid siltation of El Salvador's most important reservoirs. The capacity of the Cerron Grande Reservoir, on the Lempa River, at its current rate, will be gone in 10 years. Deforestation is a major contributing cause to soil erosion and siltation, but the dumping of urban refuse from

the San Salvador Metropolitan Area is another important factor. Since dredging is not an economical solution, reservoir siltation cannot be reversed.

Recommendation # 5

CEL should proceed on an emergency basis to repair collapsed drop structures and add check dams and other soil containing structures on tributaries to the Rio Lempa, such as Rio Acelhuate and Rio Sucio. Mid- and long-term measures such as sewage treatment, collection of urban refuse, and reforestation should be planned for immediate implementation. A study of urban refuse and dumping is needed.

Geothermal power plants can have a strong negative environmental impact. Currently, water from the existing central geothermal unit is let into national water ecosystems without prior treatment. This hct water contains high concentrations of minerals and acids. Steam from the planned wellheads will also contain these elements which will be dispersed without any control over a radius from the wellhead units thus covering local vegetation. CEL is currently studying a recycling process to obtain more energy and reduce pollution. Given increasing environmental awareness, this negative impact will certainly constrain the availability of international funding for such projects.

Recommendation # 6

CEL should prepare in depth environmental studies for existing geothermal projects, and strive to implement protection and mitigation measures.

To prevent a shortfall in supply and its consequences, such as rationing, new generation facilities should be rapidly added. With no tariff adjustments and given the expected December, 1989 peak of 407 MW, a comparison of 1994 needs with the new projects expected to come on line by then yields the following shortfall:

	Capacity Mw	Yearly Energy Gwh
New facilities Needed by 1994	105	630
Expected Plant Addition	50	335
Shortfall by 1994	55 Mw	295 Gwh

The proposed tariff adjustment will improve the financial situation, make CEL eligible for major loans and postpone generation needs by a year or so.

Recommendation # 7

The Consultants suggest that the proposed tariff adjustment and industrial demand charges be implemented. If this reduces the load factor sufficiently, then only the 20 MW slow speed diesel generators will need to be installed. If not, further peak-oriented facilities will be needed.

CEL's plans to increase power generation through the year 2000 rely extensively on the use of the geothermal resources of the country. While this is an attractive source of energy, it has a number of disadvantages. Besides its environmental impact, geothermal plants are very expensive; the economic evaluation demonstrates it is one of the least economical energy generation systems. The expansion of existing hydroelectric plants, together with their preservation, presents a much higher return. In addition, geothermal plants are risky as it is always difficult to know how much energy will be available for each plant until the wells are dug.

Recommendation # 8

CEL should reconsider its power generation plans in light of the results of this study. Greater emphasis should be put on existing and future hydro plants; these are the most economical and have the least negative environmental impact.

6. Total Investments

After careful review, ISA proposes a total of $ 490 million in investments through the year 2000.

IV. ELECTRIC POWER

The major institution involved in the electric power sector is the state owned electric utility, "Comision Ejecutiva Hidroelectrica del Rio Lempa" (CEL). Most of the data presented in this volume has been obtained from the various departments of CEL and CAESS "Compañia de Alumbrado Eléctrico de San Salvador", the largest distribution utility. Also see Volume I (Summary Report) regarding environmental concerns.

The electric power sector is a relatively small but important part of the whole energy sector. In 1987 electric power accounted for only 7.9% of the net consumption of secondary energy, as shown below;

Breakdown of Energy Consumption

Product	1987 %
Firewood	53.6
Oil Products	33.2
Electricity	7.9
Vegetable Wastes	4.8
Charcoal	0.5
TOTAL	100.0

Source: National Energy Balance.

Approximately 60% of the energy requirements of the Salvadoran population were covered by biomass (firewood, vegetable wastes and charcoal).

The high consumption of firewood, contributes to the country's widespread deforestation. This in turn affects the supply of electricity, as siltation steadily reduces the useable capacity of the hydroelectric storage reservoirs. Changes in Salvador's energy policy is urgently needed to halt this damage to the ecosystem.

A succession of droughts in recent years were possibly linked with changes in the microclimate. In 1987, rainfall was at its lowest level in 30 years. The rainy season ended practically in the second half of September and reservoir inflows shrank dramatically. This curtailed electricity generation even more than during 1986-87 and forced the utility to run the Acajutla oil-fired plant at full capacity from January until June of 1988.

Unless urgent measures are taken, the consequences of deforestation and erosion will be more drastic every year. A co-ordinated effort is needed in the entire energy field. While this is an objective of the National Integral Energy Development Plan, it should now be applied in practice.

However, it is to the power sector that the country has directed the major part of its investments. The debt service of these major investments has become a heavy financial burden. These ecological and financial circumstances worsened CEL's financial position and forced it to introduce electricity rationing, causing losses in several sectors of the economy.

Despite the funds absorbed by this sector, the benefits of electricity have not reached a large part of the low-income population.

A. INSTITUTIONAL REVIEW

1. Background

Development of electricity began in earnest in El Salvador during the 1930's. At that time a number of private companies were incorporated, in their respective cities. In time, these companies extended their supply to part of the countryside.

As power demand increased, it became desirable to exploit the hydroelectric potential of the only major river of El Salvador, the Rio Lempa. In 1948, GOES decided to set up a governing body to undertake this development. Thus, CEL was formed.

The sections which follow describe the institutional set up, the present situation of CEL, and that of the distribution companies. System constraints are presented in Problem Areas (Section K).

2. The Institutional Setup

The production and distribution of electricity are under the authority and the supervision of the Ministry of Economy, mostly at the legal and political level. Specific policies, day-to-day operations and technical matters have generally been delegated to CEL. CEL owns and operates all major power generating plants in the country; it owns and operates the high voltage transmission system; it administers, as an agent for the government, the distribution utilities which were taken over in 1985-87; it is also charged with a number of other functions in the energy field, including energy sector planning and the sale of oil products from the privately owned refinery. CEL is a stable and well managed utility. The Ministry still retains a regulatory function and authorizes selective installations.

The institutional set up is slated to change, as the legal and regulatory status of the distribution utilities are due to be redefined in the near future.

The setting of electricity rates, the definition of the limits of the authority of the utilities, and related issues are handled by the Economic Committee on an "ad-hoc" basis according to the process described under the Institutional Aspects Section of the Country Profile (Volume I).

a. Production and Transmission

CEL built four hydro plants between 1954 and 1982 and developed the high voltage transmission system which now links the country together; it undertook to distribute electricity in previously unserviced areas of the country- side; it built oil fired plants and geothermal projects.

b. Distribution

Besides its own distribution system, CEL now administers all other distribution systems in the country. While this is a temporary arrangement, it has been in effect since 1986, and no date has been set for its termination. Thus, at the present time, any and all matters dealing with electricity fall under CEL's jurisdiction.

Electricity is distributed in El Salvador by seven (formerly) private and one state owned (CEL) utility. The seven private utilities are:

- CAESS 71.00%
- CLESA 10.50%
- DEUSEM 1.60%
- CLES 3.20%
- CLEA 0.70%
- DESSEM 0.20%
- R.DE MATHEU 0.03%

These percentages indicate the share each company distributes of total consumption. The remaining 12.77% is distributed by CEL.

These seven utilities were granted 50 year operating concessions at various dates between 1935 and 1937. When the concessions expired, the assets reverted to the government. Negotiations to determine a fair value have just begun. From the expiration date of the concessions, CEL has administered these distribution utilities as going concerns.

Until this is defined, there is a question whether these utilities can borrow the funds for needed rehabilitation and expansion. Consequently urgently needed investments and repairs have been postponed.

c. Energy

During the last several years, CEL has been assigned a number of additional functions.

It undertakes :

- Overall Energy Planning for the country
- Research and development of geothermal, oil and gas resources
- Control and supervision of petroleum and petroleum product supply and distribution. The only refinery in the country (RASA) is jointly owned by EXXON (65%) SHELL (35%).

3. Institutional Description of CEL

a. Objectives

CEL is a non-profit, autonomous, public service institution. It's general objectives are to forge economic and social development of the country through conservation, production, supply and the use of national and imported energy resources to avoid imbalances and supply-shortages.

To attain these general aims, CEL has formulated the following specific objectives:

- Promote efficient use of power by consumers in the residential, commercial, industrial, agricultural, public and transport sectors.
- Investigate, explore and exploit the various national power sources, reduce import dependency and reach a balance of energy that reflects improved use of national resources.
- Promote research and development of technology appropriate to the exploitation of national power sources.
- Achieve institutional integration of the power sector so that it operates more efficiently.
- Achieve the economic and financial soundness of companies in the power sector in the medium term, by setting prices and tariffs that cover all costs and produce a surplus to finance expansion, in accordance with national development needs.
- Develop sufficient specialized human resources in power to absorb new appropriate technology, exploit additional sources of energy and manage national and regional power programs.

- Contribute to the integration of Central American energy system, with joint supply, optimization in the use of power resources, transfer of technology, and use of funds.

- Promote horizontal technical cooperation between scientific, technical and financial institutions associated with the power sector.

- Strengthen power planning capacity in all its aspects.

These objectives were set in 1980, whereby CEL passed from a purely electric utility to manager of the integrated power sector.

b. Organization

CEL's Board of Directors consists of eight members who are appointed as follows:

- One Director is named by the Ministry of the Interior. This director acts as President of the Commission.

- Five Directors are named by the Ministries of the Economy, Public Works, Agriculture, Planning and Finance.

- One Director is elected by the country's banks, in a meeting presided by the president of the Central Reserve Bank.

- One Director is elected by national bond-holders.

In addition to the above, there are seven alternate directors chosen in the same way, with the exception of the President who, in case of absence or temporary impairment, is replaced by one of the other Directors, with the agreement of the Board. An organizational chart of CEL is found in Figure IV.A.1.

4. Planning Function in the Energy Sector

As may be seen from the organizational chart, CEL's Planning Department (PLANICEL) is responsible to the Executive Director. Before 1978 the country had neither specialized institutional mechanisms nor the basic information needed to formulate integrated energy policies. The drafting of Energy Balances, brought about by CEL's Energy Superintendency through the Central American Isthmus Energy Program (PEICA), marked the beginning of energy planning activities.

Integrated energy planning is a fundamental requirement for the management of the power sector of the country. With the exception of some ad-hoc expansion plans prepared by foreign consultants with limited national participation, the country lacked energy planning capabilities until recently. PLANICEL began the process of integrated sector planning with financing from the Interamerican

Development Bank (BID). A series of studies was developed which concluded with the publication of the "National Energy Plan 1988-2000".

The organization chart of PLANICEL (Figure IV.A.2) shows how management is linked with CEL's top management.

PLANICEL consists of a power information center and three large divisions. These are the Planning and Power Development Division, the Company Planning Division, and the Institutional Development Division.

The objectives of PLANICEL are, among others to:

- Formulate expansion plans for various departments in cooperation with these various departments. Act as co-ordinator for all the institution's information management.

- Formulate power policies that can influence requests from higher levels. Produce internal institutional improvement programs. Produce institutional programs.

- Formulate policies and structures for the pricing and tariffs of various energy sources.

- Continually analyze the various environmental issues that can affect CEL.

- Promote CEL's institutional development.

To meet these objectives, PLANICEL fulfills different functions, including the following:

- Formulate development policies for the energy sector and development strategies for CEL.

- Draw up long-term plans for the power sector, by subsectors, using appropriate methodologies.

- Formulate policies for the integrated management of the power sector.

- Formulate short and medium-term plans for company development.

- Co-ordinate existing information systems to make the Departmental systems compatible with one another and with overall company data processing.

- Promote bilateral technical co-operation agreements.

TABLE IV.A.1

ORGANIZATION CHART OF CEL

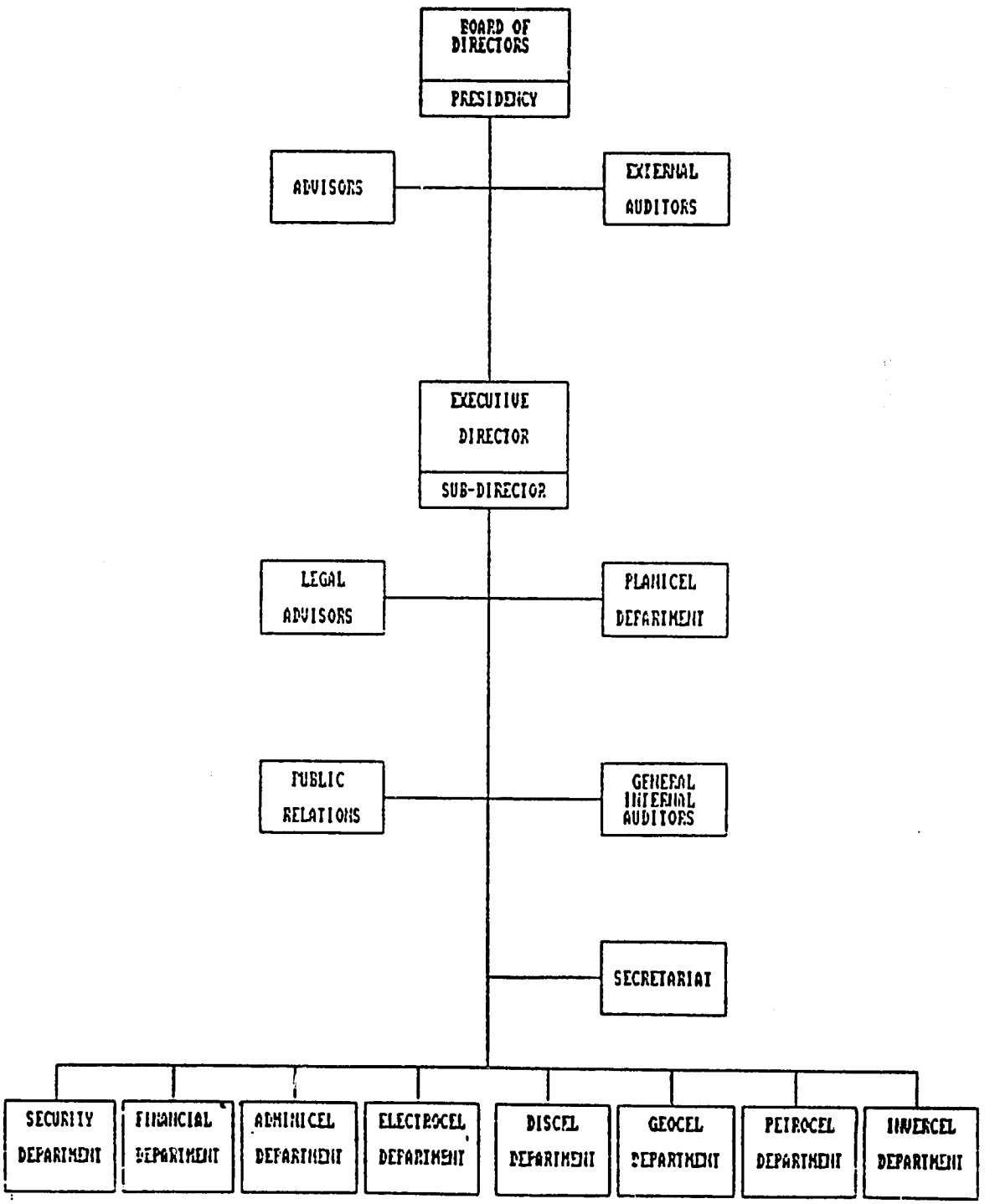
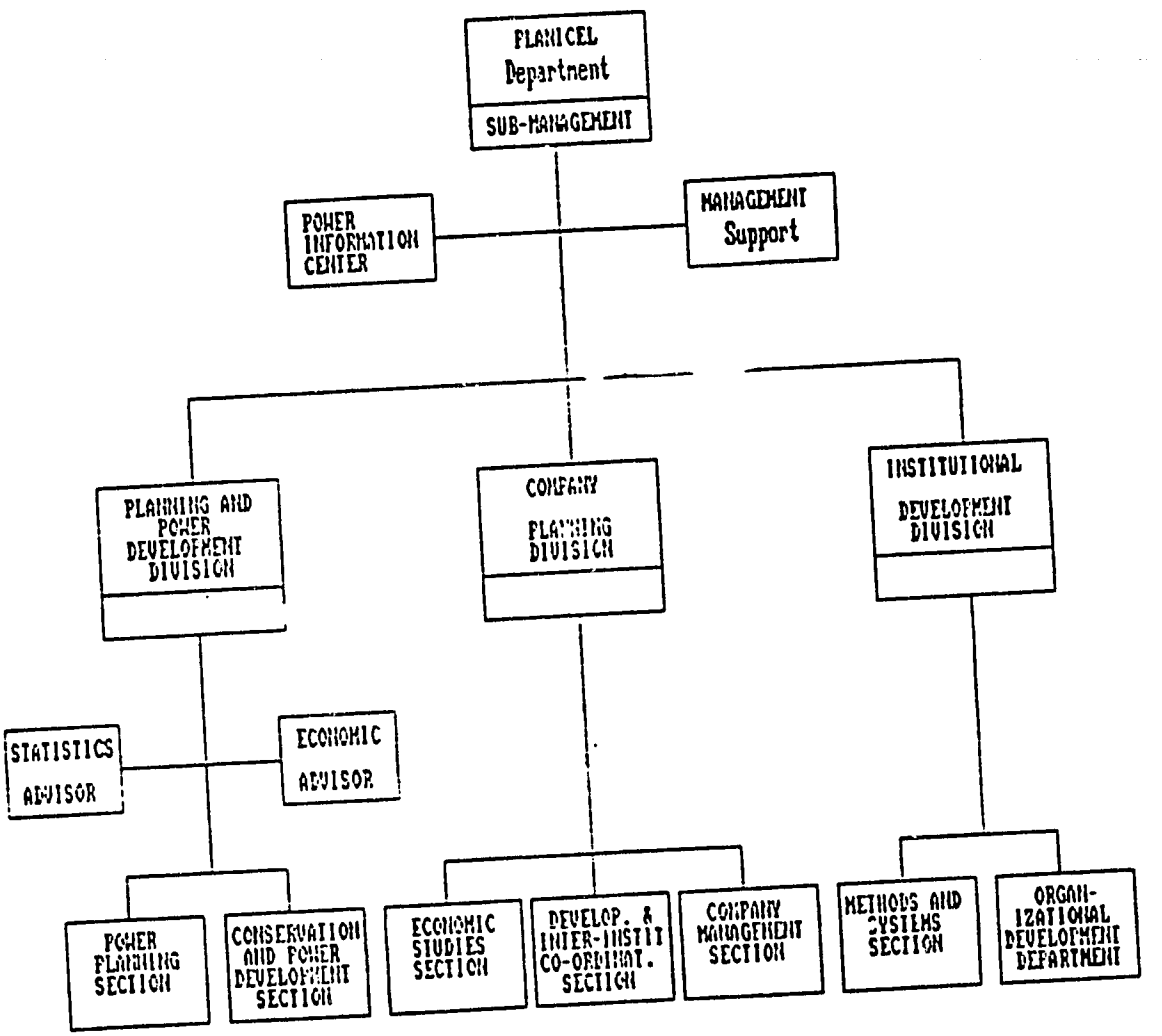


TABLE IV.A.2

ORGANIZATIONAL CHART OF THE STRATEGIC PLANNING DEPARTMENT

PLANICEL



- Structure, develop, program, implement and maintain computer systems, data bases, and model operations.

- Promote consolidation of CEL's organizational structure.

- Plan in an integrated way and consolidate the institution's development.

5. CEL Human Resources

In 1986 CEL's total number of employees was 2,786. The distribution of personnel by división is shown in Figure IV.A.3 below. The greatest number of (1,186) employees are in ELECTROCEL. The classification of personnel by categories is shown in Figure IV.A.4. Professionals are second in the number of employees. Most professionals employed are electrical engineers, civil engineers and business administrators.

Most notable in CEL's staffing pattern is the increasing importance of administrative personnel. Together the Presidency, Invercel and Admincel account for almost as many staff as Electrocel.

The importance of security personnel is currently entirely justified by the conflict, thought should be given to its "demobilization" when the conflict ends.

6. CEL Procurement Procedures

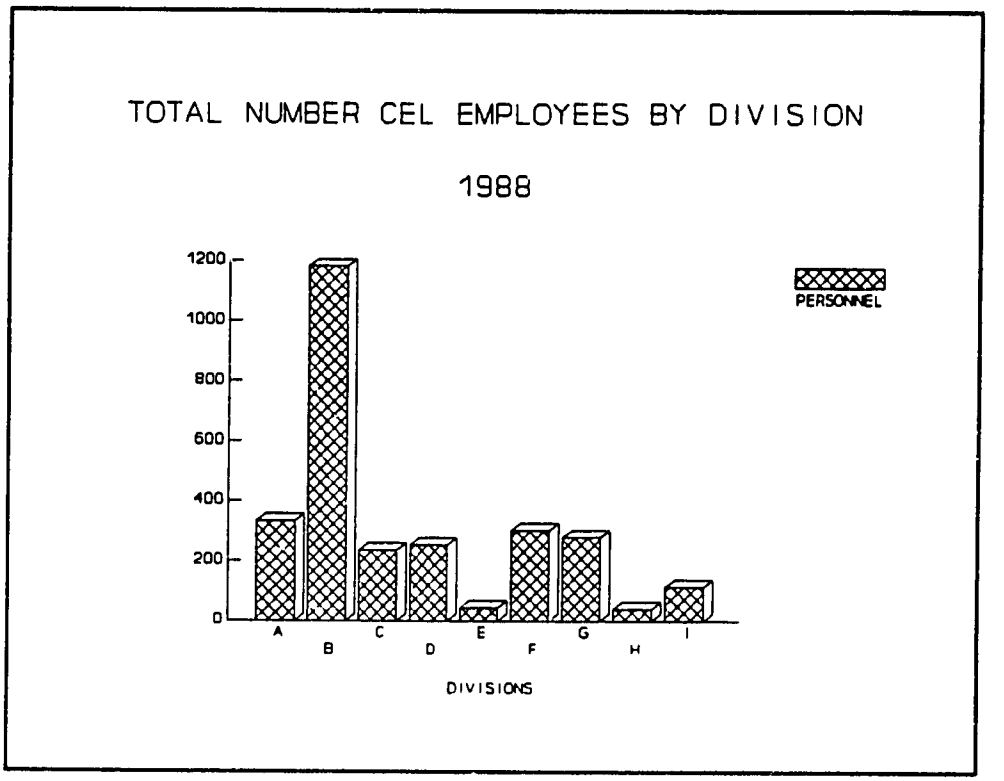
Purchases of less than C 20,000 (twenty thousand colones) are made by single source procurement, with a special requisition for goods. Each department or unit is authorized to make this kind of transaction, without having to resort to higher levels of the institution.

For purchases or investments greater than C 20,000, the following procedures are used:

- Private bidding

CEL maintains lists of Salvadoran companies which specialize in different types of construction and supply of goods. These companies may be invited to bid for supply or construction for specific projects.

FIGURE IV.A.3

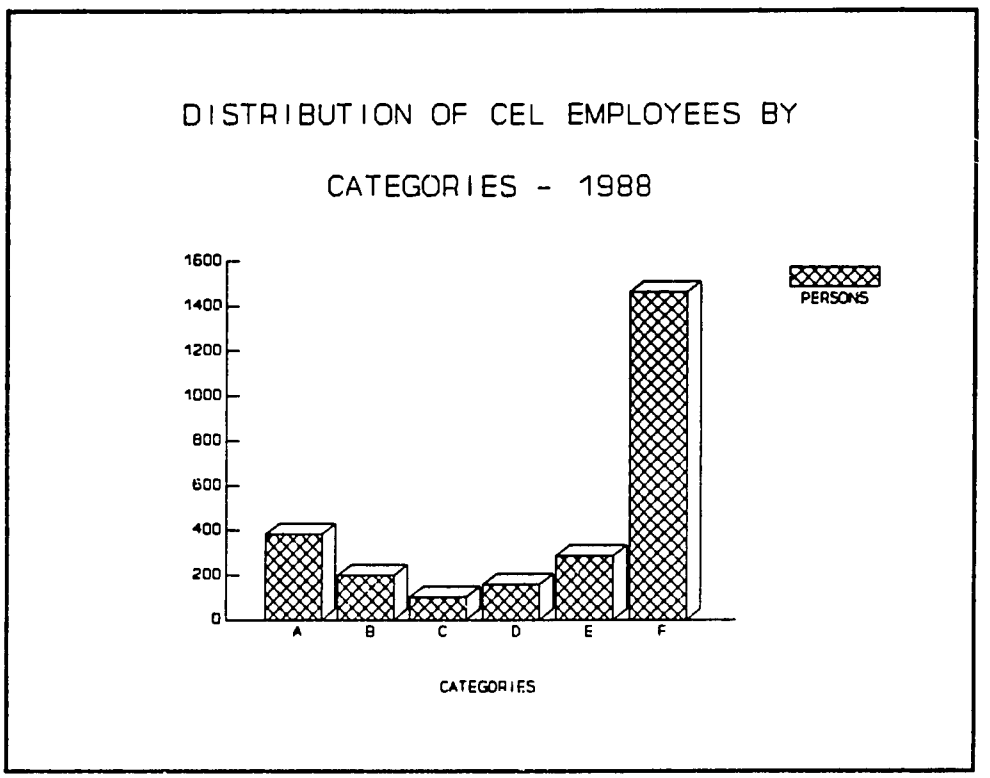


A. PRESIDENCY
B. ELECTROCEL
C. GEOCEL
D. DISCEL
E. PETROCEL
F. INVERCEL (INVESTMENTS)
G. ADMINICEL
H. PLANICEL
I. FINANCEL

TOTAL NUMBER OF EMPLOYEES = 2768

SOURCE: PRODATOS-CEL

FIGURE IV.A.4



A	PROFESSIONALS	D	ASSISTANTS
B	TECHNICIANS	E	SECURITY
C	SECRETARIES	F	WORKERS

NOTE: ADMINISTRATIVE STAFF NOT INCLUDED

SOURCE: PRODATOS-CEL, MAY 1988

In some cases, depending on the nature of the goods or services called for, only four or five firms will be invited; in order to speed up negotiations.

- Public bidding

When the work to be done justifies it, CEL calls for public bids in the principal newspapers of the country. Stipulations of the loan contract may be for national or international bids.

- System of unit prices

This system is used exclusively in rural electrification works where standards exist for construction of lines and structures. There are a number of qualified companies in the country which have a kind of rotation system among themselves depending on the size of the work.

- USAID-funded works

USAID funded works or services are contracted according to AID's contracting procedures. A report by Eng. Walter Bolanos of CEL is enclosed in Appendix IV.A.1 for a better understanding of this system.

B. INVENTORY OF FACILITIES

1. System Map

The tables on the following pages report the main data of the country's power facilities; including generating plants, transformer stations, transmission and distribution lines. An overview of the system is shown in Map IV.B.1.2.

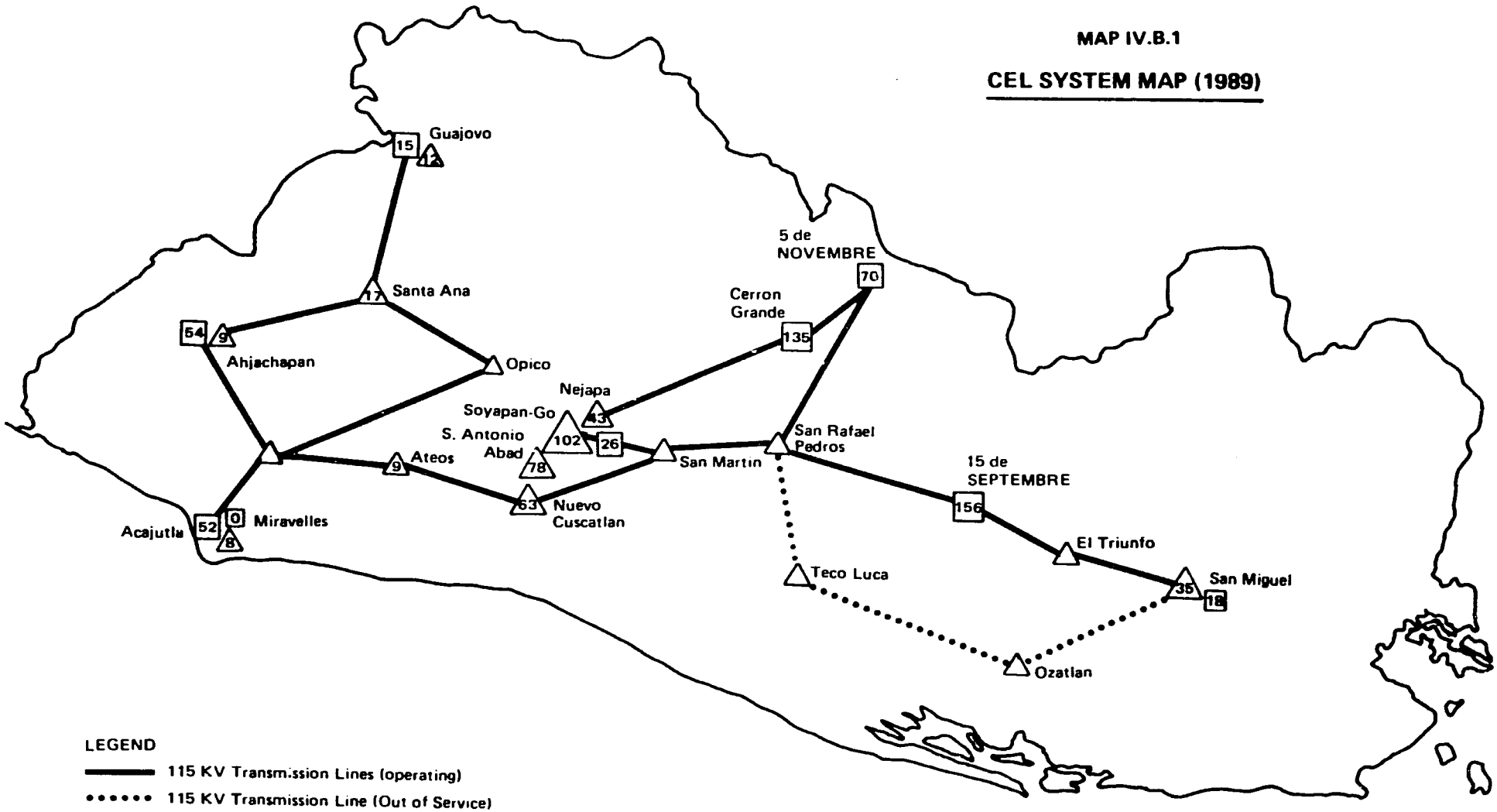
Generation

The generating facilities are of four main types, each with their specific function in the system.

- The geothermal plants, which operate continuously during the year and service base load.

- The hydro plants, which run up to the limit of their capacity during the rainy season so as to utilize all the water available. During the dry season, when there is not enough water to run continuously, they operate as peaking plants.

- The oil fired steam plant is run as a base load plant during the dry season to supplement the hydro plants. During the rainy season it is kept as reserve.


MAP IV.B.1
CEL SYSTEM MAP (1989)
Guajovo
15
Santa Ana
17
54
9
Ahjachapan
Opico
Nejapa
43
Soyapan-Go
102
26
S. Antonio
Abad
78
Ateos
9
63
Nuevo
Cuscatlan
Acajutla
52
0
Miravelles
8
5 de
NOVEMBRE
70
Cerron
Grande
135
San Rafael
Pedros
San Martin
15 de
SEPTEMBRE
156
El Triunfo
Teco Luca
San Miguel
35
18
Ozatlan
LEGEND
115 KV Transmission Lines (operating)
115 KV Transmission Line (Out of Service)
115 KV Sub Station Transformer – Figures are the 1989 Peak Load in MW
Generating Plants –Figures are the 1989 Maximum Available Capacity in MW

- The gas turbines are run either as peaking plants if needed, or as emergency plants when the capacity of the rest of the system becomes insufficient; for example when sabotage of a line cuts off another generating plant from the system.

The principal generating facilities of El Salvador are listed in Table IV.B.2 below.

The column "plant capacity available" is the forecast for December, 1989, when the hydro units will have a full flow of water, and all other units have completed their yearly maintenance and are back in service. Less capacity is available during all other months.

As the table shows, El Salvador would have enough power facilities to meet its needs, although with little to spare, were it not for the disruptions caused by civil unrest.

Against a total demand of approximately 400 Mw (1989 peak), there is over 530 MW of generating capacity. This capacity is made up of 50 - 60 Mw in geothermal plants; 90 - 100 Mw in oil-fired plants and gas turbines; and approximately 380 Mw in hydro plants. The supply may be supplemented by 50 - 60 Mw on a seasonal or emergency basis from the interconnection with the Guatemalan system. Technical data of each major generator is reported in Appendix IV.B.1. The tables include only those facilities owned by public utilities. Privately owned plants and captive industrial plants are not included. While their number is large and their output is considerable, their function is mostly to promote the development. Co-generation plants can also contribute to available power supply. However, this is only an idea, and is not a prospect for the immediate future.

3. Transmission

The Salvadoran power transmission system consists of a number of High Voltage Transmission lines operating at 115 kV. The layout of the system is radial, in that most lines feed power from the outlying generating plants to San Salvador where the bulk of the load is contained.

As shown on Map IV.B.1, the lines feed San Salvador from the three major hydro plants to the north and to the east; from the geothermal plant in the west; and from the steam plant in the west. The Guatemalan system joins the Salvadoran system at Ahuachapan, near the geothermal plant, and can supply San Salvador through existing lines. A connection with the Honduran System to the east is being prepared. See details under "Projects Underway".

The 115 kV main transmission system is complemented by a number of medium voltage lines rated at 34 kV and 46 kV, which CEL refers to as "Subtransmission Lines".

Table IV.B.2

GENERATING FACILITIES

PLANT	TYPE	NO. UNITS	PLANT CAPACITY* RATED MW	PLANT CAPACITY* AVAIL MW	OPER'ING SINCE YEAR
MAJOR PLANTS - CEL SYSTEM					
Guajoyo	HYDRO	1	15	15	1963
Cerron Grande	"	2	135	135	1977-78
5 Noviembre (Guayabo)	"	5	81	70	1953-66
15 Septiembre (S.Lorenzo)	"	2	156	156	1983-84
TOTAL HYDRO			388	376	
Ahuachapan	GEOTHERMAL	3	95	54	1975-80
TOTAL GEOTHERMAL			95	54	
Acajutla	STEAM	2	63	58	1966-69
Acajutla	GAS.T	1	7	n.a	1965
Soyapango	"	3	54	26	1972-73
San Miguel	"	1	25	18	1984
Miravalles	DIESEL	3	18	n.a	1986
TOTAL OIL FIRED			167	102	
TOTAL CEL SYSTEM			650	532	
SMALLER PLANTS - NON CEL					
Five Plants	HYDRO		16	4	
TOTAL SMALLER UNITS			16	4	
GRAND TOTAL FOR EL SALVADOR			666	536	

* Forecast for December 1989, lower in other months.

Both the transmission lines and the subtransmission lines feed power into transformer stations, or substations, from which the distribution feeders (primary distribution lines) fan out to supply the final users.

The prevalence of different transmission and subtransmission voltages stems from the fact that, up to 1985, power was distributed across the country by seven separate utilities which each selected the most economical voltage level for its franchise area. While CEL took over these separate utilities in 1986, it has had neither the opportunity nor the resources to standardize or optimize the distribution system. This will be a task for calmer times.

The total lengths of transmission and subtransmission lines are reported in the table below as are the number and ratings of the transformer stations. The technical data of the Transmission lines and Transformer Stations are presented in Appendix IV.B.1.

Schedule of Transmissions and Subtransmission Lines

Operating Voltage	No. of Line Sections	Total Length km
115 kv out of service	4	148
115 kv in service	21	606
46 kv in service		
34 kv in service		

Schedule of Transformer Stations

High Voltage	No. of Stations	Total Capacity Mva
115 kv	12	590
46 kv		
34 kv	1	8

4. Distribution

CAESS currently has 19 23 kV feeder circuits in its primary distribution network, with four principal substations. These are located in Agua Caliente, San Antonio Abad, Nejapa, and Nuevo Custcatlan and supply all the power demand for the surrounding areas of the San Salvador Metropolitan area. Of the 19 feeders, six are critically overloaded and their conductors are suffering high power losses with consequent overheating. Voltage during the maximum demand hours is considerably below acceptable levels. Seven other feeders have reached a slightly less critical state of load saturation, but loads still exceed the maximum recommended conductor amperage.

The CAESS substations of Agua Caliente (CEL-Soyapango) and San Antonio Abad (CEL - San Antonio Abad), each of which has the maximum possible installed capacity of 100 Mw, and Nejapa, which has 50 Mw installed capacity, were the only three power supply-points for the San Salvador Metropolitan Area. The latter also supplies the rural and industrial are of Quetzaltepeque and Apopa, as well as the whole department of Chaletenango. In 1984 a 23 kv temporary circuit was constructed from the CEL-Nuevo Cuscatlan transfer point, which took over part of the load of the San Antonio Abad circuit serving the South West of San Salvador, including Santa Tecla. The installed capacity of CAESS in Nuevo Cuscatlan, barely 15 Mw, will be doubled to 30 Mw at the end of the current year.

If CAESS's primary distribution system does not expand in the near future, the overload situation will force it to refuse to connect new services in the overloaded zones, especially to industrial plants which need more power. If demand growth exceeds projections, and the necessary investments within this plan are not made, we can foresee a medium-term need for a sectoral power rationing project in San Salvador, on working days from midday to dusk. The aim of such a program would be to protect circuits and electrical equipment from damage due to excessive overload.

5. National Coverage

The table below presents the growth in residential electricity coverage in El Salvador.

Residential Electricity Coverage

Year	Population		No. of Homes		No. of Residential Customers			Electrification	
	Urban	Rural	Urban (2)	Rural(3)	Urban	Rural	Total	Urban	Rural
1977	1,751	2,503	351	477	209	26	235	.59	.06
1978	1,796	2,549	361	486	225	31	256	.63	.06
1979	1,847	2,587	371	494	242	34	276	.65	.07
1980	1,899	2,630	381	502	261	38	299	.68	.08
1981	1,992	2,584	400	493	273	41	314	.68	.08
1982	2,087	2,538	419	484	284	45	329	.68	.09
1983	2,184	2,490	438	475	300	48	348	.68	.10
1984	2,282	2,441	458	466	318	51	369	.69	.11
1985	2,382	2,390	478	456	338	54	392	.71	.12
1986	2,432	2,433	488	464	355	60	415	.73	.13

All figures rounded to the nearest thousand.
(2) Using a factor of 4.98 habitants/home.
(3) Using a factor of 5.24 habitants/home.

Source: CEL

Rural coverage is much lower than in urban areas. According to NRECA, the coverage in rural areas could be increased significantly by promoting power services and simplifying application procedures.

C. PROJECTS UNDERWAY/PLANNED

1. General

CEL's precarious financial position precludes the undertaking of normal expansion programs, or even normal replacement programs. Their first priority is to use whatever resources they have to maintain service to existing customers.

Providing for the future has unfortunately become a second priority. It depends on whatever financing can be obtained from bilateral donors and international agencies.

Planning is not easy under such circumstances, it is done as best it can be, but is always subject to the caveat that it may have to be altered, either to cope with new patterns of destruction or to follow changes in the availability of external financing.

A discussion of other sector plans that would generate electricity demand is included in the section on current projections in Chapter F-Demand/Load Forecast.

2. Projects Underway

a. Generation

The main projects underway at the present time are reported in the table below:

Project Location	Capacity Addition Expected in 1990	
Rehabilitate Ahuachapan Geothermal Plant	ADD	15 Mw
Refurbish Miravalles Diesel plant	"	15 Mw
Install two new Wellhead Geothermal Units at Berlin	"	10 Mw
Drill new Steam Wells at Chipilapa, and Install two Wellhead Geothermal Units	"	10 Mw

A description of the above projects follows:

- Ahuachapan
  Rehabilitation and Life Extension of the Geothermal Plant.

  The output of the plant has dropped from 90 Mw and 600 Gwh per year in 1980 to 50-60 Mw and 400 Gwh in 1988. The objective of the project is to increase the capacity 15 Mw

and energy production by 115-120 Gwh per year and to keep it stable at the new levels. This will be achieved by drilling four or five new wells and by rearranging the steam and condensate pipes so as to achieve a more efficient operation. Financing for the $16.million will be $9.million from CABEI and the rest from CEL. Completion is expected by 1991.

- Chipilapa (First Phase)
  Installation of two 5 Mw Geothermal Wellhead Units

  This is the first phase of the development of the geothermal field which is designed to support the production of 70 Mw by the year 2000. The project consists of drilling three 1500 m deep wells and installing two 5 Mw wellhead units. One well is completed, the second is started, the third should be completed by January, 1990. The wellhead units shall be in commercial operation by June, 1990. The anticipated cost of the projects is $20 million, of which France contributes $16 million and CEL $4 million

- Miravalle
  Diesel Plant Refurbishing

  The power station basically consists of three Mirrless Blackstone generating motors, each with a capacity of 6230 kw. It also includes, three directly-connected Bruk generators, one 250 kva starter generating plant, one 25-ton crane, control boards and panels, the fuel tank, one fuel treatment plant, a cooling tower system, water softening plant, a spare parts lot, and all motor operation auxiliary equipment currently installed in the plant. In 1989 CEL signed a contract with Mirrless-Blackstone which provided for the supply of all equipment needed to undertake major revisions and adjustments, repairs and/or reconditioning supervised by CEL personnel, and to put the three Mirrless-Blackstone units and their corresponding equipment at the Miravalle Power Station into operation. This project is currently underway at a cost of approximately 1.5 million pounds sterling. The work should take 42 weeks and is scheduled for completion in May, 1990.

- Berlin
  Installation of two 5 Mw Geothermal Well Head Units

  Specific information concerning the additional units to the Berlin Power station was not readily available at the time of this report.

b. <u>Transmission</u>

Among the ongoing transmission projects the following stand out:

- Construction of a 115 kv line (28 km) linking the 15 de Septiembre power station with the town of San Miguel.

- Expansion of some 115 kv transformer stations.

- Construction of several sections (150 km) of 46 kv subtransmission lines to extend supplies to rural areas. (part of USAID/NRECA)

c. Distribution

As mentioned before the distribution system executes only essential repairs. Although development plans are being prepared, these are slow to be carried out.

Most important is the CEL-CAESS transfer point at Nuevo Cuscatlan. A CAESS substation will be built next to the existing CEL-Nuevo Cuscatlan. It will have the same name and consist of a set of 46 kv busbars and grounding tranformer. This will accommodate up to four outgoing 23 kv feeders with all the necessary circuit breakers, disconnects, protection, measurement and control equipment to handle a 50 Mw load.

The technical justifications for developing this project are the following:

- Take part of the existing loads from the Agua Caliente and San Antonio Abad substations.

- Reduce the primary distribution losses of the same two substations.

- Improve operational flexibility of the San Salvador 23 kv distribution system.

- Provide enough installed capacity to supply the expected load growth in the South-West sector of San Salvador Metropolitan Area. This sector includes La Libertad, Santa Tecla, Ciudad Merliot, Plan de la Laguna and adjacent suburbs such as Jardines de la Libertad, La Sultana and Guadelupe.

d. Rural Electrification

Another significant project is the AID sponsored Rural Electrification Program being executed by NRECA. This program, which started in 1988 and will be completed by 1990, will connect 15,000 new consumers to the system. To attain this goal, the program includes construction of 580 km of new distribution lines, improvements to 170 km of existing lines, construction of 150 km of subtransmission lines, and three new substations.

An extension of the Rural Electrification project by AID/NRECA has been approved. This would connect 11,000 new users through the construction of 420 km of distribution lines, improvement of another 40 km, an addition of 40 km of subtransmission lines and one substation. Please refer to project documents for subsequent modifications in these quantitative objectives.

3. Planned Projects

This section includes only those projects where feasibility studies, scheduling, and/or design work have actually been done. The expectation being that these projects may be executed within a 3 to 5-year span.

a. Generation and Transmission

Proposed generation projects include:

- Geothermal field at Chipilapa

  Geophysical investigations are proceeding, in anticipation of a full scale exploitation of the field. Financing by Mexico.

- 5 Noviembre Hydro Plant

  Repair, life extension and expansion. The work will include:

  - Repair of a cave-in, Tailrace Tunnel Nº 2

  - Replacement of obsolete auxiliary and control equipment both electrical and mechanical

  - Replacement of obsolete switching equipment

  - Addition of a sixth unit rated at 30 Mw. Financing expected from KfW, West Germany.

  - Oil Fired Steam Plant at Acajutla. Refurbishment of measuring and control equipment of boiler Nº 2. Financing expected from kfw, West Germany.

  - System Control Center. Replacement of obsolete computers and software. Financing expected from kfw, West Germany.

The proposed transmission project is:

Interconnection with Honduras

- Design and Tender Documents have been completed by CEL's Design office for a 220 kv transmission line between 15 de Septiembre - San Miguel and La Pavana (Honduras). Of the

total length of 140 km, 100 km are in El Salvador and 40 km in Honduras. Anticipated cost is $28 million. Financing expected from the Government of Spain.

b. Distribution and Rural Electrification

CAESS has updated a development plan which was originally submitted in 1984 for World Bank funding. The main priorities are to alleviate current overloads, address forecasted growth in demand and expand service in the area of public lighting.

4. Future Plans

a. Generation Resources

This section deals with projects which are at the pre-feasibility or reconnaissance stage and still lack a financial sponsor.

The largest water resource of El Salvador is the Lempa River Basin. Its development has been studied at pre-feasibility level by Harza Engineering in 1974 and by Sogreah Consultants in 1980. They identified an untapped exploitable capacity in excess of 1030 Mw.

The potential of the smaller rivers Paz, Jiboa, Grande of San Miguel and Goascoran was assessed in 1982 by Tahal, which estimated the exploitable capacity in excess of 240 Mw.

The department of Geothermal Resources of CEL estimate the country's geothermal potential at not less than 331 Mw. As to biomass utilization, up to 16 Mw could be produced in co-generation plants burning bagasse of sugar cane.

In sum, renewable resources could provide up to 1600 Mw. Note, however, that one third of this is ascribed to the 540 Mw "El Tigre" Hydro scheme. If built as planned this would flood Honduran territory and an international agreement with Honduras would be needed. This may prove to be difficult.

It should also be noted that many of these projects are technically feasible, but costly. They would be financially feasible only if CEL could pass production costs to the users.

(1) Hydroelectric Resources

Refer to Table IV.C.1 which lists the potential hydroelectric sites identified to date. The Mw capacity is estimated at prefeasibility level.

(2) Geothermal Resources

The table below lists known areas of geothermal potential. At present there are productive wells only in the Berlin and Chipilapa areas. See also current "Projects Underway".

Areas With Sizeable Geothermal Potential

Name of Site		Estimated Potential Mw Range
San Lorenzo		6 - 26
Chipilapa		67 -103
Caluco		6 - 24
Coatepeque		44 - 96
San Vicente		61 -173
Berlin		69 -169
Chinameca		46 -106
Chambala		17 - 35
Chilamguera		5 - 17
Olomega		4 - 18
Conchagua		6 - 20
TOTAL	minimum potential	331

Source : 1988-2000 National Energy Plan

(3) Co-generation

Electricity can be produced by burning the surplus bagasse of sugar mills. Two plants are considered feasible. These are the El Angel sugar mill, located 16 km north of San Salvador near Apopa, and the Jiboa mill in the department of San Vicente.

The generating capacity of these plants would be approximately 8 Mw for each plant, when the mills work at full capacity. Arrangements for co-generation generally prove difficult, so these plans remain doubtful.

Table IV.C.1

HYDRO-POWER RESOURCES OF EL SALVADOR

NAME OF PROJECT		CAPACITY MW
Lempa River Basin		
El Tigre		540
Zapotillo		120
Paso del Oso		40
5 November Rehabilitation		30
5 November Expansion		120
Cerron Grande Expansion		135
San Marcos		52
TOTAL for Lempa River Basin		1037
Other River Basins		
Paz	El Jobo	72.0
	Piedra de Toro	66.0
	Arce	9.5
Jiboa	Hacienda Vieja	14.4
	Santa Rita	7.6
	Malancola	8.0
	San Jose Loma	5.0
Jalponga diversion to Jiboa	Malancola	10.7
	San Jose	7.0
Grande de San Miguel	San Esteban	20.0
	San Juan	4.5
	San Jose	3.2
Guascoran	El Platanar	12.5
TOTAL IDENTIFIED RIVER BASINS		240.4
TOTAL Identified Hydro-power Potential		1277MW

Source: 1988-2000 National Energy Plan

b. Costs & Schedule of future projects

(1) Generation

A number of runs of the WASP III program described in Appendix IV.C.1 were made under various assumptions in order to establish a range of possible expansion plans. Assumptions varied water conditions, and cogeneration from bagasse, energy saving measures and geothermal potential. CEL is still working on its final expansion plan. The latest published is presented in Figure IV.C.2.

Future expansion of the generating capacity of El Salvador was to be based on the exploitation of its geothermal resources, supplemented by steam plants running on imported oil. Relatively little reliance is placed on hydro plants. While the hydro plants will add little in terms of energy, (kilowatt hours) they can and will be expanded in the distant future to add more capacity (kilowatts) to meet system peaks.

The latest revision of CEL's generation expansion plan for 1990 - 2000 consists of adding:

- Five 20 Mw Geothermal Units
  Chipilapa 2 plants
  Berlin 2 plants
  San Vicente 1 plant

- Twelve 5 Mw Wellhead Geothermal Units

- Two 50 Mw Oil-Fired Steam Units, in the Acajutla and Cutuco area.

- One Hydro Plant on the lower Lempa River
  San Marcos, 52 Mw

- Addition of 30 Mw at the 5 de Noviembre Hydro Plant

- Construction of El Tigre Hydro Plant 270 Mw.

The planned completion schedule is shown in Table IV.C.3. A schedule of costs is included as Table IV.C.4. The costs are based on prefeasibility estimates at 1986 price levels.

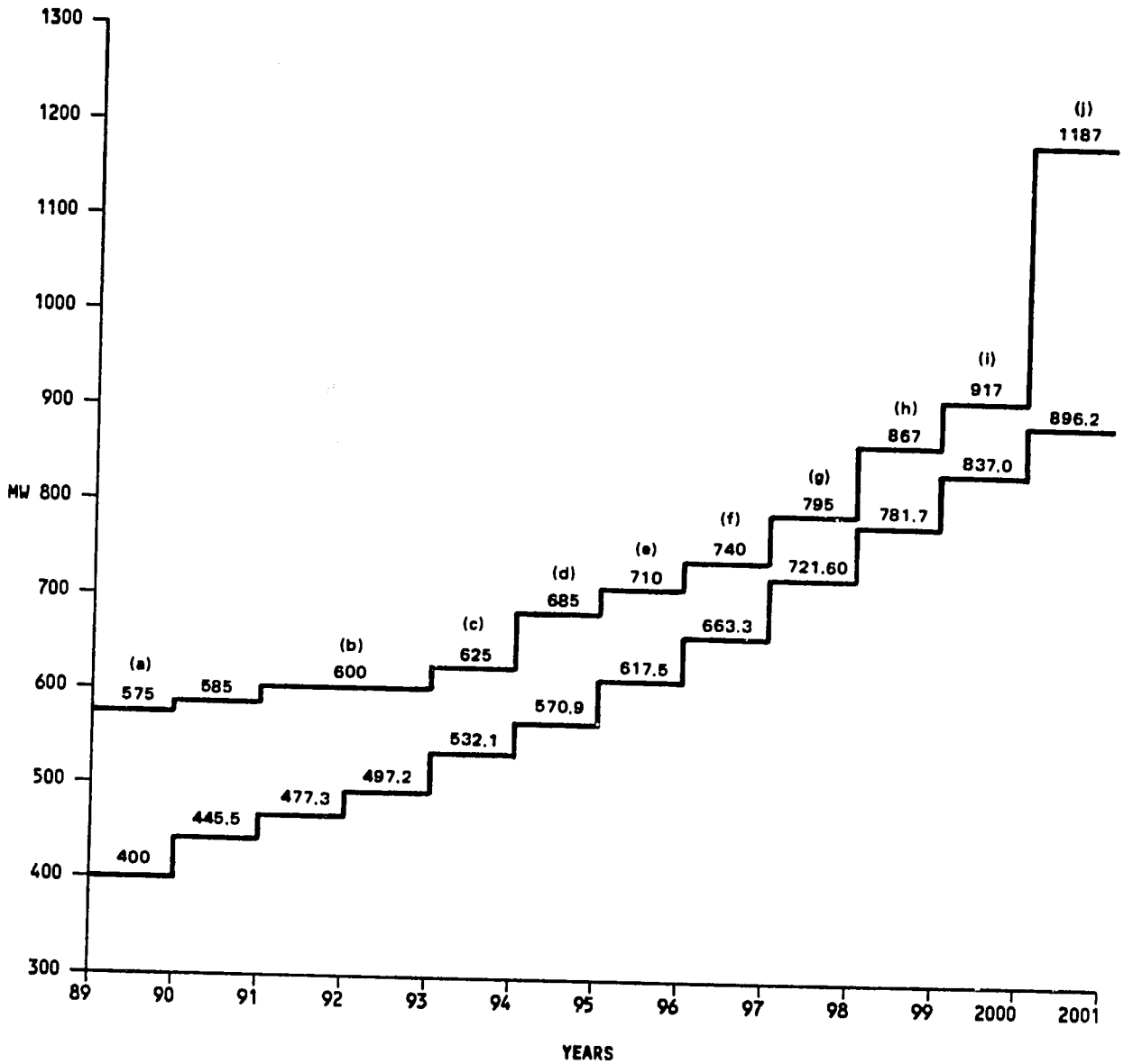
The comments about this plan are as follows:

- The development of geothermal resources contemplated in the Plan is optimistic, and this is the maximum that can be achieved in the period 1988-2000 under favorable conditions.

figure IV.C.2

Figure IV.C.2

PLAN OF EXPANSION 1989-2000, EFFECTIVE CAPACITY/MAXIMUM DEMAND



(a)		B.P. 10 MW	(f) GEOTHERMAL	20 MW	B.P. 10 MW
(b)		B.P. 15 MW	(g) EXP. 5 DE NOV	30 MW GEOTHERMAL	20 MW B.P. 5 MW
(c) GEOTHERMAL	20 MW	B.P. 5 MW	(h) GEOTHERMAL	20 MW SAN MARCOS (2)	52 MW
(d) BUNKER C	50 MW	B.P. 10 MW	(i) BUNKER C	50 MW	
(e) GEOTHERMAL	20 MW	B.P. 5 MW	(j) EL TIGRE	270 MW	

Table IV.C.3

GENERATION EXPANSION 1988-2000

Medium Growth, Average Rainfall - Deferred Hydroelectric Projects

Year	Project	Installed capacity (MW)	Accumulated installed capacity (MW)
1987			641.4
1990	2 wellhead geothermal units of 5MW each in Berlin	10	651.4
1991	3 well-head geothermal units of 5MW each, 2 in Chipilapa and 1 in Berlin	15	
1993	1 wellhead geothermal unit of 5MW in Chipilapa	5	
	1 geothermal plant of 20MW in Berlin	20	691.4
1994	2 wellhead geothermal units of 5MW each in San Vicente	10	
	1 Oil Fired steam unit of 50MW in Acajutla	50	751.4
1995	1 wellhead geothermal plant of 5MW in San Vicente	5	
	1 Geothermal Plant of 20MW in Chipilapa	20	776.4
1996	2 wellhead geothermal units of 5MW each in Coatepeque	10	
	1 Geothermal Plant of 20MW in Berlin	20	806.4
1997	1 wellhead geothermal unit in Coatepeque	5	
	2 Geothermal Plants of 20MW each in Chipilapa and San Vicente	20	
	1 expansion unit 5 de Noviembre of 30 MW	30	861.4
1998	2 hydro units at San Marcos of 26MW each	52	933.4
	1 Central geothermal of 20 MW in San Vicente	20	
1999	1 Oil fired steam unit of 50MW - Cutuco	50	983.4
2000	1 Oil fired steam unit of 50MW - Cutuco	50	1,253.4

Table IV.C.4

ESTIMATED CONSTRUCTION COSTS OF FUTURE PROJECTS
(1986 Cost Levels)

RIVER	PROJECT	COST Local (in millions $)	COST Foreign (in millions $)	COST/kW $
HYDROELECTRICS				
Lempa	Zapotillo	59.6	107.1	1,389
	Paso del Oso	19.2	45.1	1,608
	Expansion 5 Nov.	5.2	69.3	620
	Rehabilitacion 5 nov Expansion	2.7	18.0	1,041
	Cerron Grande	10.6	31.9	315
	San Marcos	41.4	75.1	2,241
	El Tigre	64.8	196.8	484
Paz	El Jobo	83.3	65.9	2,073
	Piedra de Toro	54.9	45.5	1,522
	Arce	29.3	14.5	4,606
Jiboa	Hacienda Viaja	18.3	11.5	2,072
	Santa Rita	38.3	12.4	6,676
	Malancola	16.1	8.9	3,125
	San Jose Loma	17.7	22.0	7,937
Grande de San Juan		31.5	16.2	10,606
San Miguel	San Estaban	97.0	23.3	6,015
	San Jose	22.9	15.1	11,896
Goascoran	El Platanar	125.7	43.7	13,560
GEOTHERMAL				
	20MW Power Plant	14.5	31.7	2,311
	35MW Power Plant	22.6	49.3	2,054
	55MW Power Plant	28.9	87.3	2,112
	5MW Wellhead Units	2.1	3.2	1,076
THERMAL				
	50MW Oil Fuel	15.7	37.0	1,054
	50MW Coal Fuel	27.2	56.0	1,665
	25MW Gas Turbine	1.4	7.4	353
	5MW Bagasse Plant	1.1	4.4	1,099

Source: National Energy Plan 1988 - 2000

- The El Tigre hydro project cannot be built within the decade. A doubling of the 5th of November station (120 Mw) may be considered.

- The result of adding 150 Mw of new thermal capacity will be to increase average generation costs for the system.

- To supply the load under emergency conditions, rapid start units must be added in the near term. This should be considered as a separate addition to the conclusions of the long term expansion plan.

(2) Transmission

Because CEL is currently updating its expansion plans, there are discrepancies between the Transmission system expansion plan and the Generation plan. CEL's 1987 plan is presented here describing the magnitude of the required expansion.

CEL's current plan is summarized in Table IV.C.5. For costs on some of the additions planned refer to Table IV.C.6. These lists are still preliminary.

A brief description of the expected operating results, and some reasons for these additions follow.

To compensate for the loss of the Cerron-Nejapa line, the San Martin-Nejapa line will be added in 1989 to relieve the congestion of the Soyapango-San Martin line. This will allow a direct flow of power from San Martin to Nejapa. Also during 1989, power supply to the eastern region of the country will be improved through the addition of another line between the "15th September" and San Miguel substations. This will give an alternative path to the eastern region when sabotage damages any of the existing lines.

Another standard change for 1989, is to establish a supply limit at the 34 kv level in the Sonsonate substation. This will meet a load increase of 34 kv in Acajutla and avoid overloading the transformer at this point.

Construction of a new transformer station is planned for 1990 in San Bartolo, with a line to connect it with the San Martin substation to cope with the limitations imposed by the loss of the Cerron-Nejapa line. This will relieve the loading on the Soyapango substation and therefore, on the San Martin-Soyapango line by absorbing part of the load of the industrial zone which at present is supplied only by Soyapango.

Another improvement expected for 1990 is the construction of a 46 kv substation to connect the 5 Mw wellhead units of Berlin to the 46kV network originating from the 15th September substation.

Table IV.C.5

EXPANSION OF THE TRANSMISSION SYSTEM
Intermediate Forecast (1987 issue)

1988	-	Cerron Grande-San Martin Line section T98-San Martin, 115 kV, 40 Km.
	-	Modification in San Rafael Cedros substation to connect the 15th September-San Martin line.
	-	Transformer 115/46 kV, 15/20 MVA in Ateos
1989	-	Nejapa-San Martin Line, 115 kV, 17 km.
	-	15th September-San Miguel Line, 115 kV, 50 km.
	-	Transformer 115/34.5 kV, 15 MVA in Sonsonate
1990	-	San Martin-San Bartolo Line, 115 kV, 9 km.
	-	115/23 kV, 50 MVA Substation in San Bartolo
	-	46/4.16 kV, Substation in Berlin
	-	Capacitor Bank in Soyapango, 23 kV: 20 MVAr
	-	Capacitor Bank in San Antonio Abad, 23 kV, 20 MVAr
1991	-	Honduras-El Salvador Interconnection, 230 kV: 15 Septiembre to La Pavana
	-	230/115 kV substation at 15th September for the Honduras-El Salvador interconnection
	-	Second Line of Circuit 15th September-San Martin,115 kV, 60km.
	-	46/4.16 kV Substation in Chipilapa
	-	Connect the El Angel sugar-mill to 23kV system
	-	Connect the Jiboa sugar-mill to 46kV system
1993	-	115 kV Substation, Berlin
	-	Berlin-15th September Line, 115 kV, 20 km.
	-	46/4.16 kV substation in San Vicente
1994	-	Chipilapa Substation 115 kV
	-	Chipilapa-Ahuachapan, 115 kV, 5 km.
	-	46/4.16 kV Substation in Coatepeque
1995	-	115/23 kV, 50 MVA Substation in San Marcos
1996	-	115 kV Substation, San Vicente
1997	-	Coatepeque-Santa Ana Line, 115 kV, 15 km.
	-	Cerron Grande-Nejapa Line, 115 kV, 40 km.
	-	115 kV Substation, Coatepeque
1998	-	El Tigre-15th September Line, 115 kV, 30 km.
	-	El Tigre-San Bartolo Line, 115 kV, 75 km.
	-	El Tigre-Nejapa Line, 115 kV, 85 km.
	-	115 kV Substation, El Tigre.

Table IV.C.6

ELECTRIC TRANSMISSION EXPANSION PLAN 1989-1993
(In Thousand Colones)

Projects	Total Local Currency	Total Foreign Currency	Total Total
Nejapa-San Martin Line	250.00	1,000.00	1,250.00
15 de Septiembre-San Miguel Line	140.00	1,900.00	2,040.00
Expansion Sonsonate Substation	100.00	0.00	100.00
San Martín-San Bartolo Line	1,300.00	1,550.00	2,850.00
San Bartolo Substation	1,500.00	2,500.00	4,000.00
Capacitor Banks Soyapango Substation	270.65	4,054.35	4,325.00
Capacitor Banks San Antonio Abad Substation	320.90	3,585.10	3,906.00
Transformation Capacity Increment in Nuevo Cuscatlán	495.00	6,360.00	6,855.00
Transformation Capacity Increment in Nejapa	385.00	4,740.00	5,125.00
Second Circuit of the "15 de Semptimbre-San Martín" Line	900.00	2,750.00	3,650.00
Horduras-El Salvador Electric Interconnection (Lots 1, 2, 3 and 4)	28,570.75	108,392.95	136,963.70
Berlin-15 de Septiembre Line	9,158.08	0.00	9,158.08
Central America and Panama Interconnection (Line)	44,122.10	132,366.30	176,488.40
Central America and Panama Interconnection (Substation)	37,319.86	111,559.57	148,279.43
Transformation Capacity Increment in San Bartolo	600.00	2,350.00	2,950.00
Chipilapa-Ahuachapán Line	1,003.50	1,268.00	2,271.50
TOTAL	126,165.10	380,921.92	507,087.11

Capacitor banks of 20 MVar capacity each, will be connected to the bus bars at the Soyapango and San Antonio Abad substations. This will help to solve the voltage problems in the metropolitan area, especially when the system is sabotaged.

The ability to install this circuit it will be necessary to continue with posts on the line section between tower 98 and San Martin, to substitute the section used of the second circuit of the 15th September-San Martin line, in the Cerron Grande-San Martin line, and the conductor between tower 98 and the 15th of September.

Also planned for 1990 are two sugar cane bagasse cogeneration units of 5 Mw each. These will be connected to the public system, one from the El Angel plant to the 23 kv system, and the one from Jiboa to the 46 kv system. Also, the two geothermal wellhead units will be connected to the 46kV system.

The first 20 Mw geothermal plant in Berlin is scheduled to begin operations in 1993. A 115 kv substation and the Berlin-15th September line are to connect with the transmission network.

Likewise, the first two wellhead units of San Vicente will be connected to the 46 kv subtransmission system in 1993. In 1994, the 115 kv Chipilapa substation will connect through the Chipilapa-Ahuachapan line. The first 20 Mw unit of this field, the Coatepeque wellhead units, will also be incorporated through a 46/4.16 kv substation.

The construction of another 115/23 kv substation for the metropolitan area is planned for 1995. The substation will be located in San Marcos. The objective being to absorb part of the growth of the Soyapango substation. This will complete a ring around the metropolitan area of San Salvador.

From 1996 onward, the program includes all the lines that will connect the future generation plants scheduled up to the year 2000, to the existing transmission system. Those that will strengthen the system and enable it to transmit this power to the load centers are also included.

It is assumed that the lines damaged by the guerrilla and out of service will be rebuilt by 1996. These are:

- The second circuit the Cerron Grande-Nejapa line
- San Rafael Cedros-Tecoluca line
- The Tecoluca-San Miguel line.

(3) Distribution

(a) National Needs

To match the planned expansion of the energy generation system, a corresponding expansion of capacity of the distribution system should be provided. This will ensure that electricity can flow from the primary substations to the end users.

The total investments for the period 1988-2000 are estimated at $104.3 million dollars, in 1987 dollars. This will be an annual investment of 8.2 million dollars of which 40 percent is local currency costs.

DISCEL has prepared an estimate of investments required for the expansion of the national distribution system during the period 1988-2000. 60 percent of this total should cover the expansion of the CAESS system, especially in the San Salvador area. The remaining 40% will finance the expansion of the rest of the system including the other distribution utilities and the rural electrification network.

These investments would permit the addition to the present system of 10,000 Km of distribution lines, 1,500 km of subtransmission lines, 30 distribution substations, modifications to the existing system, and protection equipment.

Table IV.C.7 shows an estimated disbursement flow for the additions to the distribution system.

(b) The CAESS Distribution System

The system's expansion program up to 1992 will be able to satisfy the demand growth as well as cover the replacement of equipment and the execution of urgent jobs to overcome the present overload situation.

The program consists of the projects detailed below.

- Expansion of the metropolitan area of San Salvador (MASS) network.

- Changes in the Agua Caliente and San Antonio Abad substations that supply the metropolitan area to improve the operational flexibility of the 23 kv system of San Salvador.

- Construction of the San Bartolo substation with a 115 kv/23 kv-30 Mva transformer. This substation is an essential part of the plan to relieve the Agua Caliente substation overload.

table IV.C.7

Table IV.C.7

DISTRIBUTION SYSTEM INVESTMENT PROGRAM
DISBURSEMENTS SYSTEM
(In Thousands Colones)

Year	Catagory	Caess	Remaining	Total
1988	ML	9,334.0	7,070.0	16,404.0
	ME	15,107.0	8,416.5	23,523.5
1989	ML	8,485.5	8,033.0	15,518.5
	ME	13,859.0	9,562.5	23,419.5
1990	ML	8,914.5	7,416.5	16,331.0
	ME	16,382.5	8,828.5	25,211.0
1991	ML	8,198.5	4,689.0	12,887.5
	ME	21,138.5	5,582.0	26,720.5
1992	ML	5,402.0	9,406.5	14,808.5
	ME	13,776.5	11,197.5	24,976.0
1993	ML	10,984.5	7,323.3	18,307.5
	ME	13,076.0	8,717.5	21,793.5
1994	ML	10,984.5	7,323.0	10,307.5
	ME	13,076.0	8,717.5	21,793.5
1995	ML	10,984.5	7,323.0	18,307.5
	ME	13,076.0	8,717.5	21,793.5
1996	ML	10,984.5	7,323.0	18,307.5
	ME	10,076.0	8,717.5	21,793.5
1997	ML	10,984.5	7,323.0	18,307.5
	ME	13,076.0	8,717.5	21,793.5
1998	ML	10,984.5	7,323.0	18,307.5
	ME	13,076.0	8,717.5	21,793.5
1999	ML	10,984.5	7,323.0	18,307.5
	ME	3,076.0	8,717.5	21,793.5
2000	ML	10,984.5	7,323.0	18,307.5
	ME	13,076.0	8,717.5	21,793.5

NOTE: ML = Local ; ME = Foreign

- Conversion of the 4.16 kv network, which suffered damage in the 1986 earthquake to 23 kv. These conversions to higher voltages reduce power losses, voltage drops, and improve the quality of service.

- Expansion of public lighting. This expansion was stopped more than seven years ago and most of the new housing developments lack the service.

- Replacement of the supervisory and remote control system of the network. This will include design, procurement and installation of a new supervisory control system for six of the eight main transformer stations in the metropolitan area.

- Expansion of the Primary System. Due to the widespread overloads, it is proposed to change conductors on part of the distribution system to improve the supply capacity.

- Distribution Transformers will be added to accommodate the projected 70 Mw load increase.

- Replacement of lines.

- Substation equipment replacement. Rehabilitation of the Agua Caliente substation including total refurbishing and a new grounding system. This is the critical substation of the system. The present substation does not meet minimal requirements of reliability, and capacity safety in spite of the fact that it supplies the largest industrial concentration of the country.

- Relocation and remodeling of the Roma Substation. The objective of this project is to transform Roma into a true commutation substation. The present substation was built 29 years ago and will still be used for secondary functions when the Nuevo Cuscatlan substation is built.

- Replacement of transportation, communication, and testing equipment.

- Circuit breaker replacement.

- Replacement of rural transformers.

To meet the situation described above, CAESS has prepared a detailed investment program for the period 1988-1992. This should allow it to attain reliable operational conditions. Investments for the rest of the period were estimated based on the amounts calculated for the first five years.

D. SYSTEM CHARACTERISTICS

1. System Outline

The Salvadoran Power System is a three phase 60 Hz system which operates with a directly grounded neutral.

The 115 kv transmission system is adequate for the present demand. A reasonably modern load dispatching center in San Salvador oversees and controls the operation of all major generating facilities and substations.

Were it not for the disruptions caused by the civil unrest, El Salvador would have an excellent power system according to the standards of a developing country.

2. System Users

The coverage of electricity service is good in the capital, but is patchy in the countryside.

The total number of consumers was 523,000 in 1988. This implies that approximately 60 percent of Salvadoran households had access to electricity services. See Table IV.D.1 showing growth of the number of customers since 1980.

It is remarkable that the electric utilities have been able to connect new users at a rate exceeding 20,000 per year in spite of the unrest. Most of these new connections (15,000 per year) are made by CAESS, and are located mainly in the metropolitan area. Efforts to give service to the countryside have been spearheaded by the AID/NRECA project which is connecting new users at the rate of 5,000 per year.

There are few large industrial users; the largest direct customers of CEL are:

- ANDA, the Water Supply Authority
- Minas San Cristobal
- Agriculture Ministry, TEXPOR S,A.,
- Cemento Maya S.A.,
- CEPA Aeropuerto
- SICEPASA. (a steel mill)

The largest customer of CAESS is ANDA, with a number of pumping stations distributed across its franchise area. Other Government Agencies are responsible for the relatively large consumption figures, but neither these, nor the local industries constitute concentrated loads.

table IV.D.1 to IV.D.3

Table IV.D.1

ELECTRICITY USERS BY CATEGORY

Year	Residen'tal	Comm'cial & M'pal	Indust'l Lighting	Govt	Public	TOTAL
1980	299,364	34,474	6,299	5,013	260	345,410
1981	314,785	36,672	5,149	5,162	262	362,030
1982	329,219	38,774	4,895	5,235	259	378,382
1983	348,004	41,058	4,929	5,301	252	399,544
1984	368,836	43,128	5,031	5,209	255	422,459
1985	391,876	45,414	5,141	5,122	249	447,802
1986	415,285	47,465	5,278	5,105	254	473,387
1987	432,671	48,540	5,447	4,923	252	491,833
1988	462,181	50,385	5,667	5,037	229	523,498

Table IV.D.2

ELECTRIC ENERGY SALES BY USER CATEGORY
(in MWh)

YEARS	RESIDENT'L	COMMERC'L	INDUSTR'L	GOVERNMENT & MUNICIPAL	PUBLIC LIGHTING	TOTAL
1980	383536	177556	515452	155847	25474	1257865
1981	383066	164978	466086	159284	26183	1199597
1982	400146	174305	440490	148728	26731	1190400
1983	436803	192462	465194	180231	27981	1302671
1984	461382	202552	469150	204925	30221	1368230
1985	476916	213144	479587	239716	30247	1439610
1986	511208	223746	471855	254356	30795	1491960
1987	551601	232827	515302	252660	31300	1583690
1988	591805	244511	527041	266026	32280	1661663

Source: CEL Planning Department

Table IV.D.3

NUMBER OF RURAL USERS, CONSUMPTION AND PRICE

YEARS	NO. OF USERS	TOT.CONSUMPTION GWh	Av.PRICE Colones/kWh	Av.CONSUMPTION kWh/User
1980				
1981				
1982	50,167	50.2	0.15	1001
1983	53,460	56.2	0.14	1053
1984	57,020	60.5	0.15	1061
1985	59,685	63.1	0.19	1058
1986	65,848	79.3	0.18	1208
1987	74,842	138.9	0.19	1833

Source: Financial Department, CEL

While the residential and commercial users show a steady increase, the number and consumption of industrial users has shrunk. Refer to Table IV.D.2.

Rural areas have the thinnest coverage, and this is quite understandable because not only are they the most expensive to supply, but they are also the most difficult to develop and service. Nevertheless, expansion of service to several areas has continued. Refer Table IV.D.3 which shows data for the most recent years.

3. Operating Procedures

The mathematical models employed by CEL for the operation of the plants (load management) are described in this section.

The System Dispatching and Control Center (COS), uses the model HYDRO for its long term simulation (one year), the function of this model is to optimize the operation of the Lempa River Hydro Plants, the model is supported by load submodels both for energy and power, from which a load duration curve is derived. Another submodel supports HYDRO by forecasting natural inflows to the reservoirs of the Lempa River.

For week-to-week planning, CEL uses the model SEXTAN which optimizes the combined use of hydro and thermal generation, and which is supported by submodels of short-term load forecast.

Owing to the continuing sabotage activity, planning of plant operations becomes very complicated and normally work is done by way of a daily program based on a calculation sheet.

The COS has acquired the TOP HYDRO model to plan the joint operation of interconnected systems, especially between Guatemala and El Salvador, for a one year period. This model is currently in a testing phase and is the object of analysis and adjustments by technicians of both countries.

COS has several other models for network analysis such as DICOR, developed by the Brazilian utility Electrobras, and the model FLUJOS (FLOW) developed by the University of Arlington.

Finally, a short-circuit model called ZB COR is being used which computes short-circuit currents, and serves to determine the setting of protection equipment.

COS runs very well although its equipment is neither modern or very sophisticated. Its staff is highly qualified and well trained, and copes remarkably well with the many problems of the system.

The Control Center tries to operate with a 10 percent spinning reserve, and whatever other reserve it can make use of. When they lose generation due to sabotage, and when reserve does not suffice

to compensate, they resort to load shedding. This is effective keeping the rest of the system from collapsing but it creates problems for disconnected users.

E. DESIGN STANDARDS

1. Standards

The Salvadoran electricity system is a three phase, 60 Hz system modelled on North American Standards. Accordingly the transmission lines are operated with a directly grounded neutral. Distribution practice follows applicable North American Standards such as:

- three phase feeder lines branch into primary single phase distribution lines

- secondary voltages are single phase 240/120 V.

Rural electrification projects tend to follow REA, standards and practices (Rural Electrification Administration)

While the distribution voltages to retail users are the customary ones in the Americas (120/240 V single phase) a variety of higher voltages are used for transmission.

Larger power generators are generally rated at 13.8 kv and the smaller generators for the geothermal wellhead units are rated at 4.16 kv. The transmission voltages include 34, 46 and 115 kv the latter being the most important.

230 kv has been used for the interconnection with Guatemala, this same voltage will be used for the interconnection with Honduras.

A variety of primary distribution voltages are in use. The metropolitan area (the former CAESS franchise) uses 22 kv. In the rural areas 13.2 kv, 7.6 kv and 4.16 kv are in use

A standardization of voltages and practices across the country is a desirable future goal, but does not carry a high priority at present.

A list of the standards currently used by CEL for design and procurement is attached as Appendix IV.E.1.

2. Construction Standards

Because of the need for fast repairs, it is difficult to maintain international design standards. This is also true for transmission and distribution work, civil works and work on mechanical and electrical equipment.

CEL personnel argue that if international standards were followed rigorously, equipment maintenance and repair costs would be very high. Certain design standards have been adapted with locally made materials in accordance with current realities of the country. This however, has not followed an organized procedure leading to a certain absence of standards today. This theme will be the object of a more detailed analysis when the opportunity arises. The aim will be to study all design standards currently used by CEL and CAESS, the possible modifications that could be made to make them more appropriate to the needs of the country without letting the quality of the service deteriorate. Possible limitations to current modifications should also be analyzed in terms of adequacy to current and future loads and conditions.

3. Maintenance Procedures

The maintenance procedures CEL and CAESS were following before the civil war have been changing as is normal in a situation of conflict like that of El Salvador. During the 1980-1987 period, sabotage to the transmission and distribution system has been increasing (see data in Section on Problem Areas), creating greater immediate needs and hence displacing normal maintenance practices that used to be carried out.

As a result, CEL and CAESS are faced with a situation of "fire-fighting" where they try to replace, in a system continually damaged by guerrillas.

Notwithstanding the above, CEL makes periodic maintenance work on its generating plants, which are in a good functioning condition. It is in the transmission and distribution system where maintenance has been difficult.

F. DEMAND/LOAD FORECAST

Different approaches for forecasting are used in the electricity sector. The general conclusion is that forecasting for the short term, one or two years, traditional methods and yield forecasts with entirely satisfactory results for programming purposes.

Longer term forecasting is in the process of switching from simple extrapolation to the use of a sophisticated mathematical model. This model is in the process of being refined. It will take some time before it is fully operational.

1. Distribution Loads

The main distribution utility, CAESS has traditionally devoted effort to short-term forecasting. This is supported by a regulation which requires that the applications for industrial building permits be accompanied by a declaration of "electrical feasibility", which means the utility has been advised, and is prepared

to supply the power needed for the project. The same applies to the larger residential developments. The commercial department follows up on their own initiative any news or announcement of new building projects. Minor projects and individual applications are treated on a statistical basis, area by area.

This approach yields accurate results over a one to two year period and this is what is needed to provide timely facilities to new customers of moderate size.

Beyond that, CAESS relies on extrapolation of historical trends. During the 1970's, load had grown at an average of 10 percent per year in the metropolitan area. It is expected that the total load growth of the CAESS system will be 10 percent during 1989, and taper off toward the 8.5 percent level by 1994. This would consist of a 9-10 percent growth in the metropolitan area and a 5-6 percent growth in the outlying rural areas which account for 30 percent of the CAESS system.

2. Dispatching

COS has its own method of forecasting for the very short term. Their problem is to schedule the availability of their facilities to meet the demand on an hourly, daily, weekly or at most yearly basis. This is done by extrapolating for up to one year the loads of the last three years. A mathematical model based on moving averages produces quite accurate results.

The effects of sabotage are treated as a random exogenous variable, again based on past experience.

3. Long Term

a. Macroeconomic Model Development

A sophisticated mathematical model was set up in 1986-87. It takes a macroeconomic approach to the whole energy field and produces as part of it the electrical demand forecasts. The model is operated by PLANICEL. Its results have not been too precise as yet, and the parameters are still being refined and improved.

The only results available are from of the first runs made in 1987. These are still being used by CEL, with corrections for recent experience. The next complete run is expected to be available during the first half of 1990. The algorithms used to forecast the demand of the different user categories are based on the following relationships.

Residential Consumption	= f	(last year's consumption, Nº connections, real disposable income/ connection, real price, urbanization index)
Commercial Consumption	= f	8(last year's consumption/ connection, sector GDP/Nº connections, real price, urbanization index)
Industrial Consumption	= f	(real industrial GDP)
Government Consumption	= f	(last year's consumption, real GDP - public admin., last year's urbanization index)

Agriculture assumes very fast technological change

This forecast deals only with the country as a whole, and does not break it down by district or by supply point. In sum, the long term forecasting method is still at the experimental stage and an evaluation of its adequacy will have to be postponed until some experience is gained with its actual performance. According to CEL, prices used in the demand forecasts from 1991 onwards reflect those that would cover production, transmission and distribution costs.

The methods and criteria used for planning future system expansion are those of the WASP III model, presented in Appendix IV.C.1.

b. Current Forecasts

The forecast being used by CEL for future loads and required resources include three scenarios of load growth; optimistic, intermediate and pessimistic. Hereafter, these will be referred to as the low, medium and high. Figures IV.F.1 and 2 compare historical and forecasted kWh consumption and the gross domestic product data underlying the National Energy Plan (NEP) electricity projection.

A comparison of growth rates is given in the following table:

Year	Historical	Energy Low	Energy Medium	Energy High	Peak Low	Peak Medium	Peak High
1970 - 1978	10.12	-	-	-	-	-	-
1979 - 1988	2.66	-	-	-	-	-	-
1987 - 1992	-	4.97	6.68	8.37	5.46	7.17	8.86
1993 - 2000	-	6.19	7.45	8.64	6.19	7.45	8.64

This data shows that the NEP forecast predicts robust growth for the power sector in all scenarios. No recession is foreseen. However, projected GDP is lower than the actual data for years where this comparison is valid.

The detail of user categories for the medium forecast is shown in Table IV.F.3. The NEP has forecast the fastest growth rate for the residential sector. This may partially explain why peak requirements are expected to grow at a higher rate than energy, as the residential class typically has a lower load factor.

figure IV.F.1

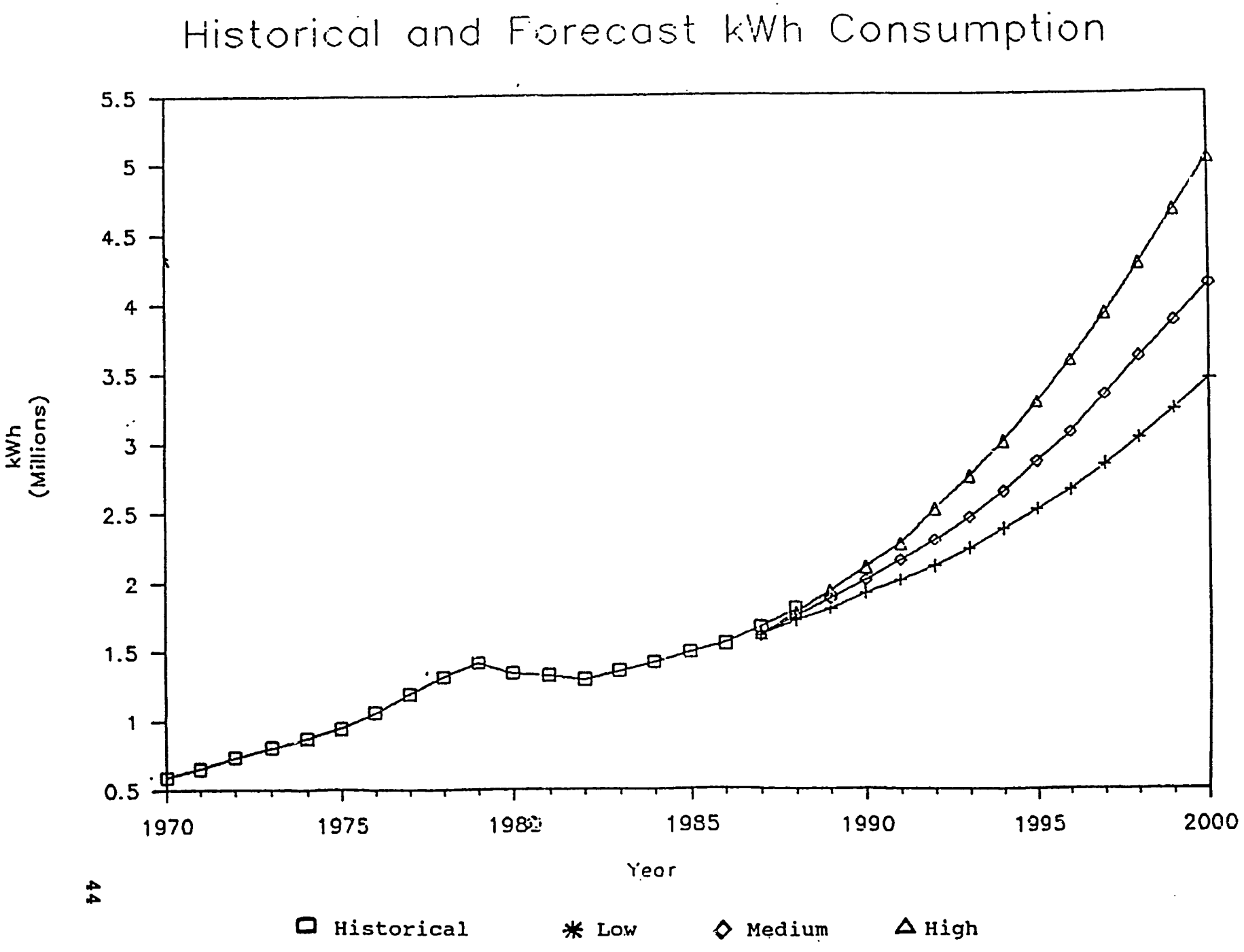

Historical and Forecast kWh Consumption
kWh (Millions)
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
1970
1975
1980
1985
1990
1995
2000
Year
Historical
Low
Medium
High

figure IV.F.2

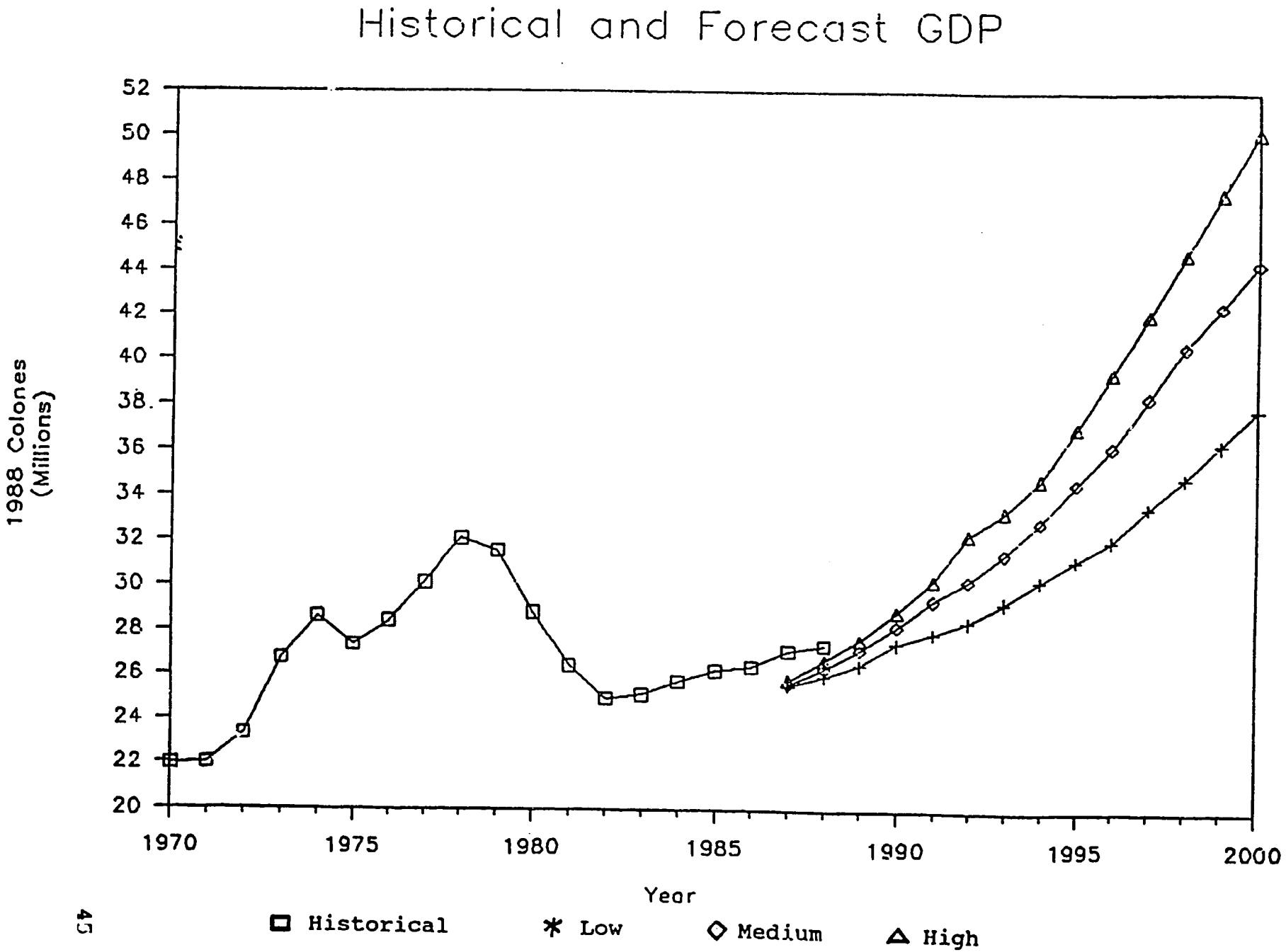

Historical and Forecast GDP
1988 Colones (Millions)
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
1970
1975
1980
1985
1990
1995
2000
Year
Historical
Low
Medium
High

Table IV.F.3

1989-2000 FORECAST OF ELECTRIC ENERGY CONSUMPTION BY USER CATEGORIES

Year	Residential Gwh	Residential %	Commercial Gwh	Commercial %	Industrial Gwh	Industrial %	Government Gwh	Government %	TOTAL Gwh	TOTAL %
1987	552.0	34.5	250.0	15.6	497.0	31.0	304.0	19.0	1,603.0	100.0
1988	603.0	34.5	283.0	16.2	538.0	30.8	323.0	18.5	1,747.0	100.0
1989	653.0	34.9	307.0	16.4	569.0	30.4	340.0	18.2	1,869.0	100.0
1990	712.0	35.5	328.0	16.3	607.0	30.3	359.0	17.9	2,006.0	100.0
1991	775.0	36.1	345.0	16.1	649.0	30.2	380.0	17.7	2,149.0	100.0
1992	845.0	36.8	373.0	16.2	681.0	29.7	395.0	17.2	2,294.0	100.0
1993	924.0	37.6	402.0	16.4	716.0	29.1	413.0	16.8	2,455.0	100.0
1994	1,012.0	38.4	436.0	16.6	754.0	28.6	433.0	16.4	2,635.0	100.0
1995	1,115.0	39.1	474.0	16.6	802.0	28.1	459.0	16.1	2,850.0	100.0
1996	1,222.0	39.9	511.0	16.7	844.0	27.6	484.0	15.8	3,061.0	100.0
1997	1,349.0	40.5	551.0	16.6	910.0	27.3	520.0	15.6	3,330.0	100.0
1998	1,483.0	41.1	598.0	16.6	971.0	26.9	555.0	15.4	3,607.0	100.0
1999	1,617.0	41.9	638.0	16.5	1,019.0	26.4	588.0	15.2	3,862.0	100.0
2000	1,760.0	42.6	679.0	16.4	1,072.0	25.9	625.0	15.1	4,136.0	100.0
RATE (%) 1987-2000	8.9	AVER 38.1	7.7	AVER 16.4	5.9	AVER 28.7	5.6	AVER 16.8	7.3	AVER 100.0

Due to the continuing political uncertainties and significantly higher forecast growth rates than those in recent history, the low forecast was used in the near term (1989-1993) and medium forecast growth rates thereafter for ISA resource planning.

Plans from the private sector, that could affect the future demand for electricity do not exist - at least not in official form. The new government is still reviewing and analyzing the prospects for the national economy. Proposals and discussions have taken place on "industrial free trade zones" and on irrigation schemes. An industrial free trade zone exists in the S. Bartolo suburb of San Salvador and an expansion which might add 6 - 8 Mw of load is being considered. A privately sponsored free zone is being designed near the Comalapa Airport. Its initial load would be 10 - 12 Mw, to reach 20 - 25 Mw after 10 years. Two smaller free zones are proposed, one in Acajutla and one in San Rosa de Lima near La Unión. A well-fed irrigation project has been proposed south of Comalapa with a pumping load of 700 kw, and two or three similar projects may follow.

c. "Load Resource" Balance

Table IV.F.4 and Figure IV.F.5 compare the National Energy Plan load forecasts with resources that are currently available or will come on line in the immediate future. Energy losses and a 10 percent peak reserve are included in the requirements data.

G. OPERATION AND MAINTENANCE COSTS

1. Historical Costs

Table IV.G.1. represents the total operation and maintenance costs of CEL from 1980-1988, divided into direct production costs, costs of fuel used for thermal generation, transmission, distribution costs for the rural electrification, and general administrative costs. Note that the latter expenses have increased since 1984, due to the security costs which include the measures adopted for the protection of CEL installations.

Table IV.G.1

HISTORICAL OPERATION AND MAINTENANCE COSTS
(In Thousands of Colones)

	1980	1981	1982	1983	1984	1985	1986	1987	1988
Direct Prod'n	11.5	15.9	16.9	15.4	18.4	20.7	33.7	36.0	45.0
Fuel	2.5	11.6	16.3	12.8	14.6	26.8	23.5	53.3	41.4
Transmission	5.8	8.6	9.3	9.3	7.0	8.6	10.0	10.8	14.8
Distribution	3.0	4.1	4.3	4.0	4.6	5.3	7.0	8.3	11.1
Administration and General	10.3	15.2	17.2	21.3	32.4	42.0	62.2	66.1	66.0
Sub-Total	33.1	55.4	64.0	62.8	77.0	103.4	136.4	174.5	178.3
Depreciation	18.5	21.9	22.0	25.1	38.8	40.8	60.2	61.2	64.4
TOTALS	51.6	77.3	86.0	87.9	115.8	144.2	196.6	235.7	242.7

Source: Balance Sheets

Since 1984, expenses for electrical operations service, institutional safety and allowances for doubtful accounts are included. Power purchases from the Guatemalan interconnection are included from 1986.

When new plants were incorporated, depreciation costs increased considerably. Note that the 15th Septiembre Hydro Plant entered operation in 1983-1984.

Fuel costs are another item that has increased considerably in recent years, as sabotage to the transmission system has forced CEL to use its thermal plants and also to start up oil-fired emergency units.

TABLE IV.F.4

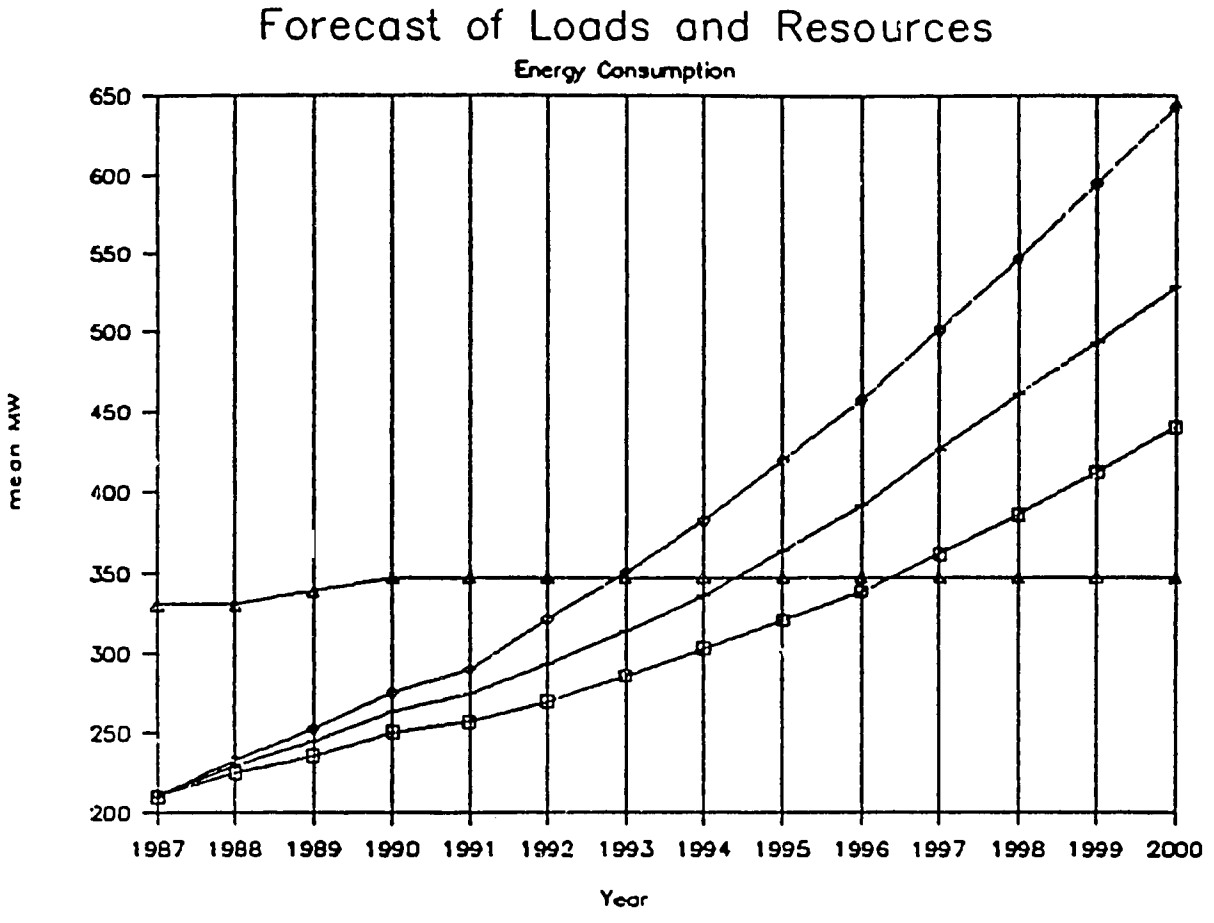
LOAD RESOURCES BALANCES

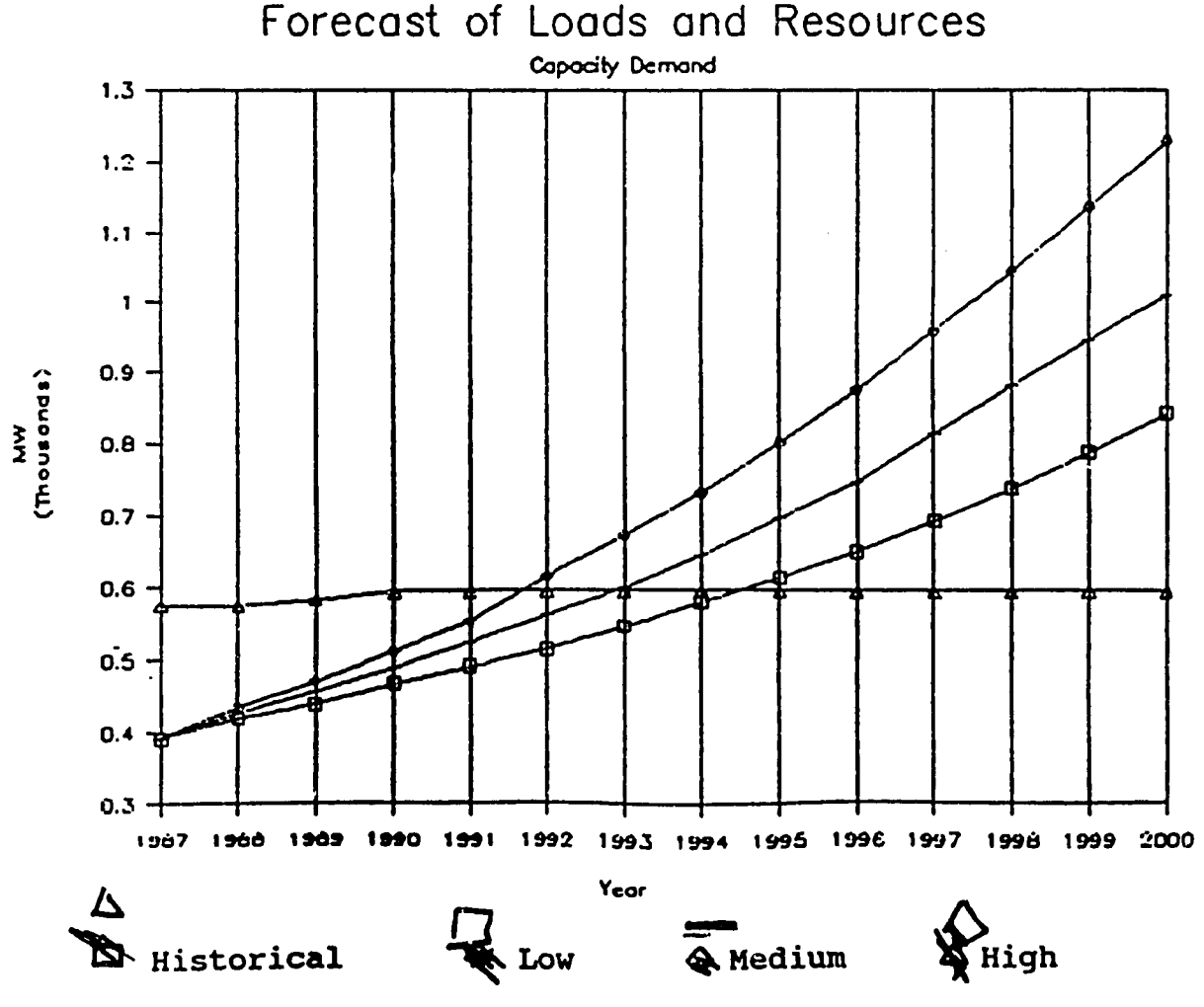
MEAN MW CONSUMED

YEAR	Requirements LOW	Requirements MEDIUM	Requirements HIGH	Resources	Surplus or Deficit LOW	Surplus or Deficit MEDIUM	Surplus or Deficit HIGH
1987	210	210	212	331	121	121	119
1988	225	229	233	331	106	102	98
1989	236	245	253	340	103	94	87
1990	251	263	275	348	97	85	73
1991	257	275	290	348	91	73	58
1992	269	293	322	348	79	55	26
1993	286	314	351	348	62	34	(3)
1994	303	337	383	348	45	11	(35)
1995	321	364	419	348	27	(16)	(71)
1996	339	391	458	348	9	(43)	(110)
1997	362	426	501	348	(14)	(78)	(153)
1998	386	461	547	348	(38)	(113)	(199)
1999	412	494	595	348	(64)	(146)	(247)
2000	440	529	643	348	(92)	(181)	(295)
CAPACITY MW DEMANDED							
1987	392	392	395	575	183	183	180
1988	419	427	434	575	156	148	1141
1989	440	457	471	585	145	128	114
1990	467	490	512	595	128	105	83
1991	490	525	554	595	105	70	41
1992	515	561	615	595	80	34	(20)
1993	546	600	671	595	49	(5)	(76)
1994	579	644	731	595	16	(49)	(136)
1995	613	696	801	595	(18)	(101)	(206)
1996	628	748	875	595	(53)	(153)	(280)
1997	692	814	957	595	(97)	(219)	(362)
1998	738	881	1,045	595	(143)	(286)	(450)
1999	788	944	1,137	595	(193)	(349)	(542)
2000	842	1,011	1,229	595	(247)	(416)	(634)

SOURCE : National Energy Plan and ISA Consultants

FIGURE IV.F.5


Forecast of Loads and Resources
Energy Consumption
mean MW
650
600
550
500
450
400
350
300
250
200
1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
Year


Forecast of Loads and Resources
Capacity Demand
MW (Thousands)
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
Year
Historical
Low
Medium
High

2. Updated Costs

The most recent available records for determining the operation and maintenance cost have been used, that is, those of CEL for production and distribution, and those of CAESS for distribution facilities. Due to the unsettled conditions in El Salvador the resulting numbersare to be used with caution, since as conditions change and hopefully normalize, the unit costs will reflect such changes.

Production costs are heavily dependent upon the cost of depreciation, because electrical facilities are highly capital intensive. Depreciation costs are not included because the allowance for depreciation has been inadequate for years. Asset book values reflect mostly the historical cost in Colones. Little revaluation of assets has taken place. Since there has been a high rate of inflation over the last ten years, assets are greatly undervalued and no precise estimates have been obtained. Asset values, however, should probably be increased by two to five times depending on the asset.

Additionally, historical data may understate maintenance costs because this work has been insufficient to keep the facilities in good condition and interim replacement of components has been neglected due to lack of funds. Finally a substantial amount of "general expenditures" are incurred in the operation of an electric utility; how these general costs are to be allocated between the various facilities is a question of accounting conventions. Nevertheless the costs are real and should be considered.

Tables below report the unit costs of operation and maintenance only, as reflected in CEL's and CAESS' unaudited accounts. Table IV.G.2 presents a comparison of operation and maintenance costs by facility type (hydro, thermal, geothermal) for existing and proposed facilities.

Thermal plants are by far the most costly to operate for both existing and proposed projects. Clearly, this is due to the cost of fuel required for operation. Hydroelectric plants, however, are the least expensive.

These estimates of O&M costs are further broken down by operating generating plant in Table IV.G.3 and by distribution facility (urban and rural) in Table IV.G.4.

Table IV.G.2

FORECAST OPERATION AND MAINTENANCE COSTS
1988 Colones

Existing Projects			
Project Type	Operation and Maint.	Mwh Generation	Cost/Mwh
Hydro	17,421,800	1,302,300	13,378
Thermal	53,956,800	249,100	216.607
Geothermal	7,153,100	430,000	16,635
Proposed Projects			
Project Type	Operation and Maint.	Mwh Generation	Cost/Mwh
Hydro	26,835,000	1,806,137	14.885
Thermal	100,710,000	735,840	136.8[illegible]
Geothermal	16,149,000	245,200	54.675
Proposed Projects (Detail)			
San Marcos Hydro	8,020,000	268,757	29.841
El Tigre	16,365,000	1,300,860	12.580
Cerron Grande	2,500,000	236,520	10.570
Jet Fuel Turbine	20,655,000	70,080	294.735
Oil Fired Steam	47,835,000	350,400	136.515
Slow Speed Diesel	32,220,000	315,360	102.169
Central Geothermal	11,275,000	229,500	49.129
Wellhead Geothermal	4,865,000	65,700	74.049

Source: CEL

Table IV.G.3

OPERATION AND MAINTENANCE COSTS OF GENERATING PLANTS
(CEC 1988)

	O&M Cost Million Colones	Available Capacity MW	O&M Cost US Dollars per KW-Year
Hydro Plants			
Guajoyo	2.02	15	26.90
Cerron Grande	4.20	135	6.20
5 Noviembre	3.03	70	8.65
15 Septiembre	2.92	156	3.75
Geothermal Plant			
(Ahuachapau)	6.18	54	22.90
Steam Plant			
(Acajutla)	6.76	58	23.30
Gas Turbine Plants			
Soyapango	4.52	26	34.75
S. Miguel	0.97	18	10.75

Source: CEL

Table IV.G.4

OPERATION AND MAINTENANCE COSTS OF DISTRIBUTION FACILITIES (RESIDENTIAL AND GENERAL USERS)

	O&M Cost Million Colones	Available Capacity MW	O&M Cost US Dollars per KW-Year
Urban distribution	15.5	355.161	$17.47
Rural distribution	14.10	89.774	$31.40

Source: CEL and CAESS

3. Inputs to Project Estimates

Two points are especially important in the comparison between existing and proposed projects. There has been a large increase in cost/Mwh for geothermal and decrease for thermal projects. These conclusions are still valid in spite of the qualifying circumstances relevant to the data mentioned earlier.

Fuel costs for 1988 were used for both existing and proposed thermal facilities. Therefore the differences cannot be explained by fuel prices. This implies that CEL could come to realize significant operation and maintenance cost savings per thermal Mwh by replacing old plants with more efficient newer plants.

Among proposed thermal plants, slow speed diesel is the most efficient with respect to operation and maintenance costs. Slow speed diesel costs are 47 percent less than the average existing thermal plant.

H. CONSTRUCTION AND INSTALLATION COSTS

1. General

The following should be observed when using data for cost estimating purposes.

All the data should be considered as engineering estimates, which are subject to the considerable limitations stemming from the conditions which prevail in Salvador at this time. Uncertainty about exchange rates, inflation and cost levels, and about working conditions make it unlikely that a better accuracy than plus/minus 30 percent can be achieved at the estimating level. Therefore the

data can be of use mainly for screening studies, rather than for forecasting actual outlays. For this latter purpose, contractor type estimates should be prepared when a project is reasonably well defined.

This said, a further distinction should be made between costs which are for site specific projects and those which are of more general application.

The costs for transmission and distribution lines are based on recent experience and can be relied upon to be representative of local circumstances because the terrain configuration does not vary greatly in Salvador and is comparable to that of neighboring countries. The records of CEL and other utilities are used and commented upon. For other items which have not been built for some time in El Salvador, such as 230 kv transmission lines, estimates prepared for other countries are adapted. However, construction times and costs are far more vulnerable to sabotage or insecurity in the countryside than those of a thermal plant.

The costs for thermal generating plants, steam, diesel, and gas turbines are only moderately influenced by the choice of the site, and can be compared with those in other countries. Therefore the data can be used with some degree of confidence.

The costs of both hydro plants and of geothermal plants are highly site specific; accurate information about the geological conditions is necessary to achieve an acceptable degree of accuracy, and such information does not seem to be available in many cases. The current conditions of insecurity would not only make it impossible to estimate costs and schedules, but may even prevent construction from being completed at all while these conditions continue. Thus preparing estimates for this type of facility is akin to an academic exercise at this time.

2. Standard Transmission Lines

The transmission voltages used in El Salvador are 115 kv for the trunk lines, and 46 kv for the subtransmission lines. Sections at both voltages have been built by CEL in recent years.

The 115 kv lines have been built using conventional H structures with wooden poles utilizing spans of 200 m. This design is dictated by the ever present danger of sabotage; a wooden H structure is much easier to replace than a latticed steel tower even if the latter allows 300 m spans.

The 46 kv lines are customarily built using centrifuged concrete poles manufactured in the country with steel crossarms. A single conductor 477 MCM ACSR is used as standard.

The construction costs recorded by CEL are:

UNIT COSTS PER KILOMETER OF THREE PHASE LINE

Line Voltage	Foreign Currency	Local Currency	Total Cost
115 Kv wood pole	26,000	11,000	37,000
46 Kv concrete pole	4,500	17,000	21,500

For future reference it would be advisable to review the construction costs of other types of transmission line.

With a view towards reconstruction of the system in a peacetime economy, the 115 kv lines should be checked to determine if heavy duty treatment of wooden poles, or other systems of preventing deterioration, can make the wood pole design competitive with concrete poles or with steel towers over a 30-year horizon.

For the 46 kv subtransmission lines, a wooden pole alternative should be considered because not all of the subtransmission lines need to last 40 years. Load growth may force their replacement by 115 kv lines well before their useful life is at an end.

3. Steel Tower Transmission Lines

The interconnection with Honduras will be built using conventional steel towers for the transmission lines. When the time comes to rebuild the Salvadoran transmission system for the long term (without having to expect to replace structures due to sabotage) steel tower designs will be the first choice.

For transmission line sections carrying high Mw loads, such as the Cerron Grande-Nejapa section, a choice will be made between 230 kv and two 115 kv lines. Therefore the data for those alternatives designs are reported here.

UNIT COST PER KILOMETER OF THREE PHASE LINE

Line Voltage and Circuits	Foreign Currency	Local Currency	Total Cost
230 kv single circuit	$78,000	$17,500	$95,500
115 kv single circuit	$56,000	$17,000	$73,000

4. Distribution Lines

Presently, the majority of distribution lines built by CEL are 13.2 kv using concrete poles. CAESS has traditionally used 23 kv lines, with little difference in cost.

The table below reports the standard construction cost estimates used by CEL.

UNIT COSTS PER KILOMETER

Distribution Line	Foreign Currency	Local Currency	Total Cost
Threephase, 13.2 kV	$2,400	$8,200	$10,600
Singlephase, 13.2kV	$1,200	$6,800	$ 8,000

The distribution line costs appear high, possibly due to the cost of concrete poles and their hardware. Its cost breakdown should be reviewed in comparison with a wooden pole design.

5. Generating Facilities

Cost estimates for hydroelectric projects are extrapolated from prefeasibility survey estimates made ten or more years ago. Consequently, they are indicators rather than estimates.

The figures for the three main projects are reported below.

PROJECT ESTIMATES
(in millions of US$ equivalent)

Hydro Project	Foreign Currency	Local Currency	Total Cost
Expansion of Cerron Grande, 135 Mw	32.0	11.0	43.0
San Marcos, 52 Mw	76.0	42.0	118.0
El Tigre, 210 Mw	180.0	80.0	260.0

While the Cerron Grande and the San Marcos estimates appear reasonable, the estimates for El Tigre are low.

Estimates prepared by GEOCEL for Geothermal Facilities are reported below. They have been carefully updated and are probably quite reliable as to equipment cost. The well drilling costs are subject to uncertainties as some wells may not be as productive as expected.

PROJECT ESTIMATES
(in millions of US$ dollars)

Geothermal Project	Foreign Currency	Local Currency	Total Cost
Two 5 Mw Wellhead Units	17	6	23
30 Mw Unit at Berlin	50	23	73

Recent experience and estimates for thermal generating plants prepared for other countries in the Caribbean have been used as a reference. Since the costs of these plants consist to a large extent in equipment, they are not very dependent on local conditions. The estimated costs proposed are:

PROJECT COSTS
(in millions of US$ dollars)

Thermal Plant	Foreign Currency	Local Currency	Total Cost
50 Mw Oil Fired Steam Plant	52.0	14.0	65.0
40 Mw Slow Speed Diesel Plant	49.0	11.0	60.0
20 Mw Gas Turbines	7.5	1.5	9.0

I. FINANCIAL POSITION

1. Overall Description

Table IV.I.1 and IV.I.2 show a comparison of CEL's balance sheets and income statements from 1978 to 1988.

These tables show the following:

During this period operating expenditures increased by 19 percent per year from 26 million Colones to 178 million, while operating revenue increased by only 12 percent per year from 106 million Colones to 349 million. As a result, the operating margin (revenues-expenses/revenues) decreased from 76 percent to 49 percent.

In nominal terms, operating income (revenue-expenses) increased from 80.5 million Colones to 170.5 million. However, when operating income is adjusted for inflation, 1988 income was only 32.3 million in 1978 Colones. Therefore, operating income fell by 60 percent in real terms from 1978 to 1988.

In 1986 and 1987, CEL's net margin was not enough to cover depreciation and interest payments. In 1988 net margin was just above these expenses. This implies that in the last 3 years CEL had to rely on increased debt to support its necessary investment expenditures. The utility showed a surplus from 1978 to 85 but, due to the devaluation, fell into a loss position in 1986-88. See Graph IV.I.3. and Table IV.I.4.

Following the devaluation of the colon, in effect doubling CEL's foreign debt, in 1986, interest payments increased from C 66 million to C 144.9 million No tariff adjustment was made in this period.

Besides the devaluation, CEL's receivables from electricity sales increased from C 25.4 million in 1983 to C 173.2 million in 1988. See graph IV.I.5. Most of these are owed by the electricity distribution companies which are to be absorbed by CEL, probably without cash; by ANDA which is in an even more difficult financial situation; and by Cemento Maya owned by the government. Note that the payment delay by customers increased from 55 days in 1978 to 203 days last year.

CEL's capital structure is burdened by a heavy debt component. Based on the ratios in Appendix IV.I.1, CEL's debt service is 40 percent above its debt service limit. The large proportion of debt to equity (63 percent to 37 percent) also increases the required rate of return because the average cost of debt is greater than equity.

CEL's own capacity to improve its financial position is very limited. The deficit problem could be improved by increasing revenue, reducing costs, or both. However, the company must plan investments 5 to 10 years in advance to satisfy the increase in demand. Reducing investment costs would risk the future supply of power.

It may be possible to reduce administrative expenses, but budget analysis shows this will not have a significant impact on results. In addition CEL's number of staff per customer served is quite low in comparison to other utilities in the world. If systematic attacks on installations cease, costs will be reduced, but much of the resources used to repair damaged installations comes from budgets for routine and periodic maintenance. (Graph IV.I.6.) Meanwhile research and development investments have been cut drastically. See graph IV.I.7.

On the income side, tariffs are fixed by the Ministry of Economics and tariff adjustments are analysed in the context of the global economic situation. Because of this added political element of revenue adjustment, CEL's ability to adjust its tariffs is limited. See Volume I - Institutional Aspects.

TABLE IV.I.1

COMPARED BALANCE SHEETS FOR YEARS 1978 -1988 (in millions of Colones)

C O S T S	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
PHYSICAL ASSETS	645.9	743.8	885.7	1,055.6	1,194.3	1,330.3	1,340.6	1,338.9	2,057.7	2,045.4	2,091.2
Goods & Installations in Service	651.1	655.9	738.6	742.9	793.5	1,414.2	1,502.9	1,512.7	1,607.9	1,691.3	1,737.0
Revaluation of Assets due to Devaluation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	685.9	684.7	687.9
LESS Accumulated Depreciation	90.4	108.0	126.4	148.6	170.4	195.2	234.0	273.5	335.4	390.5	450.1
	560.7	548.0	612.2	594.3	623.1	1,219.5	1,268.9	1,239.2	1,953.4	1,985.5	1,974.8
Construction Work in Progress	85.1	195.9	273.5	461.3	571.7	110.8	71.7	99.7	99.3	59.9	116.5
INVESTMENTS AND FUNDS	8.4	9.6	10.1	9.3	9.1	8.9	8.7	8.2	7.7	7.6	7.4
Other Properties	8.1	8.8	9.4	8.6	8.6	8.6	8.4	8.0	7.5	7.5	7.3
Investments in Associated Companies	0.3	0.8	0.7	0.7	0.5	0.3	0.3	0.2	0.2	0.1	0.1
Special Funds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CURRENT ASSETS	45.8	75.4	76.8	68.1	84.5	141.5	141.8	159.0	233.6	256.6	311.7
Cash at Bank	8.4	10.1	7.8	14.7	8.4	22.4	9.2	15.3	30.7	42.5	88.2
Special Deposits	0.7	0.2	0.4	0.5	0.1	0.5	0.0	0.1	3.5	0.4	0.5
Short Term Investments at Bank	0.4	1.0	0.7	0.2	0.2	0.5	0.9	3.6	5.0	4.3	1.9
Redeemable Funds	7.0	6.3	0.5	0.5	2.6	0.3	0.0	26.3	0.3	0.0	0.0
Accounts Recievable - Electricity (net)	16.1	23.9	39.2	28.6	26.5	25.4	98.4	80.3	122.3	155.6	173.2
Accounts Recievable - Hydro carbons	0.0	0.0	0.0	0.0	26.8	46.6	0.0	23.9	59.1	34.1	6.3
Accounts Receivable - Other (net)	13.1	33.7	2.6	2.6	2.7	3.9	0.0	7.3	10.2	18.2	26.0
Prepaid Expenses	0.2	0.2	0.2	0.3	0.5	0.7	0.6	0.9	1.5	1.3	12.1
Advance Payments - Contractors (short term)	0.0	0.0	25.4	20.9	16.7	9.1	2.9	1.4	1.1	0.2	1.6
Accumulated Assets	0.0	0.0	0.0	0.0	0.0	32.0	29.7	0.0	0.0	0.0	0.0
OTHER ASSETS	45.3	62.1	73.5	95.1	110.6	102.6	144.2	104.0	121.3	171.6	155.0
Warehouse Stocks	17.6	20.4	23.1	27.5	29.6	27.8	29.5	28.0	51.6	80.3	123.1
Discount and Debt Expenses	1.6	1.8	0.7	0.1	6.8	0.0	0.0	0.0	0.0	0.0	0.0
Research and Development	21.5	37.0	48.0	52.4	54.5	56.3	57.6	60.6	64.8	68.7	17.1
Special Accounts Receivable	0.0	0.0	0.0	14.2	16.8	16.9	17.4	12.3	4.5	6.2	5.0
Working Orders	0.2	0.6	0.5	0.1	2.2	0.6	0.6	1.1	0.1	0.0	0.0
Other Assets	4.5	3.5	1.1	0.9	0.8	0.9	39.1	2.0	0.3	16.3	9.8
TOTAL ASSETS	745.3	890.8	1,046.1	1,228.2	1,399.0	1,583.3	1,635.3	1,640.0	2,420.3	2,481.2	2,565.3

TABLE IV.1.1

COMPARED BALANCE SHEETS FOR YEARS 1978 -1988 (in millions of Colones)

COSTS	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
LIABILITIES & EQUITY	289.9	349.5	408.2	448.9	499.5	594.6	619.7	648.3	630.2	602.7	640.6
Capital	33.0	34.5	35.2	39.4	45.1	47.6	45.7	47.6	81.3	85.1	157.8
Generated Equity	213.1	243.8	292.3	303.0	302.1	270.7	395.4	357.5	408.1	362.0	327.8
Current Year Results	35.8	58.0	58.0	36.6	44.8	157.5	23.2	32.0	-42.7	-31.2	-34.9
Surplus from Donations	0.0	0.0	0.0	0.0	0.0	0.0	4.1	4.1	4.1	4.1	4.1
Funds from Extraordinary Donations	9.0	12.5	22.1	69.4	106.6	138.3	151.0	166.7	179.3	182.7	185.7
Investment Valuation Adjustment	0.0	0.7	0.6	0.6	0.4	0.2	0.2	0.1	0.1	0.0	0.0
LONG TERM LIABILITIES	391.0	468.7	543.5	647.6	710.9	799.6	768.4	752.6	1,293.0	1,184.2	1,099.7
Certificates	128.4	120.0	109.0	97.0	84.0	76.0	67.0	57.0	47.0	37.0	27.0
Loans - State	141.3	204.5	244.7	336.2	399.0	482.9	24.0	57.8	46.8	35.9	54.0
Loans - State Subsiduaries	0.0	0.0	0.0	0.0	0.0	0.0	452.3	426.6	399.5	371.4	341.4
Loans - Int'nal Financial Institutions	92.7	116.6	124.4	135.4	128.9	124.0	208.9	198.8	198.3	183.5	173.5
Other Long Term Debt	28.7	27.6	65.4	79.1	98.9	116.6	16.2	12.4	7.9	4.1	2.5
Revaluation of Liabilities for Devaluation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	593.4	547.4	501.3
CURRENT LIABILITIES	60.6	69.3	93.5	131.4	188.0	188.3	192.6	192.3	404.0	512.4	512.9
Current Long Term Debt	14.7	22.8	31.9	40.7	48.5	44.0	61.5	81.4	90.3	107.7	124.3
Short Term Debt	36.7	38.2	37.9	73.9	78.4	81.0	67.5	20.1	56.1	113.0	79.9
Interest & Commissions Payable	7.2	7.8	13.6	13.9	25.0	18.9	21.3	32.1	76.8	101.9	113.5
Supplies & Services Payable	0.0	0.0	0.0	0.0	0.0	0.0	3.5	8.0	28.2	25.2	37.5
Hydrocarbon Suppliers	0.0	0.0	0.0	0.0	25.2	38.7	37.9	20.3	38.8	25.9	22.6
Renumeration Payable	0.2	0.3	0.5	0.5	0.9	0.6	0.6	0.9	0.6	1.2	0.7
Withholdings Payable	1.9	0.1	9.6	2.5	10.0	5.1	0.2	10.8	0.8	0.9	0.7
Provisions Payable	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.8	52.7	63.9	52.9
Short Term Liabilities- Reval.for Devaluation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	59.8	72.5	80.9
OTHER LIABLILTIES	3.7	3.3	0.9	0.1	0.9	0.9	54.6	16.9	93.2	181.9	312.1
Contingent Liabilities	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.2	83.1	175.6	304.3
Other Accounts Payable	0.0	0.0	0.8	0.0	0.0	0.0	2.2	13.2	5.8	3.0	2.8
Creditors to be assigned	3.7	3.3	0.1	0.1	0.9	0.9	52.1	2.5	4.3	3.3	5.0
TOTAL EQUITY & LIABILITIES	745.3	890.8	1,046.1	1,228.2	1,399.0	1,583.3	1,635.3	1,610.0	2,423.3	2,481.2	2,565.3

SOURCE: Financial Information from Planning Management, PLANICEL - June 1988

TABLE IV.1.2

CEL - INCOME STATEMENT
(in millions of Colones)

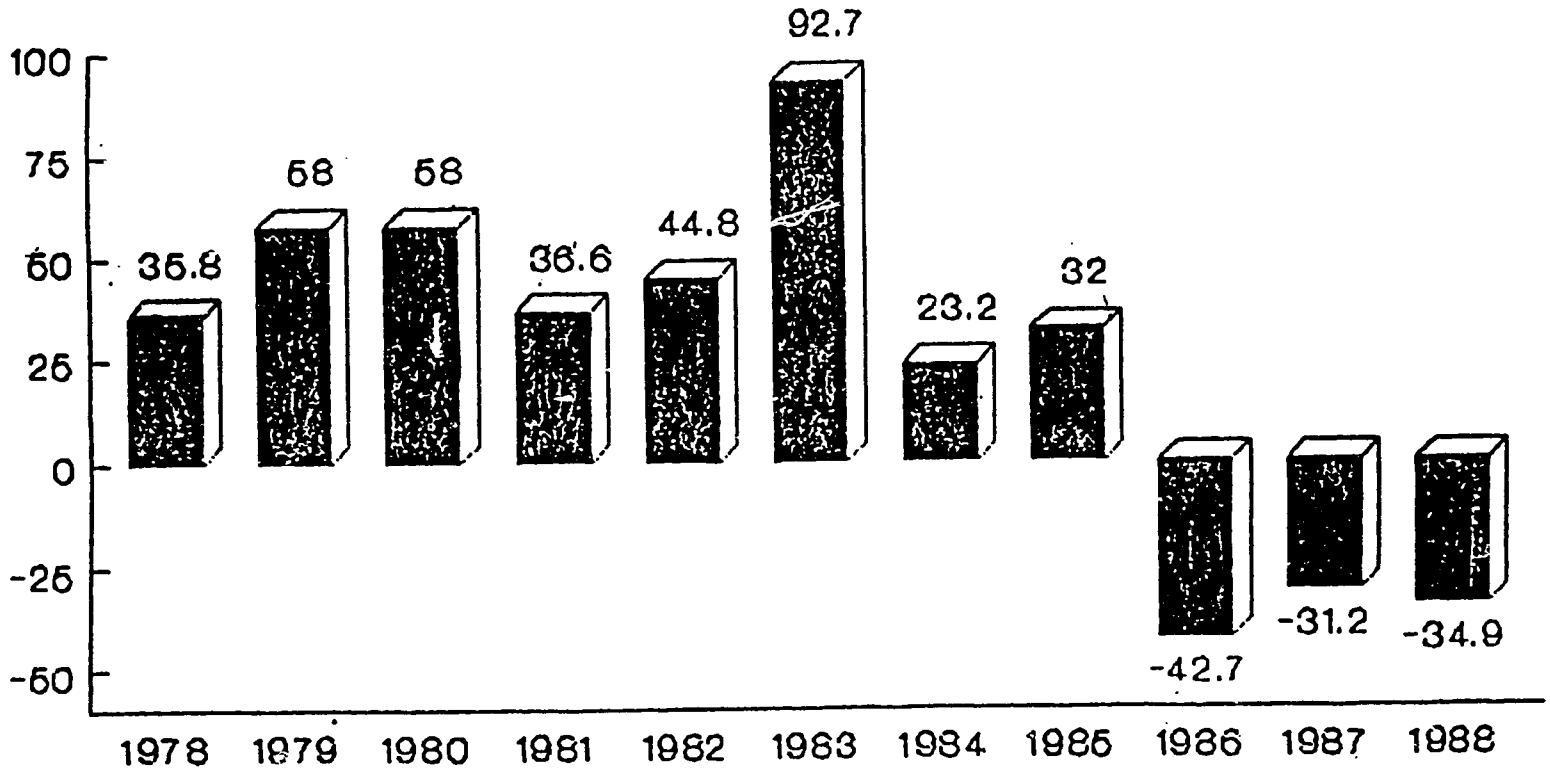
DESCRIPTION	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
REVENUE											
Electric Energy	106.0	123.7	135.7	128.1	127.4	139.1	184.9	214.4	222.4	267.9	306.4
Hydrocarbon Surplus	0.0	0.0	0.0	11.7	33.8	67.0	1.6	0.6	27.9	22.4	29.0
Other Income (Net)	0.0	0.8	0.1	2.1	3.2	4.5	20.4	26.8	54.4	10.7	13.3
TOTAL REVENUES	106.0	124.5	135.8	141.9	164.4	210.6	206.9	241.8	304.7	301.0	348.7
OPERATING COSTS & EXPENSES											
Production	7.8	9.6	11.5	15.9	16.9	15.4	18.4	20.7	33.7	36.0	44.9
Fuel	9.4	0.8	2.5	11.6	16.3	12.7	14.7	26.8	23.5	53.3	41.4
Transmission	2.9	4.3	5.8	8.6	9.4	9.3	7.0	8.7	10.0	10.8	14.8
Distribution	1.1	2.1	2.9	4.1	4.3	4.0	4.6	5.3	7.0	8.3	11.1
Energy Purchase	-	-	-	-	-	-	-	-	13.4	1.0	5.0
General & Admin. Expenses	4.1	5.9	10.3	15.2	17.2	21.3	32.5	41.2	48.8	65.2	61.0
TOTAL COST & EXPENSES	25.3	22.7	33.0	55.4	64.1	62.7	77.2	102.7	136.4	174.6	178.2
OPERATING INCOME	80.7	101.8	102.8	86.5	100.3	147.9	129.7	139.1	168.3	126.4	170.5
Depreciation	15.7	18.1	18.5	21.9	22.0	25.1	38.8	40.8	60.2	61.2	64.4
Surplus before Financial Expense	64.9	83.7	84.2	64.6	78.4	122.7	90.9	98.4	108.3	65.3	106.1
Financial Expenses	26.3	26.0	26.0	27.9	34.1	30.0	66.2	66.1	144.9	110.8	105.7
NET SURPLUS	(2.8)	0.3	(0.3)	(0.1)	0.6	0.0	(1.5)	(0.3)	(6.1)	14.3	(35.2)
ANNUAL SURPLUS :											
INVESTMENT/DEBT PAYMENT	35.8	58.0	58.0	36.6	44.8	92.7	23.2	32.0	(42.7)	(31.2)	(34.8)

SOURCE: Financial Reports, Business Planning Sup. PLANICEL

GRAPH IV.I.3

CEL - ANNUAL PROFITS AND LOSSES, 1978 - 1988

(in millions of Colones)



SOURCE: Financial Reports, PLANICEL

TABLE IV.I.4

CEL - FINANCIAL RATIOS

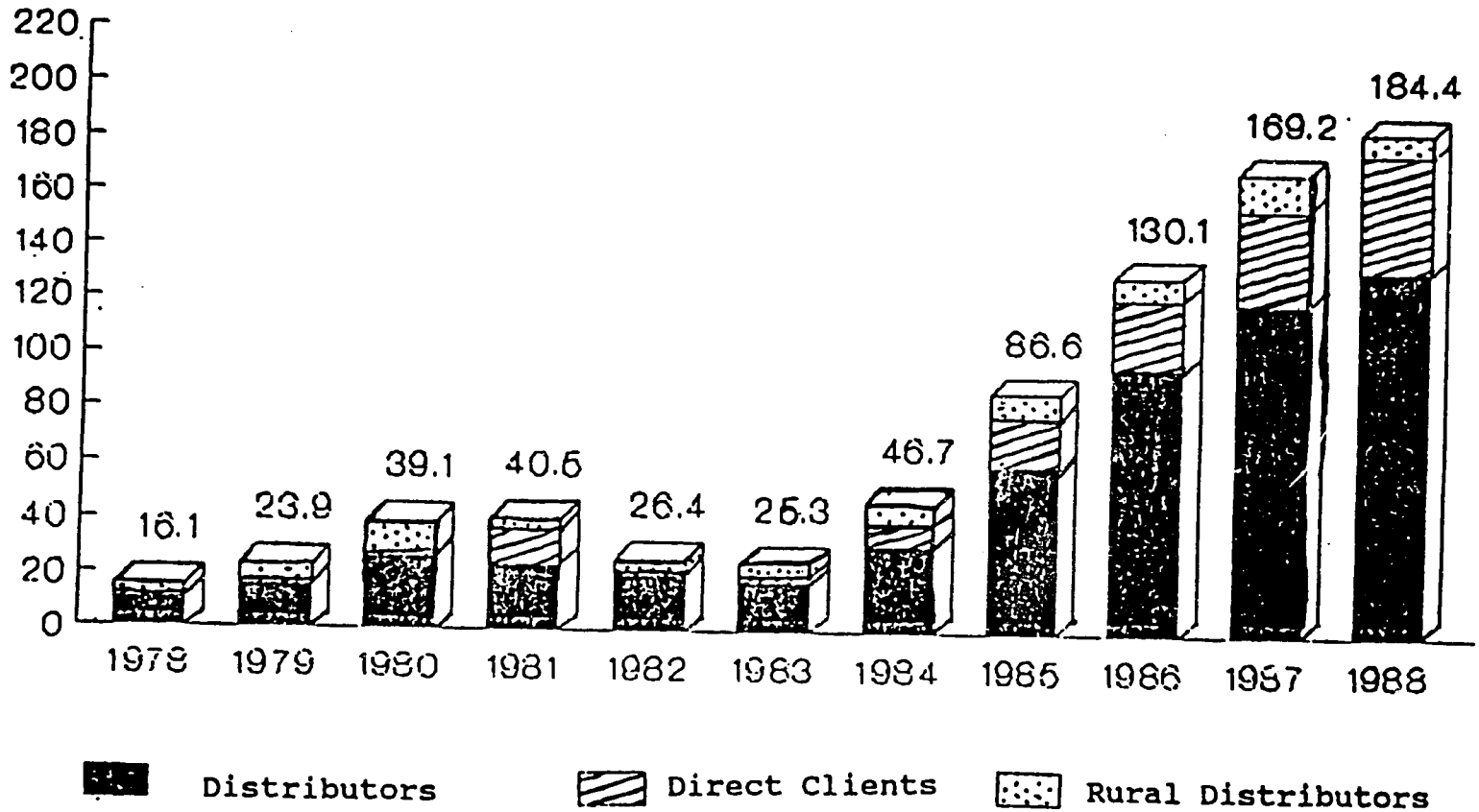
RATIOS	1978	1983	1987	1988
A. LIQUIDITY RATIOS				
1. Working Capital (Current Assets/Current Liabilities)	0.75	0.75	0.50	0.61
2. Acid Test (Cash at Bank/Current Liabilities)	0.14	0.12	0.08	0.17
3. Security Margin (Working Capital/Current Liabilities)	-0.25	-0.25	-0.50	-0.39
B. DEBT RATIOS				
1. Total Debt/Total Assets	0.61	0.62	0.76	0.75
2. Long Term Debt/Long Term Debt + Equity	0.57	0.57	0.66	0.63
3. Total Debts/Equity	1.57	1.67	3.12	3.00
4. Financial Stability (Equity/Total Assets)	0.39	0.38	0.20	0.25
C. EFFICIENCY RATIOS				
1. Rotation on Accounts receivable - Electricity (Electricty Income/Accounts Rec'ble-Electricity)	6.59	5.47	1.49	1.77
2. Average Term on Electricity Payment (360 days/Rotation Annual Electricity)	55 days	66 days	240 days	203 days
3. Rotation on Accounts receivable - Hydrocarbons (Hydrocarbon Income/Accounts Rec'ble-Hydrocarbons)	0.00	8.65	17.4	74.08
4. Average Term on Hydrocarbon Payment (360 days/Rotation Annual Hydrocarbon)	0.00	42 days	21 days	5 days
D. RETURN				
1. Net Profit Margin (Net Operating Profit/Operating Income)	0.34	0.44	-0.12	-0.10
2. Rotation of Net Operationing Assets (Operating Income/Operating Assets)	0.14	0.13	0.11	0.14
3. Potential Profit (Profit Margin/Profit Margin * Rotation of Assets)	0.05	0.06	-0.01	-0.014

SOURCE: Financial Reports, Business Planning Sup. PLANICEL

GRAPH IV.I.5

CEL - ELECTRIC RECEIVABLES, 1978 - 1988

(in millions of Colones)

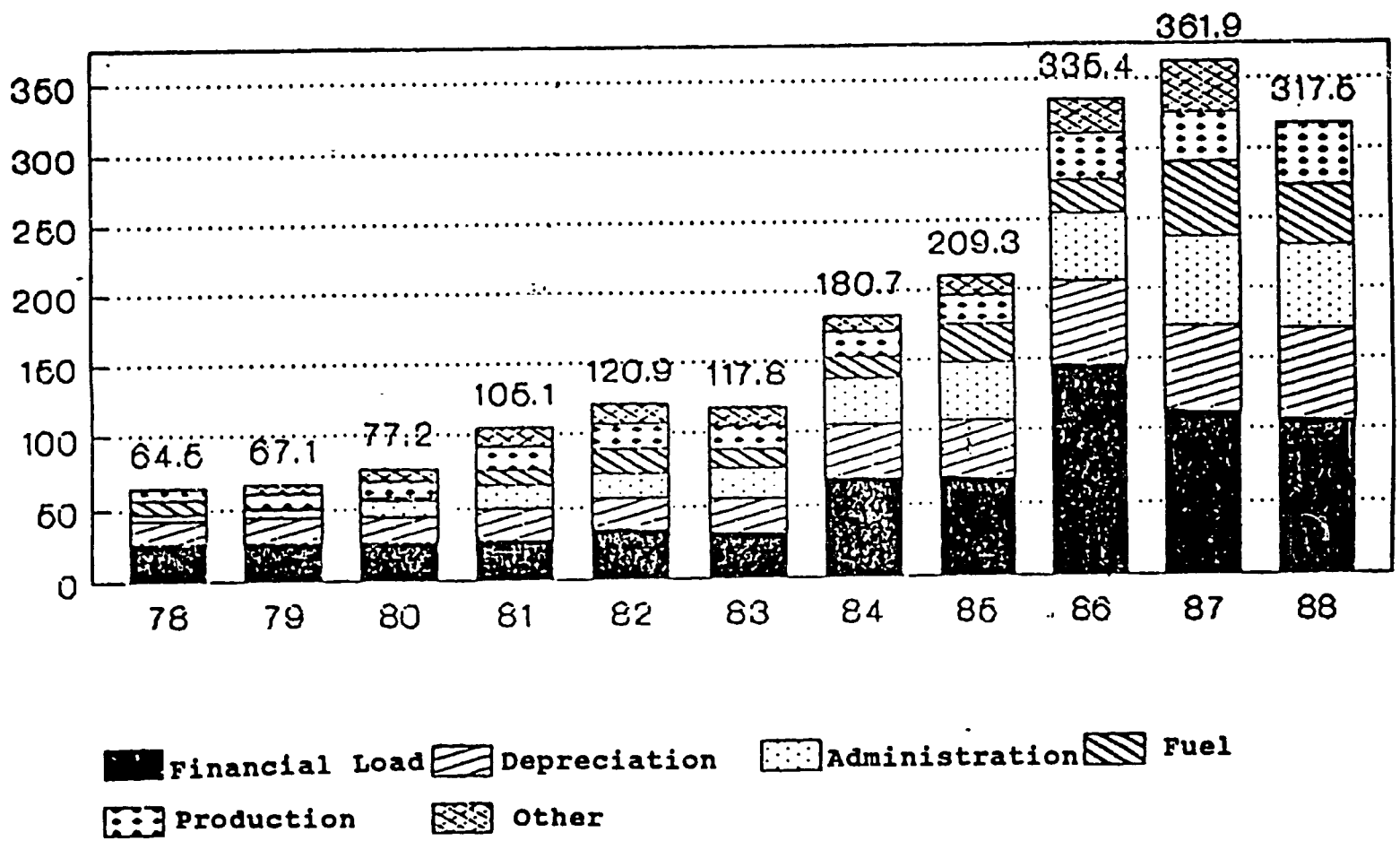


SOURCE: Financial Reports, PLANICEL

GRAPH IV.I.6

CEL - EXPENDITURES, 1978 - 1988

(in millions of Colones)

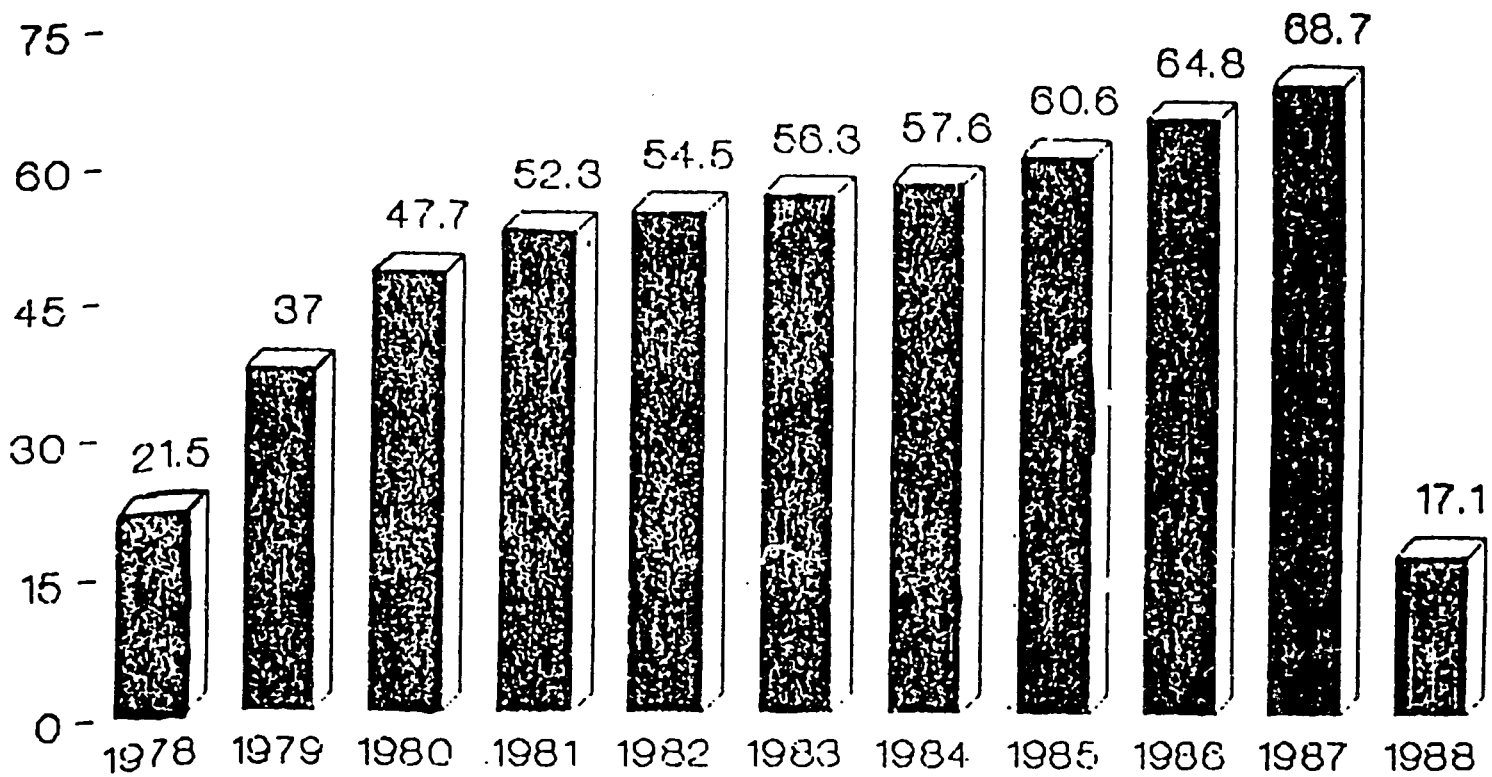


SOURCE: Financial Reports, PLANICEL

GRAPH IV.I.7

CEL - RESERACH AND DEVELOPMENT INVESTMENTS
1978 - 1988

(in millions of Colones)



SOURCE: Financial Reports, PLANICEL

The recovery of unpaid bills from the distribution companies, ANDA and Cemento MAYA, will prove very difficult because payment for the distribution companies is not settled. Action on ANDA's and Cemento MAYA's debts should be taken by the Central Government so that CEL can recover the payments owed.

The income received by CEL from marketing petroleum is not considered in this analysis because it is not a source of income related to power service. However, without this income and subsidies, CEL's financial situation would be much worse.

2. Tariffs

CEL enacted a new tariff for residential customers in 1989. The complete tariff is shown in Appendix IV.I. Year end data for 1989 is not yet available, therefore the analysis of CEL's tariffs will begin with a review of 1988 data, and then a comparison of these results with the new tariffs.

a. Needed Rate Increase

The calculations to estimate the rate increase needed are presented in Table IV.I.8. This shows that in 1988 CEL's rate of return on assets (Operating Income/Total Assets) was 6.65 percent. The required rate of return based on the breakdown of CEL's capital structure between debt and equity components was 8.57 percent. The cost rate of debt was determined by dividing interest expense by long term debt. The cost rate of equity is assumed to be equal to the growth rate forecasted in sales. It is generally accepted that to maintain electric services at a constant level, a utility's equity should grow at a rate approximating the growth in its system. This calculation is based on CEL simply maintaining its current capital structure. No improvement in the debt ratio is assumed.

The difference between the required rate of return and the actual rate applied to asset value yielded a revenue deficiency of C 49,380,000. In order to bring this deficiency into balance a rate increase of approximately 14 percent is necessary. This increase should be phased in, in order to avoid a price shock to consumers and to keep a business climate.

b. Impact of New Schedule

The new 1989 tariff schedule replaced the one enacted in 1987. The 1987 and 1989 tariffs are compared graphically in Figure IV.I.9. and in table form in Figure IV.I.10.

Table IV.I.8

CEL - EL SALVADOR
Rate Analysis

	1985	1986	1987	1988	Growth Rate %
	(in millions of Colones)				
Operating Revenue	241.77	304.74	301.09	348.70	12.2
Operating Expense	102.61	136.32	174.59	178.20	18.4
Interest Expense	66.10	144.90	110.80	105.70	15.6
Operating Income	139.16	168.42	126.50	170.50	6.8
TOTAL ASSETS	1,610.00	2,420.30	2,481.20	2,565.30	15.5
LIABILITIES					
Long Term Debt	752.60	1,293.00	1,184.20	1,099.70	12.6
EQUITY	648.30	630.20	602.70	640.60	-0.4

Current Rate of Return 6.65 %
Forecast Sales Growth Rate 6.79 %

DESIRED RATE OF RETURN

Component	Ratio Amount	Cost %	Weighted Rate %	Cost %
Debt	1099.7	63.19	9.61	6.07
Equity	641.0	36.81	6.79	2.50
TOTAL (Sum of Weighted Costs)				8.57

Required Rate of Return	8.57%
Operating Income Requirement	219.88
Revenue Defeciency	49.38
Required Rate Change	14.16%

The new tariffs have increased rates only to residential customers. The new rate implemented a sharply increasing block rate structure where the rate for the lowest consumption block was C 0.166/kwh and C 0.738/kwh for the highest block. This structure will act to severely curtail monthly consumption for large residential power users.

The 1989 tariffs eliminated the new residential schedule completely, and reduced the number of blocks within the residential class from four to six. This movement toward rate simplification is a positive step and should be continued in future tariff adjustments. The number of tariffs should be reduced to six to match many of CEL's account classifications: residential, commercial, industrial, government, public and municipal, and lighting. This simplification would reduce accounting and administrative costs.

Based on the 1988 average consumption per residential customer of 106.7 kwh per month the comparison of old and new average monthly bills are as follows: 1987 New Residential, C 20.86, 1987 Residential, C 17.49, 1989 Residential, C 23.58. A weighted average of 1986 customers yielded an average monthly bill in 1988 of C 17.67, therefore the 1989 tariffs represented a 13.0 percent increase in residential rates. As residential customers used 35.6 percent of all electricity in 1988, the new tariffs were equivalent to a 4.65 percent increase in overall rates. Incorporating different consumption levels in this analysis would have a minimal effect on this result.

As recommended CEL has moved in the direction of a phased increase. However, the amount of the increase is lower than the inflation rate while the required 14 percent increase estimated from 1988 data is in real terms. The 1989 rate increase will slow the deterioration of CEL's financial position, but only slightly.

The 1989 tariffs will also be less effective in increasing overall revenue because it affects only very large residential consumers. By focusing the tariff change in so narrow an area, a few consumers will be severely impacted and are likely to reduce their consumption as a result. A very large increase to a narrow group will produce a greater elasticity response than would a lower increase to a wider group. Additionally, at the high end, a relatively small share of consumption will be devoted to necessities and the average elasticity coefficient will be larger.

In summation, the overall revenue increase due to the 1989 tariffs will be less than the inflation rate. It will also be dampened because of the specific coverage. A significant rate increase in real terms is necessary to balance the current revenue deficiency which will become worse if CEL's financial trends continue.

TABLE IV.I.9

RATE CHANGE ESTIMATION

1987 - EXISTING CONSUMERS			
kWh	Rate	Avg. kWh	Colones
20	0.141	20.0	2.82
80	0.166	80.0	13.28
100	0.200	6.7	1.34
300	0.230	0.0	0.00
500	0.300	0.0	0.00
+ 500	0.350	0.0	0.00
TOTAL			17.44

Residential kWh : 591,805,000
Consumers : 462,181
Annual Average : 1,280.5
Monthly Average : 106.7

1987 - NEW CONSUMERS			
kWh	Rate	Avg.kWh	Colones
20	0.166	20.0	3.32
80	0.200	80.0	16.00
100	0.230	6.7	1.54
300	0.300	0.0	0.0
500	0.350	0.0	0.0
+ 500	0.435	0.0	0.0
TOTAL			20.86

New Consumers % : 6.6
Existing % : 93.4
Weighted Avg.Billing : 17.67

1989 - ALL CONSUMERS			
kWh	Rate	kWh	Colones
40	0.166	40.0	6.64
160	0.254	66.7	16.94
500	0.419	0.0	0.0
+ 500	0.738	0.0	0.0
TOTAL			23.58

Residential Change 13.04 %
Residential MWh : 591,805
Total MWh : 1,661,663
Residential/Total : 35.62 %
Change in Total : 4.65 %

c. Demand Charges

Although CEL's rates distinguish some classes by voltage level, demand charges have not been adjusted since the 1970s and are entirely inadequate. Implemen-tation of demand charges are an efficient way to encourage consumers to structure usage in a way that makes the overall system run more efficiently by reducing the load factor. The only costs to CEL would be the purchasing of demand meters. This would certainly be less expensive than purchasing a generation facility that may otherwise be required.

Industry is the most important category for a demand charge. A large portion of total load can be measured with only a few meters. Also industry is more likely to shift load in response to price signals.

A new demand and energy change could be structured to be revenue neutral, representing no net increase in costs to consumers. A time-of-day or seasonal rate would insure the correct price signal. If industry does incur costs in restructuring their load, this could be offset by a modest conservation/ modernization program. This would, in turn, benefit the entire economy.

J. PRIVATE ENGINEERING & CONSTRUCTION INDUSTRY

1. Limited Registries

CASALCO, the Salvadoran Chamber of Construction, is a private association of persons and companies working in the construction field. It classifies members into general contractors, consultants and suppliers. The Consultants have met with officials of this organization.

CASALCO does not rank either consultant or contractor members, and is only recently trying to gather information on member volume of business. This makes it difficult to assess firm's strength. At present, CASALCO's division of General Contractors has hired a marketing firm to study the situation of the construction industry in the country.

CEL does not have a general registry of firms with capacity information. The Ministry of Public Works proposes a single registry of contracting firms to avoid the present diversification of registries.

2. Business Environment

In large projects open to international bidding, national firms complain of little or no participation. Salvadoran legislation doesn't require foreign firms to joint venture with local firms when bidding. Salvadoran firms are too small to prequalify for these consulting or contracting services. Their participation is

normally limited to that of sub-contractors. Should large projects develop in the future, both local consultants and contractors could rapidly improve their capabilities, participating first in joint ventures with experienced foreign firms.

Local firms have proposed a "Regulatory Law for the Contracting and Consulting Industry" by which foreign firms would be bound to enter into joint ventures with local firms in order to participate in Salvadoran projects. The ratio of participation still has not been established but a 60/40 foreign/national ratio is often mentioned.

During the past ten years some contractors have kept working in conflictive areas, after reaching special agreements with the insurgent forces. Because equipment and contractor installations located away from urban centers are prone to be destroyed, contracting costs have risen appreciably.

Contractors can insure 50 percent of their equipment at job site against damages by guerrilla warfare. The import of construction equipment has low tariffs and is duty free for government projects.

3. Design and Construction of Civil Works

Most design of civil works has been carried out by CEL's Civil Studies Superintendency, which has a good team of engineers, draftsmen etc., and many years' experience in the field of civil design for power distribution and transmission, buildings, homes, etc. Design for large works, such as hydroelectric and geothermic stations, are made by international consulting companies, such as M. K. in Cerron Grande and COGEFAR for the 15 de Septiembre Power Station.

In recent years, contractor and supplier work levels have been rising due to many small construction works. On the other hand, there has been a decline in consulting and supervisory activities, which has brought greater unemployment in this sector. This unemployment, although small, is important because it refers to specialists.

In the event CEL were to contract out more of its civil works locally, many agencies could supply it with information on their experience with engineering and consulting firms.

4. Electrical Design and Construction

Salvadoran engineering firms and construction firms have participated in a number of transmission and rural electrification projects.

The installation of high and medium voltage transformation lines is done by CEL's Project Superintendency which has acquired technical aptitude for this type of work. The works presented in

Table IV.J.1 are an exception to this. The Table shows some national firms that were contracted by CEL to install 115 kv transmission lines. A list of rural electrification projects is currently being analyzed showing the name of the contractor, the project, its location and the size. This information has been obtained only for the last two years, since the earthquake of 1986 partly destroyed the offices of the Rural Electrification Board.

CEL carries out substation work by force account, and the large projects by public bidding.

K. PROBLEM AREAS

1. Capacity of Existing Hydroelectric Plants

a. General

The capacity of the reservoirs on the Rio Lempa is diminishing at an increasing rate due to siltation. This reduces both their usefulness and their production of electricity because:

- Loss of storage means that the excess water of the rainy season cannot be saved to be used during the dry season. Therefore another source of electricity must be found for the dry season.

- If the excess water of the rainy season has to be spilled over the dams to the sea, rather that used in the turbines, it is lost and production of electricity for the whole year diminishes. In other words, as the capacity to store water is lost, the hydro plants become run-of-the-river plants which only produce as much power as there is water in the river at the time.

Also see Volume I - Environmental Concerns.

b. The Existing Resources

There are four hydroelectric plants on the Lempa River, each with their own storage reservoir. The Cerron Grande Plant is by far the most important. The table below helps explain the importance of each plant. The live storage left in 1988 is expressed both in million cubic meters of water and in millions of kilowatt hours which the water can generate in the plant itself. The Mw capacity of the plant and the altitude above sea level of the reservoir are also shown:

TABLE IV.J.1

CENTROAMERICANA DE ELECTRIFICACION S.A. DE C.V.

Contract # CEL-1366:
Installation of 115 kV transmission line from the San Lorenzo Substation. 2km of single circuit line and 0.2km of double circuit line.
Contract: SATISFACTORY & COMPLETED

CONSORCIO INGENIERIA ASOCIADA S.A. DE C.V. AND CARCAMO ASOCIADOS S.A.

Contract # CEL-1465
Installation of 115 KW transmission line "Nuevo Cuscatlan -San Martin", 28.5 km of single circuit lines.
Contract: SATISFACTORILY COMPLETED

CONSORCIO DISENOS Y MONTAJES ELECTROMECANICOS S.A. DE C.V. AND ELECTRICIDAD Y MECANICA S.A.

Contract # CEL-1475
Installation 115 kV transmission line "15th September - San Martin", 21.7 kilometers of double circuit lines. Contract: SATISFACTORILY COMPLETED

INGENIERIA ASOCIADA S.A. DE C.V.

Contract # CEL-1589
Installation, tensioning of conductor and shield wire for the 115 kV transmission line "Cerron Grande-San Rafael Cedros", on wooden posts, 28.6 km of wood pile line.
Contract: SATISFACTORILY COMPLETED

OBRAS ELECTRMECANICAS S.A. DE C.V.

Contract # CEL-:
Installation services for 115 kV transmission line "15 September - San Miguel", 45 kms of single circuit wood pole line.
Contract: UNDER NEGOTIATION

ENERGIA Y SUMINISTROS S.A. DE C.V.

Contract # CEL-:
Construction of the 115 kV transmission line "Nejapa - San Martin", 17km of single circuit , two conductors per phase, wood pole lines.
Contract: UNDER NEGOTIATION

Hydro Plant	Storage Capacity in millions of m3	kwh	Installed Capacity Mw	Altitude a.m.s.l meters
Gurajayo	. .	. .	15	. .
Cerron Grande	231	. .	135	243
5 de Noviembre	. .	. .	80	. .
15 de Septiembre	393	22	156	49

By dividing the storage in kWh by the installed capacity in kw (1 Mw = 1000 kw), we can obtain the approximate number of hours it would take to empty the reservoirs if there were no inflows. This gives an idea of whether the plant can be used to smooth out weekly, monthly or annual variation in electricity demand.

As to the general usefulness of each plant within the system, remember that the water that flows through one plant will eventually reach all other plants downstream, and will be used again. It follows that storage capacity is more valuable in the plants higher up the river basin.

c. The Cerron Grande Reservoir

The largest and most important reservoir on the Lempa River is Cerron Grande. CEL has paid particular attention to this reservoir and has periodically carried out measurements to determine how much storage capacity is left.

The conclusions that can be drawn are alarming. If sedimentation continues at the 1988 rate, the storage capacity will be lost within 10 years. If the rate slows down, the life of the reservoir can be extended for a few years.

Loss of Storage Volume at Cerron Grande Reservoir

Date of Measurements	Storage Capacity million m3	Loss of Storage Capacity Between Measurement million m3	Average per year million m3
February, 1979	378		
		122	13.6
February, 1988	256		
		24	24
November, 1988	232		

While Cerron Grande has been selected as an example because of its importance, it is in no way unique. The first plant built by CEL, 5 de Noviembre, suffered the following reduction in storage capacity.

5 de Noviembre Storage Capacity

Year Measured	Live Storage in million m3
1953	168
1963	133
1973	90
1983	

d. Causes and Remedies

Deforestation is a major cause to soil erosion, the ensuing sedimentation and loss of reservoir capacity.

No information is available on the importance of the causes of reservoir capacity losses. The two rivers which flow through the area, the Acelhuate and the Rio Sucio, are a dumping ground for all kinds of urban refuse. Much of the debris of the 1986 earthquake ends up in the gullies that feed these rivers as does the earth excavated from new construction sites. There is no end in sight to the development of the San Salvador Area, and development will certainly spread to other centers in the Lempa Valley. The dumping is bound to continue and so will the discharge of other refuse in the rivers.

Long term remedies are reforestation, treatment and collection of urban and industrial refuse, and enforcement of regulations against indiscriminate dumping.

However, a short term remedy should be applied because the long term measures will be too late to save the Cerron Grande reservoir. The most effective method is to stop the bedload of the Acelhuate River from reaching the reservoir. This can be achieved by repairing the drop structures on the river that have collapsed or have been washed out and by adding check dams, weirs and like structures where applicable.

Time is of the essence. The first step should be a reconnaissance study which would select within three months the location and the rivers where work should be started. This would be followed by a one year pilot project of constructing inexpensive structures using gabions or similar methods. In the meantime a more wide-ranging study should be carried out dealing with sedimentation, water supply, sewage handling, river pollution, health, and all other connected environmental matters.

It is important that some remedial work start without delay. Without examining in detail the as-built designs for these collapsed structures, the ISA consultants estimate that at least $5 million should be invested in the next five years, or sooner if possible. Negotiations on the proportions to be paid by CEL and the Treasury should not be allowed to slow the necessary work. More detailed estimates should be made as soon as possible.

2. Distribution Systems

The distribution system in the Metropolitan Area of San Salvador is currently overloaded. Paradoxically, the decrease in industrial production has helped reduce the probability of blackouts in San Salvador. Similar problems exist for other distribution companies.

The delay in settlement of the terminated transmission and distribution concessions has already caused considerable damage. Minimal investments and maintenance were made in the previous decade and since then. The GOES must continue ongoing negotiations, keeping in mind that any delays in finding a solution create a net economic loss to the country.

Rapid implementation of emergency measures is required in early 1990 to avoid major disruption. Afterwards, a new development plan should be prepared based on existing land use and new demand forecasts for San Salvador.

Plans should begin now for setting up a system to manage national distribution. One option under consideration is to set a country-wide distribution utility with the participation of private capital in financing and management. To become an attractive investment, it would have to be established on a sound institutional and financial basis. The GOES could nominate a committee to prepare a proposal on this matter. Investments in distribution could then proceed more effectively.

3. The Tariff Structure

CEL's financial situation has been severely affected by the 1986 devaluation without any compensating adjustment.

A new tariff scale was implemented on August 1, 1989 but financial analysis shows that these adjustments will have a minimal effect on CEL's financial situation.

The procedural problem of tariff adjustment, as discussed in Volume I, remains and there is no guarantee that the tariff scale will be adjusted to inflation.

The need for adjustment cannot be overemphasize. The present situation directly affects investment and maintenance while increasing demand, thus jeopardizing the power supply situation.

CEL's financial situation should be improved as soon as possible. A program should be put in place including the following points:

- There should either be a utility regulation agency to support needed adjustments or, if creating a separate agency is not feasible, CEL should be given authority to adjust its tariffs to compensate for increases in operating costs and debt payments. This authorization should not be for a one time adjustment only. CEL needs to be allowed to continuously adjust its tariffs within specified financial guidelines.

- There is a need for a comprehensive tariff study to analyze tariff adjustments requirements and deal with the above issue.

- CEL's debt should be rescheduled given clear investment objectives, to permit a more gradual implementation of this increase.

- The number of tariffs should be reduced to six, one for each type of user. The number of blocks should also be reduced. This will reduce administrative costs.

In order to bring tariff deficiency into balance, a real rate increase of appoximately 14 percent is needed. This should be phased in to avoid a consumer price shock and to maintain a positive business climate.

4. Inefficient Energy Use

Since demand changes are insignificant and energy rates are low, industry currently has no incentive to:

- conserve energy

- modernize energy use

- schedule energy use to reduce CEL's load factor.

Thus, it is more than likely that industrial users have not tried to effectively control energy use and scheduling. As a result, an expensive operations facility may soon be required to meet increased peak requirements.

The demand charges in the current tariff schedule are insignificant. Implementation of a more effective industrial demand charge would be an efficient way to encourage industry to structure usage to make the overall system run more efficiently by reducing the load factor. The only costs to CEL would be purchasing of demand meters and a slight increase in accounting costs.

If necessary, new demand and energy charge could be structured to be revenue neutral, representing no net increase in costs to consumers. A time of day or seasonal rate would insure the correct price signal. If industry does incur costs in restructuring their load, this could be offset by a modest conservation/ modernization program, benefitting the entire economy.

5. Uncollected Fees

Uncollected fees represented almost 10 percent of CEL's operating losses during the 1981-1988 period. A large part of these are due from other government agencies.

Similar to the case of tariff subsidies the GOES is in effect augmenting the budget of other agencies at CEL's expense. This produces a misallocation of resources and makes government accounts opaque, limiting GOES' ability to monitor its own performance of effective supply.

State enterprise arrears should be paid to CEL.

6. Unavailability of Generating Equipment

At present the following generators are out of service:

- Unit #3 of the 5 November plant, of 15 Mw,
- Three diesel units at Miravalle, of 18.6 Mw
- Thermal plant of SIGMA, of 6.6 Mw
- Unit #3 of the Soyapango plant, of 20 Mw

Total unavailable capacity is 60.2 Mw. This is due to normal causes such as age, wear and tear, lack of spare parts, deterioration of generator, insulating material, etc. CEL's program gives priority to recovering this capacity.

7. Equipment to be replaced

Much of the mechanical and electrical equipment used at CEL's older plants is unreliable and difficult to keep in service. Manufacturers have often discontinued production and are unwilling to provide spare parts. This is the case at the 5 November plant, the Soyapango plant, and some equipment at the Acajutla plant. They will have to be replaced with modern equipment.

8. Lack of Measuring Devices

There is not enough measuring equipment to gauge the water flow at the hydro plants and to record the fuel in the tanks at the oil fired plants. This makes it difficult to adequately plan for plant operations, thereby affecting the electricity system as a whole.

There is also a shortage of electricity meters. CAESS alone has 50,000 customers without meters that are charged for estimated rather than recorded consumption.

9. Lack of Transmission Lines & Equipment

Blackouts and brownouts are often a consequence of insufficient investment in the maintenance of transmission lines. This also causes frequent ground faults and short circuits. A transmission expansion plan is needed to refurbish the system. In addition, due to the present conflict, people and economic activity have migrated to the central and western zones, causing increased demand in these areas and overloaded transmission lines.

10. Sabotage of Facilities

Sabotage of the electric system of El Salvador is one of the main problems affecting reliability of service. It produces cuts in primary and secondary transmission lines and causes blackouts. This forces the utility to incur substantial expenditures to repair damaged towers and lines. Further, it obliges the utility to resort to thermal plants, burning imported oil, to replace the less expensive, hydro power. Another consequence of the continuous sabotage is the loss of income for CEL from unsold electricity, 6 percent of the total in 1988.

Graphs IV.K.1 show the attacks against transmission lines since 1980. A record level of 500 attacks in 1988 grew from 48 in 1980. Similarly, in 1988 there were 259 attacks on subtransmission lines compared to 4 in 1980.

Sabotage to transmission lines prevented CEL from using all its hydroelectric plants just when the demand for power was at its peak. The Cerron Grande-Nejapa line, for example, was out of action from April 21st 1988, until August, 1989, causing major losses. This is one of the system's most important lines.

Up to the end of June, 1989, attacks on transmission and subtransmission lines reached 341 and 248 respectively.

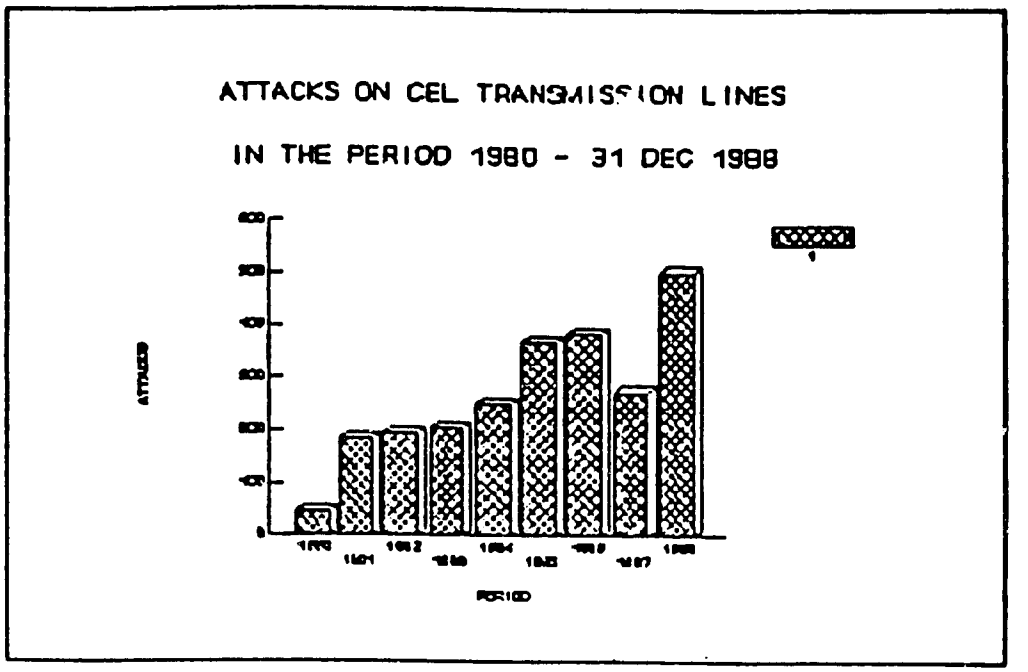
L. ECONOMIC EVALUATION AND SOCIAL IMPACT

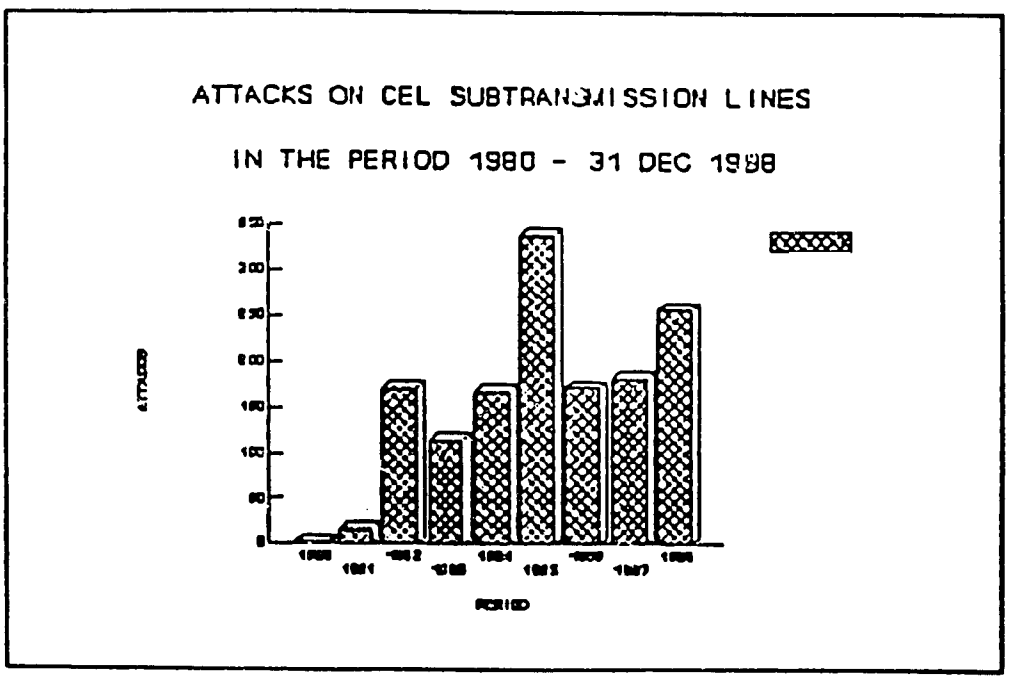
1. Benefit/Cost Methodology

A comparison of economic benefits and costs discounted over the life of a project was used to gauge project feasibility.

Project costs were the sum of investment, operating and maintenance costs. These financial costs were categorized by the following types: materials, equipment, fuel, and labor (skilled and Graph

GRAPH IV.K.1


ATTACKS ON CEL TRANSMISSION LINES
IN THE PERIOD 1980 - 31 DEC 1988


ATTACKS ON CEL SUBTRANSMISSION LINES
IN THE PERIOD 1980 - 31 DEC 1988

unskilled). Investment costs were further categorized into local and foreign investment and then spread over the years of construction based on the proposed construction schedule. Operation and maintenance were included as costs, spread equally over the project's estimated life, and discounted to the year when construction begins. Generator operation and maintenance costs for the rural generators were also categorized by the blend of fuels specific to each project. Economic costs were obtained using ISA conversion factors. (See Volume I, Macroeconomic Aspects, Scenario for Economic Analysis).

Project benefits were set equal to the value of substitute energy sources which would be displaced if the project were built. The substitute energy sources are wood, oil, other electricity and a composite of other fuels including vegetable wastes, charcoal, biogas and cogeneration. The amount of each substitute fuel displaced was proportionate to current consumption levels as shown on page 1. For example, a 10 Mw project was assumed to displace 5.4 Mw wood, 3.3 Mw oil, .8 Mw other electricity and .5 Mw of other fuels. Appendix IV.L.1 presents how the value of substitute energy sources was estimated.

In order to estimate fuel amounts for different sources in an standard measure, all energy consumption was converted to TCALS. First, the generation project's installed capacity was changed to an estimated annual Mwh production. The installed capacity was multiplied by the number of hours in a year (8760) then divided by a capacity factor measuring the projects capacity to energy ratio.

This capacity factor ranged from .4 for a peak-oriented gas turbine to .9 for a slow-speed diesel generator. The estimated annual Mwh was converted to TCALs and proportioned to the substitute energy sources. The amount of energy required for each substitute fuel was then multiplied by a unit price for each source to arrive at a value of substitute energy displaced. These values were realized over the operating life of the generation project and discounted to the first year of investment.

2. Assumptions and Limitations

This methodology hinges on the ability of consumers to use substitute energy sources, which is possible in the long term when replacement of energy consuming capital stock can take place. This assumption will discount the costs of shortages that may result if a power generation project is not built. However, it is neutral to alternative generation projects.

Each project is considered in isolation and the effects of other construction or impact of tariff changes are considered. To do so would have required the simultaneous determination of project feasibility, and substantial computer and personnel. Given the scope of this project, the current methodology should be adequate.

Furthermore, given the separate processes by which CEL plans resources and sets tariffs, this methodology is realistic.

Appendix IV.L.2 shows the assumptions and intermediate steps to estimate each project's economic feasibility.

3. Results

The results for the projects considered are summarized in Table IV.L.1. Projects are listed in order of the type of fuel; hydro, thermal and geothermal. Local and foreign investment are the actual amount (not discounted) over the construction period.The overall results are relatively low feasibility rankings for the projects. This is a result of the assumptions which have produced very conservative, probably the minimum, estimates of benefits of the projects.

The methodology also does not include productivity increases that may result from using electric power in place of other fuels. In the industrial and commercial sector, the benefits would be from the ability to use more efficient machinery and the resulting increased labor productivity. In the residential sector productivity increases would include time saved in the collection and burning of firewood. If electricity is used to displace wood as an energy source, these benefits could be substantial.

Furthermore, a modest surplus of electric power is often useful in attracting new business and industry or allowing current operations to expand. The business climate is improved if there is no wait for power projects.

The cost of shortages, productivity increases and industry promotion benefits are not included because they are very difficult to quantify. Given the resources available to ISA, several assumptions need to be made. In place of quantification of these benefits professional judgement is relied upon. Even when extensive computer and personnel resources are available, a well educated and openly discussed opinion often proves superior to mathematical models in estimating values that have no direct market price. Although these benefits are difficult to quantify, they are still important and should be given consideration.

While these benefits will increase the overall feasibility of all projects, they apply relatively equally to the different projects. Therefore, the ranking of these projects should remain constant when these benefits are included.

There are factors which could change the ranking of projects. CEL currently has an abundance of resources in hydroelectric power. Table IV.L.2 shows the breakdown of peak and energy production by resource type for a recent historical year.

TABLE IV.L.1

ECONOMIC EVALUATION OF GENERATION PROJECTS

Project Description	San Marcos Hydro
Operating Data:	
Total Capacity (MW)	52
Construction Time (Years)	5
Project Lifetime (Years)	50
Capacity Factor	59.0%
Financial Data:	
Local Investment, Actual	$210,000
Foreign Investment, Actual	$380,000
Costs Present Value	$638,164
Benefits Present Value	$403,889
Net Present Value	($234,275)
Net Present Cost/MWh	0.047
Net Benefits/Investment	0.683
Internal Rate of Return	8.46%

Project Description	El Tigre Hydro
Operating Data:	
Total Capacity (MW)	270
Construction Time (Years)	5
Project Lifetime (Years)	50
Capacity Factor	55.0%
Financial Data:	
Local Investment, Actual	$400,000
Foreign Investment, Actual	$900,000
Costs Present Value	$1,424,720
Benefits Present Value	$1,954,937
Net Present Value	$530,217
Net Present Cost/MWh	0.022
Net Benefits/Investment	1.561
Internal Rate of Return	17.50%

Project Description	Cerron Grande Exp.
Operating Data:	
Total Capacity (MW)	135
Construction Time (Years)	4
Project Lifetime (Years)	30
Capacity Factor	20.0%
Financial Data:	
Local Investment, Actual	$55,000
Foreign Investment, Actual	$160,000
Costs Present Value	$259,649
Benefits Present Value	$386,145
Net Present Value	$126,496
Net Present Cost/MWh	0.037
Net Benefits/Investment	1.746
Internal Rate of Return	19.50%

TABLE IV.L.1

Project Description	Gas Turbine
Operating Data:	
Total Capacity (MW)	20
Construction Time (Years)	2
Project Lifetime (Years)	25
Capacity Factor	40.0%
Financial Data:	
Local Investment, Actual	$7,500
Foreign Investment, Actual	$37,500
Costs Present Value	$192,184
Benefits Present Value	$139,742
Net Present Value	($52,442)
Net Present Cost/MWh	0.110
Net Benefits/Investment	0.188
Internal Rate of Return	-3.06%

Project Description	Oil Fired Steam
Operating Data:	
Total Capacity (MW)	50
Construction Time (Years)	4
Project Lifetime (Years)	30
Capacity Factor	80.0%
Financial Data:	
Local Investment, Actual	$80,000
Foreign Investment, Actual	$245,000
Costs Present Value	$614,492
Benefits Present Value	$572,066
Net Present Value	($42,425)
Net Present Cost/MWh	0.058
Net Benefits/Investment	1.022
Internal Rate of Return	12.05%

Project Description	Slow Speed Diesel
Operating Data:	
Total Capacity (MW)	40
Construction Time (Years)	3
Project Lifetime (Years)	35
Capacity Factor	90.0%
Financial Data:	
Local Investment, Actual	$55,000
Foreign Investment, Actual	$245,000
Costs Present Value	$563,183
Benefits Present Value	$585,256
Net Present Value	$22,073
Net Present Cost/MWh	0.051
Net Benefits/Investment	1.186
Internal Rate of Return	14.18%

TABLE IV.L.1

Project Description	Central Geothermal
Operating Data:	
Total Capacity (MW)	35
Construction Time (Years)	5
Project Lifetime (Years)	30
Capacity Factor	75.0%
Financial Data:	
Local Investment, Actual	$50,000
Foreign Investment, Actual	$330,000
Costs Present Value	$471,844
Benefits Present Value	$335,195
Net Present Value	($136,649)
Net Present Cost/MWh	0.068
Net Benefits/Investment	0.756
Internal Rate of Return	9.02%

Project Description	Wellhead Geothermal
Operating Data:	
Total Capacity (MW)	10
Construction Time (Years)	3
Project Lifetime (Years)	15
Capacity Factor	75.0%
Financial Data:	
Local Investment, Actual	$34,500
Foreign Investment, Actual	$101,500
Costs Present Value	$188,551
Benefits Present Value	$101,576
Net Present Value	($86,975)
Net Present Cost/MWh	0.191
Net Benefits/Investment	0.529
Internal Rate of Return	2.66%

Source: See Appendixes L.1 and L.2

Table IV.L.2

	Energy	Peak
Hydro	74.1%	61.4%
Geothermal	21.9%	14.5%
Fossil Fuel	4.0%	24.1%

In order to diversify their resource base, it might be advisable to move away from hydroelectric power. This would be especially true if the siltation problem are not solved, and if the effects of global warming were to reduce rainfall.

The larger the degree of uncertainty in a forecast, the more attractive are projects with a shorter construction time and investment costs. Smaller projects will allow the utility to adjust to changing circumstances in a more timely fashion.

4. Final Considerations

Expansion of a current hydro facility (shown as Cerron Grande, but applicable to others) is the most economically justified project. This project will increase peak capability and have little negative environmental impact.

El Tigre also has a positive net benefit to investment ratio, but other factors should be considered. This project places even more of CEL's resource portfolio in hydroelectric power and is by far the largest investment. The siltation problem also is a definite negative in considering El Tigre. El Tigre's relatively inexpensive cost per Mwh makes it a project worth considering, preferably under the following circumstances: an at least partial solution to the siltation problem, a relatively certain long term forecast of peace and prosperity for effective operations and expansion in demand, and agreement with Honduras.

San Marcos does not appear economically viable. However, benefits from San Marcos include irrigation which were not included in the analysis, for power projects. Therefore, it merits further review.

Slow-speed diesel is economically borderline. Given the conservative estimate of benefits, it is probably a worthwhile project. It also serves the goal of resource diversity. The project has a high capacity factor and will complement the increased peak capability of hydro expansion. Slow-speed diesel in conjunction with hydro expansion are good additions to resources.

The remaining projects, including geothermal plants do not yield high positive net benefits and would not be as cost effective as those listed above.

5. Sensitivity Test of Projects to changes in Fuel Price

The impact of increases of fuel prices upon the feasibility of thermal plants is analysed. Given the estimated fuel conversion factor and current fuel prices, the oil-fired steam and slow-speed diesel plants, have net benefit to investment ratios greater than one. Fuel prices for these plants were increased in order to determine at what level the plants would no longer be feasible. The results of this test are presented below in Table IV.L.3. Jet fuel turbine was not tested because it has a net benefit to investment ratio less than one at current prices and these prices are already relatively low in historical terms.

Table IV.L.3

% Increase From Current Fuel Price	Oil Fired Steam: Ratio	Slow speed Diesel: Ratio
0.0%	1.022	1.186
2.5%	1.007	1.176
3.5%	1.001	1.172
4.0%	0.998	1.170
10.0%	0.961	1.146
30%	0.840	1.067
45%	0.748	1.007
50%	0.718	0.987

These calculations assume the following efficiencies, measured in kwh per barrel: slow-speed diesel, 770 kwh/barrel; oil-fired steam, 530 kwh/barrel; jet-fuel turbine, 440 kwh/barrel.

Slow speed diesel, start from a higher ratio and is also less sensitive to changes in fuel price. Diesel is less sensitive to price changes because of its greater efficiency. Both the feasibility under current prices and plant efficiency work in favor of diesel. A substantial increase in fuel price is required to reduce the ratio to less than one. Oil fired steam becomes unfeasible with only a 4 percent increase in fuel price.

6. Social Impact

Social impacts are separated into three categories, direct employment impacts, environmental effects and development related effects. Environmental effects are described in Volume 1.

Estimates of direct employment effects are shown in Table IV.L.4 Development related effects are not computed.

The employment for each project is determined by first dividing the skilled and unskilled portion of annual project costs by respective wage rates to determine the hours devoted to each project per year. Total annual hours are then divided by an estimate of 2000 hours worked for a full time worker to determine the annual employment for each project. This procedure is followed for investment, operations and maintenance costs.

M. SECTOR PROJECT NEEDS

1. The 1989-1994 Period

The five-year period from 1990 to 1994 will be critical for El Salvador. Hopefully, the civil war will cease and peace will return within the next three year. The tasks of reconstruction of the country and of return to normal conditions will begin.

It will be a period of:

- shortages, as it will take quite some time to channel domestic savings into power investment
- "making do" with what little there is
- transition from a war situation to one of normal business and progress.

a. Load Growth

Based on recent electricity consumption growth rates and on evaluation of near term prospects, CEL's low forecast growth rate of 5 percent for the near term was used. This growth rate was applied to the adjusted 1989 electric energy consumption which CEL's system control staff computes regularly. This is the actual load (2056 Gwh) increased by the energy not supplied (126 Gwh) due to power interruptions. The total adjusted 1989 energy consumption is calculated as 2182 Gwh.

b. Additions programmed for 1990-1994

The addition of new plants and the refurbishment of existing facilities are described the section on Projects Underway.

TABLE IV.L.4

EMPLOYMENT EFFECTS OF POWER PROJECTS

INVESTMENT	Annual Cost		Cost/Hr		Hours		Persons per Year		Number of Years
	Skilled	Unskilled	Skilled	Unskilled	Skilled	Unskilled	Skilled	Unskilled	
San Marcos Hydro	10,500,000	4,200,000	10.24	8.72	1,025,391	481,617	513	241	5
El Tigre	20,000,000	8,000,000	10.24	8.72	1,953,125	917,747	977	459	5
Cerrone Grande	5,500,000	1,375,000	10.24	8.72	537,109	157,738	269	79	4
Jet Fuel Turbine	1,500,000	375,000	10.24	8.72	146,484	43,015	73	22	2
Oil Fired Steam	5,600,000	1,600,000	10.24	8.72	546,875	183,549	273	92	4
Slow Speed Diesel	7,333,333	1,833,333	10.24	8.72	716,146	210,317	358	105	3
Central Geothermal	4,000,000	500,000	10.24	8.72	390,625	57,359	195	29	4
Wellhead Geothermal	4,600,000	1,150,000	10.24	8.72	449,219	131,926	225	66	3

OPERATION & MAINT.	Annual Cost		Cost/Hr		Hours		Persons per Year		Number of Years
	Skilled	Unskilled	Skilled	Unskilled	Skilled	Unskilled	Skilled	Unskilled	
San Marcos Hydro	750,000	300,000	10.24	8.72	73,242	34,410	37	17	50
El Tigre	1,250,000	500,000	10.24	8.72	122,070	57,359	61	29	50
Cerrone Grande	600,000	150,000	10.24	8.72	58,594	17,206	29	9	30
Jet Fuel Turbine	600,000	150,000	10.24	8.72	58,594	17,206	29	9	25
Oil Fired Steam	1,379,000	394,000	10.24	8.72	134,668	45,199	67	23	30
Slow Speed Diesel	1,600,000	400,000	10.24	8.72	156,250	45,867	78	23	35
Central Geothermal	1,166,400	145,800	10.24	8.72	113,906	16,726	57	8	30
Wellhead Geothermal	946,900	236,500	10.24	8.72	92,383	27,131	46	14	15

These would contribute the following new capacities:

New or Refurbished Facilities	Capacity Mw	Yearly GWh
Miralvalles Medium Speed Diesel	15	80
4 Geothermal Wellhead Plants 5 Mw each	20	140
Refurbishment of Ahuachapan Geothermal	15	115
	50 Mw	335 GWh

This is all that can be counted on because it is unlikely that any of the listed Planned Projects can be on line by 1994. The 30 Mw expansion of 5 de Noviembre is too uncertain, since the feasibility study has yet to be done. Adding one 67 Mw machine at Cerron Grande could certainly be done in time, but only if financing for the transmission lines could be arranged in the near future. The Berlin 30 Mw geothermal plant is in a similar position.

2. New Generating Facilities 1990-1994

To prevent a shortfall and its consequences, such as rationing, new facilities must be added rapidly to the CEL system. Further, measures should be taken to allow the implementation of other planned facilities without further damaging delays.

If new facilities are to be added by 1993 or 1994, the choice is restricted to those types of plants which can be built within a short time period. The options considered are:

1) Tariff adjustments (overall and demand charge) and slow-speed diesel plant.

2) Smaller tariff adjustments, slow-speed diesel plant and Cerron Grande expansion (given early eligibility for financing and cessation of hostilities.)

3) No tariff adjustments, improved reserve margin, slow-speed diesel and gas turbine.

See Table IV.M.1 for a summary of these options.

It is not possible to make a recommendation within the limitations of the present study. This would require a thorough study of the

Table IV.M.1

OPTIONS FOR MEETING GENERATION NEEDS, 1990-1994

Installation/ Event	Capacity Added MW	Capacity Added Gwh	Estimated Cost First Option	Estimated Cost Second Option	Estimated Cost Third Option
Miravalles diesel	15	80	2.2	2.2	2.2
Wellhead geothermal	20	140	46	46	46
Ahnaehapan rehab.	15	115			
Interconnection with Honduras (power swap)	70	300	28	28	28
Slow-speed diesel	40	320	55	55	55
Rec. tariff adjustments			complete		
Recommended real tariff adjustments			complete	partial	none
Cerron grande	144	80	-	43	delayed
Gas turbine	20	80			9
Totals			131.2	174.2	140.2
Capacity Added					
MW			160	304	180
Gwh			955	1035	1035

operational requirements of CEL (for the timing, size, and location of the plants), and more importantly, an investigation of the financing possibilities.

a. First Option: Tariff Adjustments and Slow Speed Diesel Plants.

(1) Overall Tariff Adjustments

Generation needs within the power sector are a function of available resources and the forecast of loads. The load forecast will be significantly affected by rate setting policy.

A 14 percent overall rate increase has been recommended. If this is implemented, load growth can be expected to decline and therefore the sector needs for resource additions will also decline. A simple calculation may give a rough approximation of the impact of a 15 percent rate increase.

A simple calculation may give a rough approximation of the impact of a 14 percent rate increase. Studies have estimated a short-term electric power price elasticity coefficient of -0.5. CEL's medium forecast predicts a growth rate of approximately 7 percent. The proposed 15 percent rate increase multiplied by -0.5 would reduce demand by about 7 percent.

(2) Demand Charge

A more urgent requirement will be peak resources. A demand charge tariff adjustment would be an inexpensive way to avoid purchasing additional peak generation equipment.

The additional demand charge may be difficult, given CEL's rate setting procedures. Absent other means of defining loads, resource additions will be necessary. These additions are evaluated in the following sections.

(3) Additional Facility

In this option, an additional 40 Mw would probably suffice, as follows:

TWO	20 Mw slow-speed diesel generators	40 Mw	320 GWh

The two slow-speed diesel generators would be run on residual oil and should therefore be installed in Acajutla close to the RASA refinery, or next to the existing steam plant.

b. Second Option: smaller tariff adjustments, the slow-speed diesel plant described, and Cerron Grande expansion.

For this option to be achieved, Financing and transmission lines would have to be quickly arranged.

c. Third Option: no tariff adjustments and improved reserve margin; slow speed diesel and gas turbine. Cerron Grande would come in a little later.

A prudent review of sector needs would also consider the very real possibility of no rate increase. This scenario would require resource additions in the near term.

(1) Energy and Capacity Balances

With no tariff adjustments, and given the expected December 1989 peak of 407 Mw, a comparison of 1994 needs with the new projects expected to come on line by then, the shortfall is as follows:

	Capacity Mw	Yearly Energy GWh
New facilities needed by 1994	105	630
Expected Plant Additions	50	335
SHORTFALL by 1994	55 Mw	295 GWh

(2) Alternatives Within This Option

To meet these requirements two alternatives are discussed here:

- gas turbine plus slow-speed diesel
- a combined cycle plant

Technically, both appear to be equally feasible. However, only the diesel appears economically feasible.

The gas turbine - slow speed diesel alternative could include:

ONE	20 Mw gas turbine	20 Mw	80 Gwh
TWO	20 Mw slow speed diesel generators	40 Mw	320 Gwh
		60 Mw	400 Gwh

The gas turbine could be installed in the San Salvador Metropolitan Area as a peaking/emergency unit. The indicated production capability of 80 Gwh/year should be exploited only in a dry year, given the high cost of jet fuel.

The two slow-speed diesel generators would be run as described above.

A combined cycle plant alternative would consist of a combination of gas turbines and a steam turbine. The total rating could be chosen between 60,90 or 105 Mw. If normal gas turbines, burning distillate (jet fuel) are selected a location near the capital is the most favorable one, provided cooling water can be found for the steam unit. the production cost, however, will be high because of the premium fuel.

The production data could be either:

	Mw	Total Gwh
Two 20 Mw gas turbines and one 20 Mw steam turbine	60 Mw	360 Gwh
Or three 20 Mw gas turbine and one 30 Mw steam turbine	90 Mw	540 Gwh

The advantage of the combined cycle plant is that either one or both the gas turbines can run independently for peaking. One of the disadvantages is that with the steam unit in operation, it should be run at no less that 50 percent capacity to reach an acceptable efficiency. It is probably possible to fire the gas turbines with residual oil after suitable treatment. Whether the reliability of such an arrangement is acceptable is a point to be investigated, as is the whole feasibility of the combined cycle plant.

Other alternatives may be considered; for instance one using medium speed diesel engines (400-500 rpm) comparable to those which CEL has at Miralvalle. The drawback, however, is that these units are currently available only in the 10-12 Mw range. Therefore, several more units would be needed than for the larger (20-26 Mw) slow speed diesel units, with the complications that this entails.

If the gas turbine - slow speed diesel alternative were retained, then it would be worth considering whether CEL can afford to buy larger units at a marginal increase in cost. The next commercially available sizes are 35 Mw for the gas turbine, and 2 X 26 Mw for the S.S. diesel units. The increase in cost is much less than the increase in output indicated below:

One 35 Mw gas turbine	35 Mw	140 Gwh
Two 26 Mw slow speed diesel	52 Mw	400 Gwh
	---	---
TOTAL CAPACITY	87 Mw	540 Gwh

This would probably be better since it would give CEL breathing space into 1995 and 1996.

If CEL succeeds in implementing this, its system would remain in essentially the same operating condition as today, i.e. operating in a precarious condition and without a sufficient reserve margin to prevent power cuts to users.

d. **Operating Reserve Margin**

The CEL system has been operating in recent years without an adequate reserve margin. In its simplest form, this implies that when a generator is disconnected, and is no longer feeding into the system, users must be disconnected immediately and left without power. This "Load shedding" procedure achieves the goal of matching the available generating capacity with the load it can supply without overloading the machines.

One option would be to improve the system's reserve margin equal to "spinning reserve" (10 percent of the load to cover sudden faults or load increases) plus the capacity of the two largest units (15 de Septiembre 78 Mw and Ahuachapan 35 Mw). Under this criterion the capacity reserve margin could be set even as high as 150 or 160 Mw over the 1990 - 1994 period. Thus, this criterion tends to suggest a very high reserve due to large units and high risk of damage. It may be preferable to accept some of the risk.

This is approximately 600 Gwh (average hydro production - 1600 GWh, less dry year production 1000 Gwh). More refined criteria can be developed to determine the reserve margin but this is sufficient for the purposes of a summary review.

e. **Toll storage in Honduras**

The interconnection project with Honduras, already mentioned in C.2.b above, is slowly moving towards execution. Realistically it cannot be expected to operate much before the end of 1993, although it could slip further if the financing negotiations with the Spanish Government were to drag on.

The 230 kV line would connect CEL's largest plant, 15 de Septiembre, with the Honduran system at La Pavana.

Honduras does not seem to have any hydro power for sale for the time being, but could generate power in its refurbished thermal plants if CEL needed it.

The immediate advantage of the interconnection lies in a toll storage agreement which CEL and ENEE(Honduras) are negotiating. Under this agreement CEL would send power to Honduras in the rainy season when there is a surplus. Honduras, which has a large reservoir at El Cajon, would then be able to return the energy to CEL during the dry season. The significant amount of 300 GWh is approximately ten percent of CEL's needs, and CEL would compensate ENEE by paying a toll charge for the storage.

Thus the interconnection with Honduras should allow CEL to produce an additional 300 GWh from its hydro plants in an average year. In addition, the interconnection will give CEL access to a thermal reserve and improve the security of supply, at least within the limits if the capacity of the interconnection line. As indicated, it is a very beneficial arrangement, but is not as secure as if CEL owned a new plant. The toll storage depends first on the Rio Lempa having surplus water in the rainy season and secondly, on the transmission line capacity being available when CEL needs it.

3. Transmission and Distribution Facilities 1990-1994

a. Transmission Facilities

The increase in generating facilities must be accompanied by a corresponding addition to transmission capacity. The precise location of the new line sections and their scheduling must be defined after load flow studies and other system studies have been carried out to simulate the system's performance with the new arrangements. Since the country is small the cost of these new transmission lines will only be a fraction of the generating facilities. Also, since CEL has shown itself to be quite capable to have 115kV lines built efficiently and inexpensively. Also, transmission within the country needs to be treated as an adjunct to the generating projects.

b. Transformer Facilities

An expansion of the transformer facilities in San Salvador is underway which will feed power from the 115 kv trunk line system into the 23 kv distribution system. This is the construction of the San Bartolo Substation and expansion of the Nuevo Cuscatlan Substation. The financing for this is secured through USAID.

There are considerable requirements for materials and equipment to refurbish substations and to repair lines throughout the rest of El Salvador. A number of items such as circuit breakers and disconnect switches in the substations are so old that spare parts are no longer obtainable.

There are also the substations in Tecoluca and Ozatlan which must be rebuilt along with the lines that connect them to the system. A preliminary estimate of the cost of materials and equipment exceeds $12 million. The installation costs should add another $5-6 million to this.

c. Distribution Facilities

The major task of refurbishing the whole 23 kv distribution is necessary to make it possible for the users to absorb power that will be generated and transmitted. It consists of large numbers of minor projects such as replacing overloaded cables with larger

ones or installing new ones, replacing transformers and switches, and generally rearranging the distribution network.

This work will either be done or supervised by the utilities' own personnel. It is very different from building a new plant in that the refurbishing work must go on with the minimum of disruption in the service to adjoining parts of the system. Thus there are physical limitations to how fast this work can proceed, even after the financial resources become available. As a working assumption we can estimate that at least six years will be needed to refurbish the system and to return it to the degree of efficiency and capability margin which it had in 1978-79. The cost of this work is $30 million, of which at least half is in local currency. To be able to proceed, rates of the distribution companies must be raised sufficiently above CEL'S wholesale rate so that they can generate the cash flow they need.

The alternative of tapping local savings resources is desirable in the long term. It is not realistic to expect that bonds in local currency can be placed in the near future by companies without an established earnings record. Foreign loans can help these companies, but the essential ingredient to rebuilding distribution is to put it on a profit making footing.

Since there are approximately 7000 km of distribution lines which have suffered from insufficient maintenance during the last ten years, it is estimated that between $5 and $10 million dollars should be allocated during the next six years.

d. Private and Captive Plants

The economic resurgence of El Salvador will carry with it an increase in industrial activity and an increase in the industrial and commercial demand for electricity. It is entirely possible that the public utility system may be unable to supply the necessary power in time. To prevent the damage to the economy that would ensue, industrial users should be allowed and indeed encouraged to produce and to share their own electricity.

Industries which use processed steam would be the first candidates, since they could install topping turbines to produce power at competitive prices. Other industries would have to use diesel generators, but to make this an economic proposition units larger than 1000-2000 kw would be needed. This implies that several industries would have to share a diesel plant and would therefore have to use the public distribution system, or an extension, to receive the power.

This opens the door to introducing cogeneration agreements. Industrial power plants could keep operating at night and could feed power to the public utility system.

This would require legal and tariff changes. CEL's monopoly of generation and transmission would have to be limited to units above 25 Mw and to voltages of 115 kv and above. Private producers should be free to enter the field below these limits, provided they meet published technical conditions. CEL or the distribution utilities should be required to purchase the power offered at a fair price. To establish the price there are a number of mechanisms to choose from, but all must be based on the actual cost of production not on a fixed and immutable figure set by the executive power.

Since the likelihood of a power shortage in the next four years is high, and the proposed avenue to private power is only blocked by legal institutional obstacles, it is advisable that these be removed without delay. It is important that either a cogeneration or a private power enterprise be encouraged to start as soon as possible. Unless the first plant is a success, however, other entrepeneurs may not follow in time to help the economy.

4. The period 1995-1999

a. The Financing Problem

There is sufficient time, (6 years), to plan and execute major projects with costs exceeding a single year's revenue, approximately $50 million. The traditional sources of capital for this have been the Multilateral Development Banks (MDB), including the World Bank, IADB and CABEI.

During the last six or seven years, electricity rates have been kept below cost and this has damaged CEL's financial position. The devaluation of the Colon in 1986 brought about operating losses for the first three years, and consequently, CEL is no longer eligible for credit. It has thus turned to bilateral government, government grants, and credits from its oil suppliers, Mexico and Venezuela, to finance smaller projects. These sources can only be relied on for limited amounts and not to finance many years of expansion.

It follows that prerequisites for major projects during the second half of the decade are:

- Increased electricity rates to cover all costs and generate a return on investment which can be applied to expanding facilities.

- An end to the civil war, to allow major construction projects to be built at reasonable cost.

For the purposes of this section we assume that electricity rates will return to normal by 1991; that the utilities become eligible for credit by 1992; and that hostilities will have ceased by the early 1983. Should this not occur, the program of expansion will

have to be curtailed and be resigned to continue along present lines. ISA does not consider the alternative of continued use after that date.

b. Generation Expansion 1995-2000

The major projects to be considered in the long-term are:

- The doubling of the Cerron Grande Hydro Plant, adding 135 Mw, if conditions prevent it being completed earlier.

- The 30 Mw extension of the 5 de Noviembre Hydro Plant, to be reviewed by 1991 after the feasibility study is completed.

More slow-speed diesel and other oil-fired plants would be still needed unless fuel prices significantly and/or geothermal costs are brought down with further study of resources and design. In that case the following would also be considered:

- The installation of two Geothermal units at Berlin, which should add 70 Mw of capacity and 500 Gwh of energy production.

- A geothermal plant at Chapilapa if the drilling results justify it.

Major hydro projects, such as San Marcos or El Tigre, are not considered for the period because their lead time is 9 or 10 years and feasibility studies have yet to be done.

The schedule for Cerron Grande is based on four years being needed from call for tenders to commercial operation. In the event Berlin also becomes feasible, the schedule would be similar or may be somewhat longer because of the time needed to drill the wells.

Assuming Berlin were to become economically feasible, the stated delays for financial eligibility and an end of hostilities, the schedule for commercial operation would be:

1995/96	Cerron Grande Unit 3	67.5 Mw
1996	Berlin Geothermal Unit 1	35 Mw
1997	Cerron Grande Unit 4	67.5 Mw
1999	Berlin Geothermal Unit 2	35 Mw

The cost of this program is estimated at approximately $180 million.

c. Transmission Expansion 1995-2000

The doubling of Cerron Grande will make it necessary to rebuild the Cerron Grande Nejapa line, either as two 115 kv lines or as one 230

kv line (50 Km). If the interconnection with Honduras has been built, then another line (230 or 115 kv) will probably have to be added between the 15 de Septiembre plant and either the Nejapa or the San Bartolo Substation (50-70 Km). The 115 kv ring around San Salvador will have to be closed with a 115 kV section from San Bartolo to the line from Nuevo Cuscatlan (20 Km). The Berlin Plant will have to be connected to the San Miguel 15 de Septiembre line with a 20 Km section of 115 line and transformer and switching stations will have to be expanded to handle the new loads.

The total investment for this work is estimated to be in the range of $20-25 million. Neither the scheduling, nor the execution of this plan should run into difficulties since each item can be built within a period of 2 years.

d. Distribution 1995-2000

No plans have been prepared for distribution expansion during the period. Therefore, we can only proceed on the basis of rough estimates. This assumes a load growth of 7 percent per year, that can be split into a 3 percent increase by existing users and an increase of 4 percent in the number of users. This would amount to approximately 110,000 new users over the five years. At an average investment of $600 per user (intermediate between urban addition and new rural extensions) the total cost would be $66 million for the 5 year period.

5. Summary Overview

a. Energy and Capacity Balances

The programs outlined in the preceding section would barely suffice to cover the requirements of a load growing at 5 percent per year (CEL's low scenario). The CDSS scenario of 4 to 5 percent growth in GDP beginning in 1993 would be more consistent with CEL's middle scenario and a growth rate of over 7 percent in electricity demand. The load growth at 5 percent over ten years is summarized in the table below;

Year	Expected (Adjusted) Capacity Demand Mw	Energy Demand Gwh
1989	407	2182
1990	425	2314
1994	510	2812
1999	650	3590
	---	---
increase 1989 - 1994	103	630
increase 1995 - 1999	140	778
increase 1989 - 1999	243	1408

Capacity additions posited in this table are summarized in the Table IV.M.2 for the third option. These additions barely cover the anticipated growth. There is an 88 Mw increase in capacity which will go to improve the Mw capacity reserve margin. There is, however, a 120 Gwh shortfall in energy production and of course no energy margin for dry years. If it becomes apparent that the other avenues are insufficient to help, then one or more large diesel units (20-26 Mw) will have to be added.

The other avenues referred to here are the power swap (toll storage) with Honduras, purchases from Guatemala, Honduras or Costa Rica, or the growth of private generation or cogeneration.

b. Investment Needs

These assumptions show the financing requirements to be in the range of $403 million. CEL's requirements are approximately $325 million. Two thirds of this could be financed and one third should come from CEL's internal cash generation. The distribution companies' requirements of $125 million should be generated by utilities.

N. PROJECT IMPLEMENTATION

1. General

The procedure for project implementation should be determined, in theory, by the requirements that the project is executed at the least possible cost (lifetime cost) and on schedule. In practice, the procedures are set by laws, regulations and loan contracts.

When a foreign government or a multilateral development bank provides financing, it will require that its own regulations be followed.

2. Projects Financed Internally

For these types of projects, based on the procurement of goods is by price negotiation from invited bidders. Procurement of services, including construction and installation, may be from invited bidders or through a form of Force Account. This is also true and customary for jobs in small lots that are repeated during the year. The utility may set a price for certain work, and then parcel out work to selected contractors. This is satisfactory as long as the work is fairly priced and the reason for the award is explained. Work may simply be handed to a contractor who has been shown to be reliable in the past and who gives assurance that he can complete the work on schedule; i.e. he has both the staff and the equipment available.

Table IV.M.2

Summary of National Expansion Program 1990-1999
(Based on Third Option)

YEAR	INSTALLATION/EVENT	CAPACITY ADDED MW	CAPACITY ADDED GWH	ESTIMATED COST (in millions US$) Generation	Transmission	Distribution
1990	Miravalles Diesel Refurbished	15	80	Financed		
1990	4 x 5 MW Wellhead geothermal	20	140	Financed		
1991	Electricity Rates raised to remunerative level	event				
1992	Ahuachapan rehabilitation	15	115	Being negotiated		
1992	CEL and Distribution utilities become eligible for credit	event				
1992	Transformer stations at San Bartolo and Nuevo Cuscatlan	N/A	N/A		6	
1993	Peace returns to El Salvador	event				
1993	Interconnection with Honduras	(70) (Power Swap)	(300)	Financed		
1993	20 MW gas turbine (at Soyapango?) (1)	20	80	9		
1994	40 MW Slow Speed Diesel Plant (at Acajutla?)	40	320	55	5	
1994	Refurbish other Transformer and Switching Stations					12
1990-95	Rural electrification 15000 users			Financed		
1990-94	Refurbishment of distribution systems					30
1990-94	Add 12000 users per year					30
	SUBTOTAL 1990-1994	**110**	**705**			
	Investment to be financed			**$64**	**$23**	**$60**
1995-96	Cerron Grande Unit 3	67.5	40	23		
1996	Berlin Geothermal Unit 1 (2)	35.0	250	73		
1996	Transmission Expansion for above (3)	N/A	N/A		25	
1997	Cerron Grande Unit 4	76.5	40	20		
1995-00	Distribution Expansion 15000 new users each year					45
1995-00	Rural Electrification (4)					20
1999	Berlin Geothermal Unit 2 (2)	35	250	70		
	SUBTOTAL 1995-2000	**205**	**580**	**186**	**25**	**65**
	Investment yet to be financed					
	TOTAL 1990-2000	**335**	**1,285**			
	Financial resources required 1990-2000			250	48	125
	TOTAL					423

(1) If proposed tariff agreements are not adopted to reduce load factor.
(2) Based on CEL plans, although its feasibility is not apparent and hydro on thermal options would be preferred.
(3) Rough estimate, currently under CEL review.
(4) Includes rough estimate for USAID 1985 Funding and possible future funding. Excludes local funds.

3. Projects Financed by Foreign Sources

Projects financed either by foreign government aid or by multilateral development banks tend to be larger, which must be planned years in advance.

A good part of the long-term planning period is due to the procedures needed to secure approval of financing and approval of the project. The the construction of a mid-sized hydro project needs a lead time of nine to ten years. An estimated schedule has been compiled to show what determines this time and is presented in Appendix IV.N.1.

Much of the time is allocated to studies, negotiations and approvals. Projects with a shorter construction time will suffer from the same problem.

Some of the remedies are obvious, but are not necessarily easy to implement. The prospective borrower, eg. CEL, must be in good financial shape; it must have access to house consultants so that lenders will not question the specifications or designs of the project; it must have a competent team to evaluate proposals and to prevent legal delays. Furthermore, the borrowers must have access to substantial bridge financing to compensate for delays in disbursements by the lender.

Thus a shortening of the schedule for major projects and the consequent reduction in their cost is dependant upon improvements in the utility's own condition.

APPENDIX IV.A.1

THE SYSTEM OF STANDARDIZED UNIT PRICES AS AN ALTERNATIVE TO FACILITATE THE CONSTRUCTION OF RURAL DISTRIBUTION PROJECTS

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Introduction

Even though the governments are aware of the need to promote rural development in their respective countries, and that a basic element of this development is the introduction of electricity, the low or nonexistent rate of returns that these projects normally have has traditionally been an obstacle to their implementation. On the other hand, private distribution companies orientated their commercial policy on the procurement of benefits, without considering the social objectives involved in the distribution of rural electricity.

Faced with this reality, some international finance institutions started to consider the possibility of giving financial aid to the government, soft loans, to give impetus to the execution of rural electrification programs, initiating in the majority of developing countries the impetus of this vital service in rural areas.

Completed Programs of Rural Distribution

As an opening for the National Rural Electrification Program in El Salvador, and having as its complimentary objective the acquisition of experience necessary in aspects of administration, consumption, costs etc., the Executive Committee of the Lempa River (CEL) , an autonomous institution of state character, prepared a study which began to crystalize in I962 with a program called "RURAL ELECTRIFICATION PILOT PLAN" at an approximate cost of US $200,000.00 with funds derived from the Interamerican Development Bank, at a four-year term, with seven years, grace, and an interest-rate of 4.25% pa on balances.

This pilot plan permitted the construction of 17.2km of subtransmission lines, 41.2km of distribution lines and one substation of I000 KW to serve eleven communities in the Department of La Paz (Zone 15) , with approximately 3200 users.

After this test, the CEL identified 17 zones to be provided with electricity across the width and breadth of the country, whose development plan was given in the following form:

PROJECT	ELECTRIFIED ZONES	USERS SERVED
1964-1965	1, 2, 15, and 17	814
1966-1968	8, 9, 10, and 11 *	6,054
1969	3	1,520
1970-1972	All Zones	5,271
1973-1975	**	7,341
1977-1978	1, 2, 3, 8, 9, 10, 11, 14, 15, and 17	13,086
1979-1980	Nine Zones	7,939
1981-1982	1, 2, 3, ***	6,498
1983	**	3,799

* CEL created the Lines Department, with a massive contracting of personnel that permitted it to reach an average construction of 1km/day.

** There was no defined program, applications were accepted that were partly funded by the users.

*** In these years the office of Special Resources (ORE) of the Ministry of Public Works financed a program of rural electrification, the CEL experimenting with a system of unit prices to offset the bureaucratic administration of the bids; in 1982 the Management of Communal Development (DIDECO) of the Interior Ministry offered finance for the construction or rural lines with the contribution of the unqualified labor of the future users.

Projects 1984-1989

In 1984, the Agency for International Development (AID), by way of the External Technical and Financial Secretariat (SETEFE) , a dependency of the Planning and Economic and Social Development Ministry, granted finance to develop rural electrification projects in the Eastern zone of the country; the limitations of time involved with the agreement and the quantity of work presented a problem that CEL could not resolve with its own resources, for which reason the only alternative was thought to be the use of private companies which working simultaneously could offer the technical and physical resources necessary to fulfill the obligation incurred.

The solution that was implemented discarded the use of the traditional system of public bidding, since the process of preparing specifications, bidding and design documents, like the study and evaluation of offers with the aim of awarding the work to those who guarantee the required fulfillment of contracts, requires at least a period of one year starting from the moment the required projects are defined, for a total or maximum of line. Summarizing the efforts and experience of the Rural Electrification Superintendency, which, in that time, was responsible for the execution of the projects of construction of lines, determined what were later called STANDARD UNIT PRICES for each of the different departures or activities involved in the construction of distribution lines. These prices are applied equally to all the companies that are previously assessed by CEL in the technical aspects, equipment, and financial capacity.

System of Unit Prices

This procedure, which had shown its worth in the program effected in 1981, would improve in 1984, given the opportunity to establish a process to industrialize the construction of electric lines taking into account the different sections, related with the construction, the state of the work per section, the analysis of the cost per section, and the reasonable margin of utility for the whole of the work to be done; in 1987 a new revision was done of the standardized sections, incorporating the activities of design and drafting of the projected line.

Sections of the Table of Prices

The sections contemplated within this system are:

1) Transport of materials from the work contractor's premises.
2) Transport of materials and equipment within the work.
3) Transport of posts to the projects.
4) Transport of posts to inaccessible places within the work.
5) Clearing and grubbing.
6) Excavations for posts and guy ropes.
7) Erection or removal of posts.
8) Mounting or removal of structures.
9) Installation or removal of guy-ropes.
10) Installation or removal of transformers and their accessories.
13) Design of the line.

14) Administration and general expenditure.

Each of these sections has various subsections depending on the type of post, equipment or material to be used, and three categories related to the level of difficulty of the terrain.

Price Determination

The unit cost of each section is based in the real cost of the labor and use of equipment of each one. The estimates of necessary man-hours and a utility of 20% over the calculated real cost, also taking account of the legal social loans and the composition of a work group structured according to the type of activity.

Tariff Revision

With all the data considered at the basis of the calculation, a computer program has been formed which allows us to actualize the prices of each section that is seen to be affected by changing one or other of the parameters involved in each stage of the work; increases in the minimum salary, fuel, insurance premiums, prices of equipment and tools, bank interests, etc., are variables which, when affected by some modification, affect different sections that are automatically corrected by the aforementioned program.
To this moment, there have been two revisions of the unit prices, one on April 30th 1986 and the other on June 16th 1988; to be implemented, these adjustments should be approved by the Board of Directors of the Commission, following Justification and demonstration.

So that a company can apply for and obtain its assessment to work as a contractor it should fulfill the following basic requirements:

- Proved experience in this section
- Have equipment for the construction of lines and sufficient and adequate mobilization.
- Availability of financial resources to pay the expenses of construction until the work is completely finished
- Demonstrate the organizational and administrative capacity necessary for the good management of the project.
- Have the necessary technical equipment, under the responsibility of an Electrical Engineer, who will be the person directly responsible for the assigned work.

Once the document certifying the requirements is presented,

xt is analyzed by an Evaluation Committee which subsequently,if everything is satisfactory, requests the formalization of the assessment of the firm from the Board of Directors, whose approval is registered with the relevant dependencies to be able to act as a contractor in the different programs which are realized annually. In 1984 assessment was made of 13 companies, and to date 36 have been enabled to work with CEL in the electrification programs.

Competition

In the scheme presupposed by this system, it could appear that the advantage of free competition is lost, but this is only an appearance, since although the companies do not compete on price, they do compete on quality and the speed of execution of the projects; their administrative, financial and technical capacity is continually submitted to tests, and the number of projects awarded to each contractor depends basically on the speed with which the above has been physically and legally finalized.

Conclusions and Recommendations

Assuming up what has been said previously, the following could indicate some conclusions on the advantage of applying the system of STANDARD UNIT PRICES:

1) Great capacity for execution by way of the resources of the contractors.

2) At the moment of receiving the finance of the programs, the construction of the lines can begin, dead periods virtually disappear and a large quantity of small company contractors that also compete, generate work and give opportunities to new businessmen.

3) Cyclic contracting of additional administrative resources is not necessary; control of execution and supervision of construction absorb very few staff.

4) The bureaucratic administration involved in the contracting of these services is essentially straightforward and the start of work is immediate.

It is also necessary to bear in mind that to provide logistical support for 36 contractors, in the provision and receipt of materials, procedures should be established for

the provision and dispatch of materials with sufficient efficiency to avoid stagnating the flow of the construction.

APPENDIX IV.B.1

CEL TECHNICAL DATA: GENERATORS LARGER THAN 5 MVA - June,1989

NAME OF PLANT	UNIT	RATED MVA	RATED PF	RATED kV	SPEED RPM
5 DE NOVIEMBRE	1	16.6670	0.900	13.80	200.00
5 DE NOVIEMBRE	2	16.6670	0.900	13.80	200.00
5 DE NOVIEMBRE	3	16.6670	0.900	13.80	200.00
5 DE NOVIEMBRE	4	16.6670	0.900	13.80	200.00
5 DE NOVIEMBRE	5	23.8000	0.900	13.80	225.00
GUAJOYO	1	16.6670	0.900	13.80	300.00
CERRON GRANDE	1	75.0000	0.900	13.80	150.00
CERRON GRANDE	2	75.0000	0.900	13.80	150.00
15 DE SEPTIEMBRE	1	87.0000	0.900	13.80	105.90
15 DE SEPTIEMBRE	2	87.0000	0.900	13.80	105.90
AHUACHAPAN	1	37.5000	0.800	13.80	3600.00
AHUACHAPAN	2	37.5000	0.800	13.80	3600.00
AHUACHAPAN	3	40.0000	0.875	13.80	3600.00
ACAJUTLA	1	35.2900	0.850	13.80	3600.00
ACAJUTLA	2	40.2900	0.850	13.80	3600.00
ACAJUTLA	SIGMA	7.7800	0.850	6.60	3600.00
SOYAPANGO	1	21.1760	0.850	13.80	3600.00
SOYAPANGO	2	21.1760	0.850	13.80	3600.00
SOYAPANGO	3	27.6870	0.850	13.20	3600.00
SAN MIGUEL	1	29.7410	0.850	13.80	3600.00

CEL TECHNICAL DATA: TRANSFORMERS AT STEP DOWN SUBSTATIONS - June, 1989

SUBSTATION	MVA RATING	MVA	VOLT. RATING HIGH kV	LOW	OPERAT. VOLT. HIGH kV	LOW	REACTANCE	TAP POSITION
GUAJOYO	30/40/50	30.00	110.00	46.00	115.00	48.0909	6.38	5
ACAJUTLA	30/40/50	30.00	110.00	34.50	115.00	36.0682	6.90	
ACAJUTLA	15/20	15.00	110.00	46.00	115.00	48.0909	6.65	N
CERRON GRANDE	15	15.00	110.00	23.00	115.00	24.0455	10.80	1
15 DE SEPTIEMBRE	30/40/50	15.00	110.00	46.00	115.00	48.0909	11.41	2
SOYAPANGO 1 AND 2	30/40/50	30.00	110.00	23.00	115.00	24.0455	6.50	5
SOYAPANGO ZONA 15	15	30.00	110.00	46.00	115.00	48.0909	6.25	4
SAN RAFAEL CEDROS	30/40/50	15.00	110.00	46.00	115.00	46.0000	11.80	5
SAN MIGUEL	30/40/50	30.00	110.00	46.00	115.00	48.0909	6.87	4
SANTA ANA	30/40/50	30.00	110.00	46.00	115.00	48.0909	6.40	4
SN ANTON. ABAD T1	30/40/50	30.00	110.00	23.00	115.00	24.0455	6.53	5
SN ANTON. ABAD T2	30/40/50	30.00	110.00	23.00	115.00	24.0455	6.52	5
NEJAPA	30/40/50	30.00	110.00	23.00	115.00	24.0455	6.18	5
NUEVO CUSCATLAN	30/40/50	30.00	110.00	23.00	115.00	24.0455	6.10	5
NUEVO CUSCA AUTOT	3.5	3.50	35.50	22.00	38.80	24.0455	2.20	
NUEVO CUSCA AUTOT	5	5.00	35.50	22.00	38.80	24.0455	2.10	
ATEOS	15/20	15.00	110.00	46.00	115.00	48.0909	10.80	

PLANT - UNIT	NEW CAPACITY	MVA	RATING HIGH kV	RATING LOW	VOLT. HIGH kV	VOLT. LOW	REACTANCE	TAP POSITION
5 DE NOV 1 AND 2	37.5/50/62.5	37.50	120.00	13.20	115.00	12.6500	7.90	
5 DE NOV 3	13.33/16.67	13.33	120.00	13.20	115.00	12.6500	11.10	3
5 DE NOV 4	13.33/16.67	13.33	120.00	13.20	115.00	12.6500	10.02	3
5 DE NOV 5	15/20/25	15.00	120.00	13.20	115.00	12.6500	7.93	3
15 DE SEPTIEMBRE	60/60/100	60.00	120.00	13.20	115.00	12.6520	6.00	4
SOYAPANGO 1 AND 2	25.5/33.9/42.5	25.50	23.00	13.20	24.05	13.8026	6.27	3
SOYAPANGO UNIT 3	18/24/30	18.00	115.00	13.20	115.00	13.2000	7.28	2
GUAJOYO	13.75/18.30	13.75	120.00	13.20	115.00	12.6570	4.90	3
SAN MIGUEL	15/25	15.00	46.00	13.80	48.09	14.4270	3.90	2
ACAJUTLA - SIGMA	8.25	8.25	34.50	6.60	36.07	6.9003	6.20	
ACAJUTLA 1	27.5/33.00	27.50	120.00	13.20	115.00	12.6500	10.40	4
ACAJUTLA 2	29.0/38.70	29.00	120.00	13.20	115.00	12.6500	9.85	3
AHUACHAPAN 1	37.5	37.50	115.00	13.80	115.00	13.8000	7.84	2
AHUACHAPAN 2	37.5	37.50	115.00	13.80	115.00	13.8000	8.12	4
AHUACHAPAN 3	40.0	40.00	115.00	13.80	38.80	13.8000	8.53	4
CERRON GRANDE 1&2	52/69.3/86.6	52.00	120.00	13.20	38.80	12.6500	6.50	3

OVERALL DATA OF TRANSMISSION LINES

TYPE Nº	Nº OF BETWEEN SUBSTATIONS AT:	Nº OF CONDUCTORS AT:	THERMAL DESIGNATION	LENGTH	LINES IN SERVICE AND SIZE	CIRCUITS	LINE PER PHASE	CONDUCTOR RATING	(KMS)
1	5 DE NOVIEMBRE	CERRON GRANDE	L7-10-17-01		ACSR-477-MCM	1	1	670	18.1
2	5 DE NOVIEMBRE	SN RAFAEL CEDROS	L7-10-32-01		ACSR-477-MCM	1	1	670	30.0
3	GUAJOYO	SANTA ANA	L7-11-35-01		ACSR-477-MCM	1	1	670	27.3
4	ACAJUTLA	OPICO	L7-13-38-01		ACSR-477-MCM	1	1	670	64.6
5	ACAJUTLA	SONSONATE	L7-13-41-01		ACSR-477-MCM	1	1	670	23.7
6	AHUACHAPAN	SANTA ANA	L7-16-35-01		ACSR-477-MCM	1	1	670	36.5
7	AHUACHAPAN	SONSONATE	L7-16-41-01		ACSR-477-MCM	1	1	670	25.5
8	CERRON GRANDE	SAN MARTIN	L7-17-43-01		ACSR-477-MCM	1	1	670	50.2
9	15 DE SEPTIEMBRE	SN RAFAEL CEDROS	L7-18-32-01		ACSR-4/0	1	1	670	40.1
10	15 DE SEPTIEMBRE	SAN MIGUEL	L7-18-34-01		ACSR-4/0	1	1	370	45.6
11	15 DE SEPTIEMBRE	SAN MARTIN	L7-38-43-01		ACSR-477-MCM	2 *	1	370	61.0
12	SOYAPANGO	NEJAPA	L7-30-37-01		ACSR-477-MCM	1	1	670	10.1
13	SOYAPANGO	SAN MARTIN	L7-30-43-01		ACSR-477-MCM	1	1	670	11.2
14	SN RAFAEL CEDROS	SAN MARTIN	L7-32-43-01		ACSR-477-MCM	1	1	670	20.8
15	SANTA ANA	OPICO	L7-35-38-01		ACSR-477-MCM	1	1	670	23.1
16	SN ANTONIO ABAD	NEJAPA	L7-36-37-01		ACSR-477-MCM	1	2	1340	6.7
17	SN ANTONIO ABAD	NVO. CUSCATLAN	L7-36-42-01		ACSR-477-MCM	1	2	1340	11.6
18	NEJAPA	OPICO	L7-36-38-01		ACSR-477-MCM	1	1	670	19.0
19	SONSONATE	ATEOS	L7-41-44-01		ACSR-477-MCM	1	1	670	28.3
20	NVO CUSCATLAN	SAN MARTIN	L7-42-43-01		ACSR-477-MCM	1	2	1340	30.0
21	NVO CUSCATLAN	ATEOS	L7-42-44-01		ACSR-477-MCM	1	1	670	23.3
									606.7

Nº	LINES OUT OF SERVICE BETWEEN SUBSTATIONS AT:		LINE DESIGNATION	CONDUCTOR TYPE AND SIZE	Nº OF CIRCUITS	Nº OF CIRCUITS PER PHASE	RATING	LENGTH (KMS)
1	CERRON GRANDE	NEJAPA	L7-17-37-01	ACSR-477-MCM	2 $	1	670	40.0
2	SN RAFAEL CEDROS	TECOLUCA	L7-32-39-01	ACSR-477-MCM	1	1	670	27.7
3	SAN MIGUEL	OZATLAN	L7-34-39-01	ACSR-477-MCM	1	1	670	43.6
4	OZATLAN	TECOLUCA	L7-39-40-01	ACSR-477-MCM	1	1	670	37.5
								148.8

Nº	LINES OUT OF SERVICE BETWEEN SUBSTATIONS AT:		LINE DESIGNATION	CONDUCTOR TYPE AND SIZE	Nº OF CIRCUITS	Nº OF CIRCUITS PER PHASE	RATING	LENGTH (KMS)
1	15 DE SEPTIEMBRE	SAN MIGUEL	L7-18-34-01	AAAC- 4/0	1	1	365	50.0
2	NEJAPA	SAN MARTIN	L7-37-33-01	ACSR-477-MCM	2	1	1340	20.0
3	SAN MARTIN	SAN BARTOLO	L7-33-35-01	ACSR-477-MCM	1	1	670	9.0
4	SN RAFAEL CEDROS	SAN MARTIN	L7-32-43-01	ACSR-477-MCM	1	1	670	21.5
5	15 DE SEPTIEMBRE	SN RAFAEL CEDROS	L7-18-32-02	ACSR-477-MCM	1	1	670	39.5
								140.0

* ONLY ONE CIRCUIT OPERATIONAL $ DATA FOR EACH CIRCUIT JUNE 1989

APPENDIX IV.C.1

Methodology and Planning Criteria of the Electric System

The model WASP (Wien Automatic System Planing) was created and the International Atomic Energy Organization (OIEA), which permits - producing programs of optimum expansion for a system of generation - interconnected energy, coherent with the projections of demand and with the system,s own restrictions, within a determined horizon of planning.

To establish this optimization, the program compares the stages of the different expansion alternatives generated from the projects), and using dynamic programming techniques, produces an optimum trajectory to minimize the total costs.

Within the limitations that the model presents for use in El Salvador is that of making simulations of the operation of the system, as if this were uninodal (concentrating on the generation and load of only one node), which does not allow consideration of the restrictions imposed by the sabotage of the transmission system.

Another limitation is the way in which it handles the operation of the hydroelectrics, under different hydraulic conditions (which is an entry-datum for the model) and load conditions: it has to fit the amount of energy to be generated by each plant or the load conditions of the system, which the model does not do, since the generation of the projects is treated exogenously and as has been mentioned above, it is an entry-datum, and can not be modified under any circumstances.

Preliminary definition of Optimum Trajectory

The principal aspects that are followed to establish the preliminary expansion trajectory are the following:

- Raising the basic data and information.
- Definition of the macroeconomic scene.
- Discussion and consolidation of the database of the power system with a multi-disciplinary work group.
- Estimation of the demand for energy and power for the planning period.
- Identification of generation projects with their installed capacity and their capacity for generation.
- Collaboration and/or actualization of the investment costs of the generation projects.
- Calculation of a merit index for each generation project,

taking into consideration relative costs of investment, fuel [when dealing with a thermic project), operation and maintenance and the additional benefit of point capacity (MW) of the project to the system.
- Based on the results of the previous item, an arrangement of projects (in order of merit) is established, within the category of projects of Base and Point.
- Formulation of different expansion alternatives which should be coherent with the different projections of demand.

Demand Trajectories

To define the optimum expansion trajectory the starting point is the obtained preliminary expansion alternative, which is an entry-datum for the WASP III model; this, in turn, generates many more alternatives, simulates operation and compares total costs at current values and selects the alternative of minimum present cost.

PLANNING PARAMETERS

Security Criteria

Owing to the failings which can occur in the units and the requirements of maintenance, it is not possible to make available the total installed capacity 100% of the time; this makes necessary the availability of a reserve, with the aim of securing a dependable supply.

The level of dependability which is desired to fill the demand imposes restrictions on the possible alternatives of expansion. In this way, elevated criteria of security are established, for example the dry hydrological condition, the installed capacity would be greater if the security limits were less strict, for which additional investment is required.

Given the characteristics of the existing system, which is predominantly hydroelectrical (generation capacity variable depending on the hydrological conditions), it is necessary to establish two security criteria to supply the demand; one acting on dependability of peak demand (MW) and the other on the supply of energy (GWH).

Security in Peak Demand

To establish the criterion of security in the supply of maximum demand, the criterion of Loss of Load Probability (LOLP) is used, which defines as the fraction of time when lt is prepared for the load to exceed the available generation. The value that the LOLP adopted in the initial years of the period until 1992) was a maximum value of 4 days/year, owing to the conditions of lack of dependability in the supply - because of the sabotage of the transmission system, using a maximum of 2 days/year for the rest of the period, considering that the dependability conditions of the same would improve.

It is important to stress the fact that in systems with a high percentage of installed hydro-capacity, this criterion loses importance and it is the supply of energy which takes greater weight.

Security in the Supply of Energy

Owing to the unpredictable nature of the rains and, as a result of that, the availability of water for generation, similarly the unavailability of generation units because of maintenance or for other reasons, it is necessary to establish a criterion to calculate the effects produced by the fact of not supplying all the energy required.

The criteria used by WASP III to evaluate this impact, is the cost of energy not supplied, in $/WH, by way of a polynomial of up to grade three to be able to consider different levels of energy not supplied.

In the country there is no study in progress to determine the cost of energy not supplied, for which reason previous studies used approximations of this cost, the elasticity of the PIB with respect to international consultants, these recommend not to use this approximation, because it has a high margin for error, and that in place of it a criterion should to satisfy the demand under any hydrological conditicns should be used.

This last criterion seems to be very drastic, since it implicates the planning of a system based only on the dry hydrological condition, which would bring a greater quantity of investments; for this reason, it is decided to fill all the demand of the system considering the probability of occurrence of the different hydrological conditions.

Simulation of the Operation

With the aim of determining the operation costs of the different expansion alternatives, it is necessary to simulate the annual and periodic generation of the centers, with the object of determining the quantity of energy it is necessary to generate, for each type of center, to satisfy the projected demand, and with that establish the operation costs for each alternative.

The WASP II model has a module (MERSIM) of probability simulation, which takes account of the rate of forced exits and the requirements of maintenance to determine the energy to be generated by control.

Two basic criteria should be established to effect the simulation of the operation, the first refers to the rolling reserve which must be maintained to avoid cuts in the supply, for the forced shutdown of some unit which is in operation; and the second has reference to the defining an order of load of the different units which make up the system.

As a criterion of the rolling reserve, the practice has been to have a reserve equal to the biggest unit which is in operation, less 3% of the maximum demand of the period.

The order of load has been established in the following way: The geothermic units, together with the hydroelectrics of a trickle of water, cover the base of the demand; the hydroelectric projects with regulation in the first years cover the middle part of the demand, being displaced to cover the peak of the demand in the future, whereby the demand rises and they enter into operation (vapor thermals, geothermals) unable to cover the peak of the demand.

The Thermal Centers are given loads according to their increasing costs of total generation.

Rate of Discount

The rate of discount that was taken was 12%, which is recommended by the International Finance Organizations for developing countries like El Salvador.

For the planning of the energy sector as a whole it is necessary to bear in mind the existing relationships between economy and energy which permit the formulation of rational solutions, under a conceptual standard articulated in the social and economic development of the country.

The conceptual standard of economic integration-energy, in

the integrated energy planning, presents four fundamental activities.

- The Design of Basic Socio-Economic-Energy Scenarios
- The Simulation of Energy Economy-Demand Interactions
- The Simulation of Energy Supply-Demand Interactions
- And the global evaluation of alternatives for the choosing of an Expansion Plan of the Energy Sector at the lowest cost.

With the aim of being able to produce a projection of the future trajectory of the economy, CEL constructed a macroeconomic model linked to a matrix of macroeconomic product-input, by way if which scenarios are structured of the various macroeconomic and sectoral components.

Given that the country does not have a current long-term Economic-Social Development Plan, owing to the armed conflict, which began some ten years ago, it was necessary to construct this model.

The model in question is composed of joint equations, which have difficult functional forms, lineal or nor lineal, dynamic in that past events influence future events, interdependent and of simultaneous solution.

Model simulation is realized by way of the software packet of the program AREMOS, of great versatility and rapidity for simulation work. The model was divided into six sub-models that take account of the areas of interest from a macroeconomic point of view: they being the following

- Submodel of accumulated demand.
- Submodel of balance of payments.
- Submodel of the financial sector.
- Submodel of public finance.
- Submodel of prices.
- Submodel of product-input.

The six submodels are interrelated, so it is impossible to obtain an individual solution for each one.

APPENDIX.IV.E.1

STANDARDS IN USE AT CEL

NAME	ABBREVIATION
American Society for Testing and Materials 1916 Race Street Philadelphia, Pennsylvania 19103, USA	ASTM
American Welding Society 345 East 47th Street New York, New York 10017, USA	AWS
National Electrical Manufacturers Association 155 East 44th Street New York, New York 10017, USA	NEMA
American Society of Mechanical Engineers 345 East 47th Street New York, New York 10017, USA	ASME
Institute of Electrical and Electronic Engineers 345 East 47th Street New York, New York 10017, USA	IEES
American National Standards Institute, Inc. (formerly American Standards Association, Inc.) 1430 Broadway New York, New York 10018, USA	ANSI
American Society of Civil Engineers 345 East 47th Street New York, New York 10017, USA	ASCE
International Electrotechnical Commission 1, Rue de Varembe Geneve, Switzerland	IEC
Insulated Power Cable Engineers Association 238 Valley Road Montclair, N. J. 070402, USA	IPCEA
Canadian Standards Association 178 Rexdale Boulevard Rexdale 603, Ontario, Canada	CSA

American Association of State Highway & Transportation Officials General Offices 917 National Press Building Washington, D.C., USA.	AASHTO
American Concrete Institute 22400 W Seven Mile Road Detroit, Michigan 48219, USA	ACI
American Institute of Steel Construction, Inc. 101 Park Avenue New York, N.Y. 10017, USA	AISC
American Society for Testing Materials 1916 Race Street Philadelphia, Pennsylvania 19103, USA	ASTM
American Welding Society 345 East 47th Street New York, N.Y. 10017, USA	AWS
Insulated Power Cable Engineers Association 192 Washington Street Belmont, Massachusetts 02178, USA	IPCEA
National Boards of Fire Underwriters 85 John Street New York, N.Y. 10007, USA	NBFU
National Electric Code Board of Underwriters 85 John Street New York, N.Y. 10007, USA	NEC
National Electric Manufacturers Association 155 East 44th Street New York, N.Y. 10007, USA	NEMA
Bureau of Standards National Electrical Safety Code Superintendent of Documents U.S. Government Printing Office Washington, D.C., 20025, USA	NESC
U.S. Bureau of Reclamation Attention Code 992 P.O. Box 25007, Building 67 Denver Federal Center	USBR

APPENDIX IV.I.1

Specific ratios for electric companies taken from the book "Investments" by D.F. Jordan and H.G. Dougall and stipulations on loans contracts signed by the Government of El Salvador and CEL with BIRF and BID.

INDICATORS FOR 1988	RATIO
Fixed Assets/Income This indicator shows the soundness an electric service company. It also shows whether there is excess investment. If net assets are used, the norm establishes that the assets should not be more than 5.5 times income. In this respect, CEL is fine because of revaluation following the devaluation of the colon. The ratio could be better if were assets are revalued owing to inflation.	6.44
Debt/Net Value of Value Assets This factor shows the degree to which assets backup liabilities. The accepted figure in the private sector is a maximum of 55%. CEL is fine in this respect.	0.56
Total Expenditure/Gross Income This coefficient attempts to measure two aspects: operating efficiency if the expenditure is kept between 80% and 72% depending whether the generation is thermic or hydraulic and whether acceptable levels of maintenance and deterioration are being covered; this is proved when the coefficient is very low with respect to the norm. CEL is fine in this respect.	0.79
Payment of Interests/Net Income This index tests the capacity of a company to generate income to cover dividend and interest. Six percent (6%) is a good guarantee for investment and loans. CEL has a very low ratio.	2.10
Operation Utility/Net Fixed Assets Operating profit interest payment over net investments in plant: 6.5% after tax, is considered a fair return on investment.	0.03

Debt

CEL should not acquire additional debts, unless the Bank agrees. If its net income in the year prior to the contracting for more debt, taking the higher quantity, were lower that the sum, multiplied by 1.5 representing the maximum requirement for the service of all the debt (including the debt to be contracted). According to Clause 5.07 of BIRF Loans-1288-ES.

1988 CEL had (in millions of colones):

Net Income	306.5 - 178.3	=	128.2
Debt Service Limit	128.2 x 1.5	=	192.3
Debt Service		=	269.4

Indicating that the financial load of CEL is not in line with its income and further indebtedness is not recommended as long as the economic and financial situation is not resolved.

INDICATORS	FORMULA	RATIO
ECONOMIC		
Physical Production/Workers	Net Energy (KWH) / Total	697,307 kWh/Worker
Value of Production/Workers	Income for Energy sales(C) / Total Workers	108,771 kWh/Worker
Physical Production/Value of Production	Available energy (kWh) / Total Net Assets	0.766 kWh/C
Value of Production/Capital	Income/Sale of Energy(C) / Total Net Assets	C .119
Investment per C/Invoiced kWh	Total Net Assets / Invoiced kWh	C 1.654
FINANCIAL		
Index on net rate of returns	Net operating income / Annual Sales	11.38 %
Rate of return to capital	Net operating income / Net Capital	5.44 %
TECHNICAL		
Investment per Installed Hydraulic kW	Inv'tment.Hydro Genration / Installed hydro capacity	C 2,821.58
Investment per Installed Geothermal kW	Inv'tment.GeoThermal Gen. / Installed geothermal capacity	C 2,633.87
Investment per Installed Thermal kW	Inv'tment. Thermal Gen. / Installed thermal capacity	C 576.76

APPENDIX IV.L.1

ECONOMIC VALUE OF ENERGY SOURCES IN EL SALVADOR

	Salvadoran Consumption	Average Cost ($ 1988)	Percent of Total Energy	Calculation of Costs: Unit	Calculation of Costs: Cost	Calculation of Costs: Source/Note
FIREWOOD						
Ton	3,273,988.0	82.5	48.6%	Cl '86/Ton	292.0	CEL
Tcal	9,992.0	27,041.5		Cl '88/Ton	389.6	Allowing for infl.
Ton/TCal	327.7			$ '88/Ton	77.9	Without Siltation
				$ '88/Ton	82.5	Incl. Silt. Costs
OIL						
1000 Bl	5,645.0	18,221.5	36.8%	Cl '88/Bl	124.1	LBII
TCal	7,566.5	13,594.2		$ '88/Bl	24.8	
1000 Bl/TCal	0.7461			$ '88/1000 Bl	24,825.5	
ELECTRICITY						
MWh	1,747,287.0	330.0	7.3%	ct '88/kWh	33.0	LBII
TCal	1502.7	383,712.5		$ '88/MWh	330	
MWh/TCal	1,162.8					
OTHER						
TCal	1497.3	383,712.5	7.3%			
TCal	1497.3	383,712.5				
TCal/TCal	1.0000					

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

CENTRAL GEOTHERMAL

Operating Data:	
Total Capacity (MW)	35
Construction Time (Years)	5
Project Lifetime (Years)	30
Capacity Factor	75.0%

Financial Data:	
Local Investment, Actual	10,000
Foreign Investment, Actual	66,000
Costs Present Value	94,369
Benefits Present Value	67,039
Net Present Value	(27,330)
Net Benefits/Investment	0.76
Internal Rate of Return	9.02%
Dollars/MWh	0.013679603

PROJECT COSTS

	Generation		Investment		Operation and Maintanence		INVESTMENT COSTS			
							Financial		Economic	
Year	(TCal)	(MWh)	Actual ($ thousands)	Discounted ($ thousands)	Actual Costs ($ thousands)	Discounted ($ thousands)	Foreign	Local	Foreign	Local
1	0	0	4,516.2	4,516.2	0	0	2,640	400	4,118	398
2	0	0	6,774.2	6,048.4	0	0	3,960	600	6,178	597
3	0	0	33,871.2	27,001.9	0	0	19,800	3,000	30,888	2,983
4	0	0	45,161.6	32,145.1	0	0	26,400	4,000	41,184	3,978
5	0	0	22,580.8	14,350.5	0	0	13,200	2,000	20,592	1,989
6 - 35	198	229,950	0.0	0.0	2,255	1,279	0	0	0	0
Total	5,933	6,898,500	112,904.0	84,062.1	67,647.4	10,306.6	66,000	10,000	102,960	9,944

PROJECT BENEFITS (Substitute Energy Costs)

	Firewood			
Year	Generation (TCal)	Generation (Tons)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
6 - 35	96.1	31,491.5	2,599.0	1,474.7
Total	2,883.3	944,743.8	77,968.7	11,879.1

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

	Year	Oil Generation (TCal)	Generation (1000 Bl)	Actual Costs ($ thousands)	Discounted ($ thousands)
	1	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0
	6 - 35	72.8	54.3	989.3	561.4
	Total	2,183.2	1,628.8	29,679.9	4,522.0
		Electricity			
	Year	Generation (TCal)	Generation (MWh)	Actual Costs ($ thousands)	Discounted ($ thousands)
	1	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0
	6 - 35	14.4	16,786.0	5,539.4	3,143.2
	Total	433.1	503,579.4	166,181.2	25,319.0
		Other			
	Year	Generation (TCal)		Actual Costs ($ thousands)	Discounted ($ thousands)
	1	0.0		0.0	0.0
	2	0.0		0.0	0.0
	3	0.0		0.0	0.0
	4	0.0		0.0	0.0
	5	0.0		0.0	0.0
	6 - 35	14.4		5,539.4	3,143.2
	Total	433.1		166,181.2	25,319.0
Total	Year	Generation (TCal)		Actual Costs ($ thousands)	Discounted ($ thousands)
	1	0.0		0.0	0.0
	2	0.0		0.0	0.0
	3	0.0		0.0	0.0
	4	0.0		0.0	0.0
	5	0.0		0.0	0.0
	6 - 35	197.8		14,667.0	8,322.5
	Total	5,932.7		440,011.1	67,039.0

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

WELLHEAD GEOTHERMAL

Operating Data:	
Total Capacity (MW)	10
Construction Time (Years)	3
Project Lifetime (Years)	15
Capacity Factor	75.0%

Financial Data:	
Local Investment, Actual	6,900
Foreign Investment, Actual	20,300
Costs Present Value	37,710
Benefits Present Value	20,315
Net Present Value	(17,395)
Net Benefits/Investment	0.52947
Internal Rate of Return	0.02661
Dollars/MWh	0.0382650852

PROJECT COSTS

	Generation		Investment		Operation and Maintanence		INVESTMENT			
Year	(TCal)	(MWh)	Actual ($ thousands)	Discounted ($ thousands)	Actual Costs ($ thousands)	Discounted ($ thousands)	Foreign	Financial Local	Economic Foreign	Local
1	0	0	1,939.8	1,939.8	0	0	1,015	345	1,583	356
2	0	0	17,458.1	15,587.6	0	0	9,135	3,105	14,251	3,207
3	0	0	19,397.9	15,463.8	0	0	10,150	3,450	15,834	3,564
4 - 18	57	65,700	0.0	0.0	973	693	0	0	0	0
Total	848	985,500	38,795.7	32,991.2	14,601.5	4,719.1	20,300	6,900	31,668	7,128

PROJECT BENEFITS (Substitute Energy Costs)

	Firewood			
Year	Generation (TCal)	Generation (Tons)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4 - 18	27.5	8,997.6	742.6	528.5
Total	411.9	134,963.4	22,276.8	3,599.8

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

'Oil

Year	Generation (TCal)	Generation (1000 Bl)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4 - 18	20.8	15.5	282.7	201.2
Total	311.9	232.7	4,240.0	1,370.3

Electricity

Year	Generation (TCal)	Generation (MWh)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4 - 18	4.1	4,796.0	1,582.7	1,126.5
Total	61.9	71,939.9	23,740.2	7,672.6

Other

Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4 - 18	4.1	1,582.7	1,126.5
Total	61.9	23,740.2	7,672.6

Total

Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4 - 18	56.5	4,190.6	2,982.8
Total	847.5	73,997.1	20,315.3

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

GAS TURBINE

Operating Data:	
Total Capacity (MW)	20
Construction Time (Years)	2
Project Lifetime (Years)	25
Capacity Factor	40.0%

Financial Data:	
Local Investment, Actual	1,500
Foreign Investment, Actual	7,500
Costs Present Value	38,437
Benefits Present Value	27,948
Net Present Value	(10,488)
Net Benefits/Investment	0.18849
Internal Rate of Return	(0.03058)
Dollars/MWH	0.0219388229

PROJECT COSTS

	Generation		Investment		Operation and Maintenance		INVESTMENT			
Year	(TCal)	(MWh)	Actual ($ thousands)	Discounted ($ thousands)	Actual Costs ($ thousands)	Discounted ($ thousands)	Foreign	Financial Local	Economic Foreign	Local
1	0	0	7,287.2	7,287.2	0	0	4,125	825	6,435	852
2	0	0	5,962.3	5,323.5	0	0	3,375	675	5,265	697
3 - 27	60	70,080	0.0	0.0	4,131	3,293	0	0	0	0
Total	1,507	1,752,000	13,249.5	12,610.7	103,263.2	25,826.1	7,500	1,500	11,700	1,550

PROJECT BENEFITS (Substitute Energy Costs)

240

60

	Firewood			
Year	Generation (TCal)	Generation (Tons)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3 - 27	29.3	9,597.4	792.1	631.4
Total	732.3	239,934.9	23,761.9	4,952.4

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

'Oil

Year	Generation (TCal)	Generation (1000 Bl)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3 - 27	22.2	16.5	301.5	240.4
Total	554.5	413.7	7,537.8	1,885.2

Electricity

Year	Generation (TCal)	Generation (MWh)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3 - 27	4.4	5,115.7	1,688.2	1,345.8
Total	110.0	127,893.2	42,204.7	10,555.4

Other

Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3 - 27	4.4	1,688.2	1,345.8
Total	110.0	42,204.7	10,555.4

Total

Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3 - 27	60.3	4,470.0	3,563.4
Total	1,506.7	115,709.2	27,948.4

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

OIL FIRED STEAM

Operating Data:	
Total Capacity (MW)	50
Construction Time (Years)	4
Project Lifetime (Years)	30
Capacity Factor	80.0%

Financial Data:	
Local Investment, Actual	16,000
Foreign Investment, Actual	49,000
Costs Present Value	122,898
Benefits Present Value	114,413
Net Present Value	(8,485)
Net Benefits/Investment	1.02213
Internal Rate of Return	0.12046
Dollars/MWh	0.0116912395

PROJECT COSTS

	Generation		Investment		Operation and Maintanence		INVESTMENT			
								Financial	Economic	
Year	(TCal)	(MWh)	Actual ($ thousands)	Discounted ($ thousands)	Actual Costs ($ thousands)	Discounted ($ thousands)	Foreign	Local	Foreign	Local
1	0	0	4,668.1	4,668.1	0	0	2,450	800	3,822	846
2	0	0	14,004.2	12,503.8	0	0	7,350	2,400	11,466	2,538
3	0	0	42,012.7	33,492.3	0	0	22,050	7,200	34,398	7,615
4	0	0	32,676.6	23,258.5	0	0	17,150	5,600	26,754	5,923
5 - 34	301	350,400	0.0	0.0	9,567	6,080	0	0	0	0
Total	9,040	10,512,000	93,361.6	73,922.7	287,010.6	48,975.6	49,000	16,000	76,440	16,922

PROJECT BENEFITS (Substitute Energy Costs)

	Firewood			
Year	Generation (TCal)	Generation (Tons)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5 - 34	146.5	47,987.0	3,960.3	2,516.9
Total	4,393.6	1,439,609.6	118,809.5	20,273.7

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

Oil

Year	Generation (TCal)	Generation (1000 Bl)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5 - 34	110.9	82.7	1,507.6	958.1
Total	3,326.8	2,482.0	45,226.6	7,717.5

Electricity

Year	Generation (TCal)	Generation (MWh)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5 - 34	22.0	25,578.6	8,440.9	5,364.4
Total	659.9	767,359.1	253,228.5	43,211.0

Other

Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5 - 34	22.0	8,440.9	5,364.4
Total	659.9	253,228.5	43,211.0

Total

Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5 - 34	301.3	22,349.8	14,203.7
Total	9,040.3	670,493.0	114,413.3

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

SLOW SPEED DIESEL

Operating Data:	
Total Capacity (MW)	40
Construction Time (Years)	3
Project Lifetime (Years)	35
Capacity Factor	90.0%

Financial Data:	
Local Investment, Actual	11,000
Foreign Investment, Actual	49,000
Costs Present Value	112,637
Benefits Present Value	117,051
Net Present Value	4,415
Net Benefits/Investment	1.18581
Internal Rate of Return	0.14184
Dollars/MWh	0.0102048098

PROJECT COSTS

	Generation		Investment		Operation and Maintanence		INVESTMENT			
Year	(TCal)	(MWh)	Actual ($ thousands)	Discounted ($ thousands)	Actual Costs ($ thousands)	Discounted ($ thousands)	Foreign	Financial Local	Economic Foreign	Local
1	0	0	8,780.3	8,780.3	0	0	4,900	1,100	7,644	1,136
2	0	0	35,121.2	31,358.2	0	0	19,600	4,400	30,576	4,545
3	0	0	43,901.5	34,998.0	0	0	24,500	5,500	38,220	5,682
4 - 38	271	315,360	0.0	0.0	6,444	4,587	0	0	0	0
Total	9,492	11,037,600	87,803.0	75,136.5	19,332.7	37,500.1	49,000	11,000	76,440	11,363

PROJECT BENEFITS (Substitute Energy Costs)

	Firewood			
Year	Generation (TCal)	Generation (Tons)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4 - 38	131.8	43,188.3	3,564.3	2,537.0
Total	4,613.3	1,511,590.1	106,928.5	20,741.1

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

Oil

Year	Generation (TCal)	Generation (1000 Bl)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4 - 38	99.8	74.5	1,356.8	965.7
Total	3,493.2	2,606.1	47,487.9	7,895.4

Electricity

Year	Generation (TCal)	Generation (MWh)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4 - 38	19.8	23,020.8	7,596.9	5,407.3
Total	692.9	805,727.0	265,889.9	44,207.3

Other

Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4 - 38	19.8	7,596.9	5,407.3
Total	692.9	265,889.9	44,207.3

Total

Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4 - 38	271.2	20,114.8	14,317.3
Total	9,492.3	686,196.3	117,051.2

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

SAN MARCOS HYDRO

Operating Data:	
Total Capacity (MW)	52
Construction Time (Years)	5
Project Lifetime (Years)	50
Capacity Factor	59.0%

Financial Data:	
Local Investment, Actual	42,000
Foreign Investment, Actual	76,000
Costs Present Value	127,633
Benefits Present Value	80,778
Net Present Value	(46,855)
Net Benefits/Investment	0.68296
Internal Rate of Return	0.08460
Dollars/MWh	0.0094980154

PROJECT COSTS

	Generation		Investment		Operation and Maintanence		INVESTMENT			
Year	(TCal)	(MWh)	Actual ($ thousands)	Discounted ($ thousands)	Actual Costs ($ thousands)	Discounted ($ thousands)	Financial Foreign	Financial Local	Economic Foreign	Economic Local
1	0	0	8,087.9	8,087.9	0	0	3,800	2,100	5,928	2,160
2	0	0	16,175.7	14,442.6	0	0	7,600	4,200	11,856	4,320
3	0	0	32,351.4	25,790.3	0	0	15,200	8,400	23,712	8,639
4	0	0	64,702.8	46,054.2	0	0	30,400	16,800	47,424	17,279
5	0	0	40,439.3	25,699.9	0	0	19,000	10,500	29,640	10,799
6 - 55	231	268,757	0.0	0.0	1,604	910	0	0	0	0
Total	11,557	13,437,840	161,757.0	120,074.8	80,196.0	7,558.0	76,000	42,000	118,560	43,197

PROJECT BENEFITS (Substitute Energy Costs)

	Firewood			
Year	Generation (TCal)	Generation (Tons)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
6 - 55	112.3	36,806.0	3,037.6	1,723.6
Total	5,616.5	1,840,300.9	91,126.9	14,313.6

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

	Oil			
Year	Generation (TCal)	Generation (1000 Bl)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
6 - 55	85.1	63.5	1,156.3	656.1
Total	4,252.8	3,172.8	57,814.6	5,448.7

	Electricity			
Year	Generation (TCal)	Generation (MWh)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
6 - 55	16.9	19,618.8	6,474.2	3,673.6
Total	843.6	980,940.7	323,710.4	30,507.7

	Other		
Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6 - 55	16.9	6,474.2	3,673.6
Total	843.6	323,710.4	30,507.7

Total	Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
	1	0.0	0.0	0.0
	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
	6 - 55	231.1	17,142.3	9,727.0
	Total	11,556.5	796,362.3	80,777.7

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

EL TIGRE HYDRO

Operating Data:	
Total Capacity (MW)	270
Construction Time (Years)	5
Project Lifetime (Years)	50
Capacity Factor	55.0%

Financial Data:	
Local Investment, Actual	80,000
Foreign Investment, Actual	180,000
Costs Present Value	284,944
Benefits Present Value	390,987
Net Present Value	106,043
Net Benefits/Investment	1.56067
Internal Rate of Return	0.17503
Dollars/MWh	0.0043808571

PROJECT COSTS

	Generation		Investment		Operation and Maintanence		INVESTMENT			
Year	(TCal)	(MWh)	Actual ($ thousands)	Discounted ($ thousands)	Actual Costs ($ thousands)	Discounted ($ thousands)	Foreign	Financial Local	Economic Foreign	Local
1	0	0	18,154.0	18,154.0	0	0	9,000	4,000	14,040	4,114
2	0	0	36,308.0	32,417.9	0	0	18,000	8,000	28,080	8,228
3	0	0	72,616.0	57,889.0	0	0	36,000	16,000	56,160	16,456
4	0	0	145,232.0	103,373.3	0	0	72,000	32,000	112,320	32,912
5	0	0	90,770.0	57,686.0	0	0	45,000	20,000	70,200	20,570
6 - 55	1,119	1,300,860	0.0	0.0	3,273	1,857	0	0	0	0
Total	55,937	65,043,000	363,080.0	269,520.1	163,660.0	15,424.0	180,000	80,000	280,800	82,280

PROJECT BENEFITS (Substitute Energy Costs)

	Firewood			
Year	Generation (TCal)	Generation (Tons)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
6 - 55	543.7	178,151.7	14,702.7	8,342.7
Total	27,185.4	8,907,584.3	441,080.2	69,281.9

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

	Oil			
Year	Generation (TCal)	Generation (1000 Bl)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
6 - 55	411.7	307.1	5,596.8	3,175.8
Total	20,584.8	15,357.3	279,839.4	26,373.2

	Electricity			
Year	Generation (TCal)	Generation (MWh)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0
6 - 55	81.7	94,960.7	31,337.0	17,781.5
Total	4,083.4	4,748,034.2	1,566,851.3	147,666.2

	Other		
Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6 - 55	81.7	31,337.0	17,781.5
Total	4,083.4	1,566,851.3	147,666.2

Total	Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
	1	0.0	0.0	0.0
	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	0.0	0.0
	6 - 55	1,118.7	82,973.5	47,081.4
	Total	55,937.0	3,854,622.2	390,987.4

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

CERRON GRANDE EXPANSION

Operating Data:	
Total Capacity (MW)	135
Construction Time (Years)	4
Project Lifetime (Years)	30
Capacity Factor	20.0%

Financial Data:	
Local Investment, Actual	11,000
Foreign Investment, Actual	32,000
Costs Present Value	51,930
Benefits Present Value	77,229
Net Present Value	25,299
Net Benefits/Investment	1.74635
Internal Rate of Return	0.19501
Dollars/MWh	0.0073185857

PROJECT COSTS

	Generation		Investment		Operation and Maintanence		INVESTMENT			
Year	(TCal)	(MWh)	Actual ($ thousands)	Discounted ($ thousands)	Actual Costs ($ thousands)	Discounted ($ thousands)	Foreign	Financial Local	Economic Foreign	Local
1	0	0	3,064.2	3,064.2	0	0	1,600	550	2,496	568
2	0	0	15,320.8	13,679.2	0	0	8,000	2,750	12,480	2,841
3	0	0	24,513.2	19,541.8	0	0	12,800	4,400	19,968	4,545
4	0	0	18,384.9	13,086.0	0	0	9,600	3,300	14,976	3,409
5 - 34	203	236,520	0.0	0.0	500	318	0	0	0	0
Total	6,102	7,095,600	61,283.0	49,371.2	14,994.0	2,558.6	32,000	11,000	49,920	11,363

PROJECT BENEFITS (Substitute Energy Costs)

	Firewood			
Year	Generation (TCal)	Generation (Tons)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5 - 34	98.9	32,391.2	2,673.2	1,698.9
Total	2,965.7	971,736.5	80,196.4	13,684.8

APPENDIX IV.L.2

ECONOMIC EVALUATION OF GENERATION PROJECTS

Oil

Year	Generation (TCal)	Generation (1000 Bl)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5 - 34	74.9	55.8	1,017.6	646.7
Total	2,245.6	1,675.3	30,527.9	5,209.3

Electricity

Year	Generation (TCal)	Generation (MWh)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0
5 - 34	14.8	17,265.6	5,697.6	3,621.0
Total	445.5	517,967.4	170,929.2	29,167.4

Other

Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5 - 34	14.8	5,697.6	3,621.0
Total	445.5	170,929.2	29,167.4

Total

Year	Generation (TCal)	Actual Costs ($ thousands)	Discounted ($ thousands)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5 - 34	203.4	15,086.1	9,587.5
Total	6,102.2	452,582.8	77,229.0

APPENDIX.IV.N.1

ESTIMATED EXECUTION SCHEDULE FOR
A MID-SIZED HYDRO PLANT
(See notes below)

ACTIVITY	MONTHS	SUB-TOTAL MONTHS	CUMULATIVE FROM START (MONTHS)
1-Studies, financing			
Prepare application for financing to MDB	3		
Apply and obtain approval from MDB	6		
Government signs financing agreement	1		
1-Obtain financing for studies		10	(10)
2-Selection of firm			
Obtain approval for scope of work and for list of firms	3		
Calls for proposals	3		
Evaluate proposals and negotiate contract	5		
Obtain approval from MDB	1		
2-Select consulting firm	12	12	(22)
3-Studies, execution			
Feasibility Study	15		
Report received and approved	2		
Design of plant	8		
Preparation of tender documents	3		
Obtain approval from MDB	3		
3-Execution of feasibility and design studies		31	(53)

ACTIVITY	MONTHS	SUB-TOTAL MONTHS	CUMULATIVE FROM START (MONTHS)
<u>4-Project, procurement</u>			
Call for tenders from equipment supplier	4		
Evaluation of tenders and selection	4		
Negotiation of contract	3		
Approval by MDB			
4-Procurement of equipment		13	(66)
<u>5-Project, execution</u>			
Construction of Civil Works	54		
5-Supply and installation		54	(110)

Estimated total duration of activities 1 to 5 110 months from start

NOTES:

1.The schedule deals only with the electromechanical equipment. It assumes that well drilling and civil construction will fit into the same schedule.

2.It assumes that negotiations for financing of the capital cost by the MDB are successfully completed by month 46.

3.It assumes that war activity in the area:

a.Has abated sufficiently by week 22 to allow field work to be done for the feasibility study.

b.Has ceased by month 48 so as to allow well drilling to proceed and civil works to begin by month 60.

MDB = Multilateral Development Bank

IV. TELECOMMUNICATIONS

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GLOSSARY

ALCATEL	Central American Telecommunications Institute
ANTEL	National Telecommunications Administration
CCS	Unit of measure for telephone traffic, equivalent to 100 conversation-seconds
CROSSTALK	Inducement from a signal channel to another
ERICSSON	International telephone equipment corporation
ERLANG	Unit of measure for telephone traffic, equivalent to 36 CCs
GHZ	Gigahertz, 10**9 cycles per second
IRR	Internal rate of return
ISA	Infrastructure Sector Assessment
ITT	International telephone equipment corporation
ITU	International Telecommunications Union
PCM	Pulse code modulation
SIEMENS	International telephone equipment corporation
SPC	Stored program control

SUMMARY AND RECOMMENDATIONS

1. The Financial Constraints of Meeting Demand

The future of telecommunications in El Salvador will not be determined by the demand for services, but rather by the development strategy of the GOES and the role it attributes to this sector. Investments are not based exclusively on retained earnings and potential returns from reinvestment. They are determined, however, by the level of investment budgets approved by the Government. That is, while ANTEL has extensive liquid funds available, its expansion depends upon the priority attributed to this sector by the government.

Consequently, there is considerable backed-up demand for additional subscriber service. A total of 76,000 applications are pending for new lines and an additional 30,000 would probably apply if they thought there would be a chance for their requests to be met. Meanwhile, ANTEL is preparing a National Telecommunications Plan with assistance from the International Telecommunications Union.

Recommendation # 1

GOES should consider giving ANTEL more leeway in reinvesting its income in expansion. It is recommended that ANTEL continues its expansion program until the ITU-supported national plan is completed. It should then be promptly reviewed and approved by GOES.

2. Staff Turnover and Training

ANTEL has been affected by the quick turnover of qualified staff, and its training program does not sufficiently match its needs. There is a need for a massive, redundant program to make sure qualified staff is available, despite the turnover. Planning and traffic forecasting are special areas that require a more experienced staff and a strong training program. The agency's immediate need is being met by ITU support, both in developing a national plan and in specific training support.

There is some question as to whether ANTEL's long-term training (especially planning training) needs can be met.

Recommendation # 2

ANTEL should approve and implement the training program currently

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being developed with ITU assistance. It should develop and carry out training in planning, traffic measurement and forecasting and digital technology, with ITU support.

3. Operations and Maintenance Organization

O&M is organized by type of equipment. There is a need for considerable interaction between teams to identify and solve specific maintenance problems. For example, outside plant, commutation and trunk line teams need to coordinate to identify where problems originate. This makes problem-solving difficult.

Recommendation # 3

ANTEL should reorganize its O&M activities on the basis of regionalized teams.

4. Equipment Balancing

ANTEL has the potential for equipment imbalances among lines, outside plants, central offices, etc. ANTEL lacks traffic measuring equipment and the trained staff needed to measure the extent of these possible imbalances.

Recommendation # 4

Plan equipment needs based on careful traffic measurements and forecasting.

5. Private Sector

The private sector's participation in telecommunications is severely limited. ANTEL thus depends almost exclusively upon its own efforts to promote the use of its facilities.

Recommendation # 5

In addition to examining the feasibility of a greater private sector role in construction and maintenance, it is recommended that new opportunities for concessions to private firms be identified for the following services: public phone offices, FAX, mobile phones and data transmission.

6. Non-Telecommunication Activities

ANTEL has a number of activities not directly related to its major

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function. It runs a major hospital, has a vehicle repair shop and makes real estate investments. These activities may distract management from efforts in the telecommunications area.

Recommendation # 6

Consider spinning off those activities considered distracting from the development of the telecommunications sector.

TELECOMMUNICATIONS

A. INSTITUTIONAL ASPECTS

1. Introduction

The telecommunications sector is concentrated in one institution, the National Telecommunications Administration (ANTEL), which was created in 1963 and is now under the Ministry of the Interior. Prior to June 1988 (the inauguration of the new government), the utility was under the Ministry of Culture and Communications, which no longer exists.

ANTEL has a monopoly on the telecommunications industry in El Salvador. It provides telephone and telegraph services to approximately 260 municipalities regulates telecommunications, and is in charge of frequency registration.

ANTEL was created as an autonomous Public Law Institution to provide telecommunications services, such as telephone, telegraph, radiotelephone, radiotelegraph, telephoto, and related infrastructure along with works, installations and services. It is in charge of planning, finances, implementation, operations and maintenance of facilities.

ANTEL's current objectives are:
- to provide an improved service
- to improve the Company's image
- to improve the data service
- to move toward a digital network, involving fibre optics.

One of the consequences of El Salvador's 10-year old conflict has been the systematic destruction of basic infrastructure. ANTEL has been, and continues to be, one of the most affected sectors, since the telecommunications network is viewed by the guerrillas as a military target. This has caused service failures, income losses (especially from international calls), damaged lines and greater expenditure on continuous repair work.

ANTEL is generally well organized and managed, and is one of the most solvent public institutions in spite of the damage from the conflict. It produces yearly profits with which, income taxes are paid and investments are made within budget limits set by the GOES.

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2. Organization

ANTEL's Board of Directors consists of the following:

- A Director appointed by the President of the Republic who acts as Chairman of the Board;

- A Director and an Alternate, appointed by the following Ministries:

  - Interior
  - Defense and Public Safety
  - Finance
  - Economy

- Two Directors and two Alternates appointed as follows:

  - An Incumbent and an Alternate appointed by the banking system
  - An Incumbent and an Alternate appointed by the agricultural, industrial and commercial associations or organizations.

The current organization was approved by the Board of Directors in January 1988. It does not differ greatly from the previous structure. Figure V.A.1 shows a summarized organizational chart for ANTEL.

3. Planning

The Planning Division is the unit responsible for traffic planning, the formulation and evaluation of projects, and the preparation of ANTEL's budget. It works together with the Engineering Division which provides the design, and with the Financial Division which considers the availability of investment funds for new projects. It has nine engineers, twelve other professionals, and about twenty clerks and assistants. The Planning Division's organization is shown in Figure V.A.2.

The functions of the Planning Division are to:

- Draw up national telecommunications development plans according to government and agencies policies.

- Draw up project investment and budget plans.

- Develop and present proposals for telecommunication development plan policies, strategies and guidelines.

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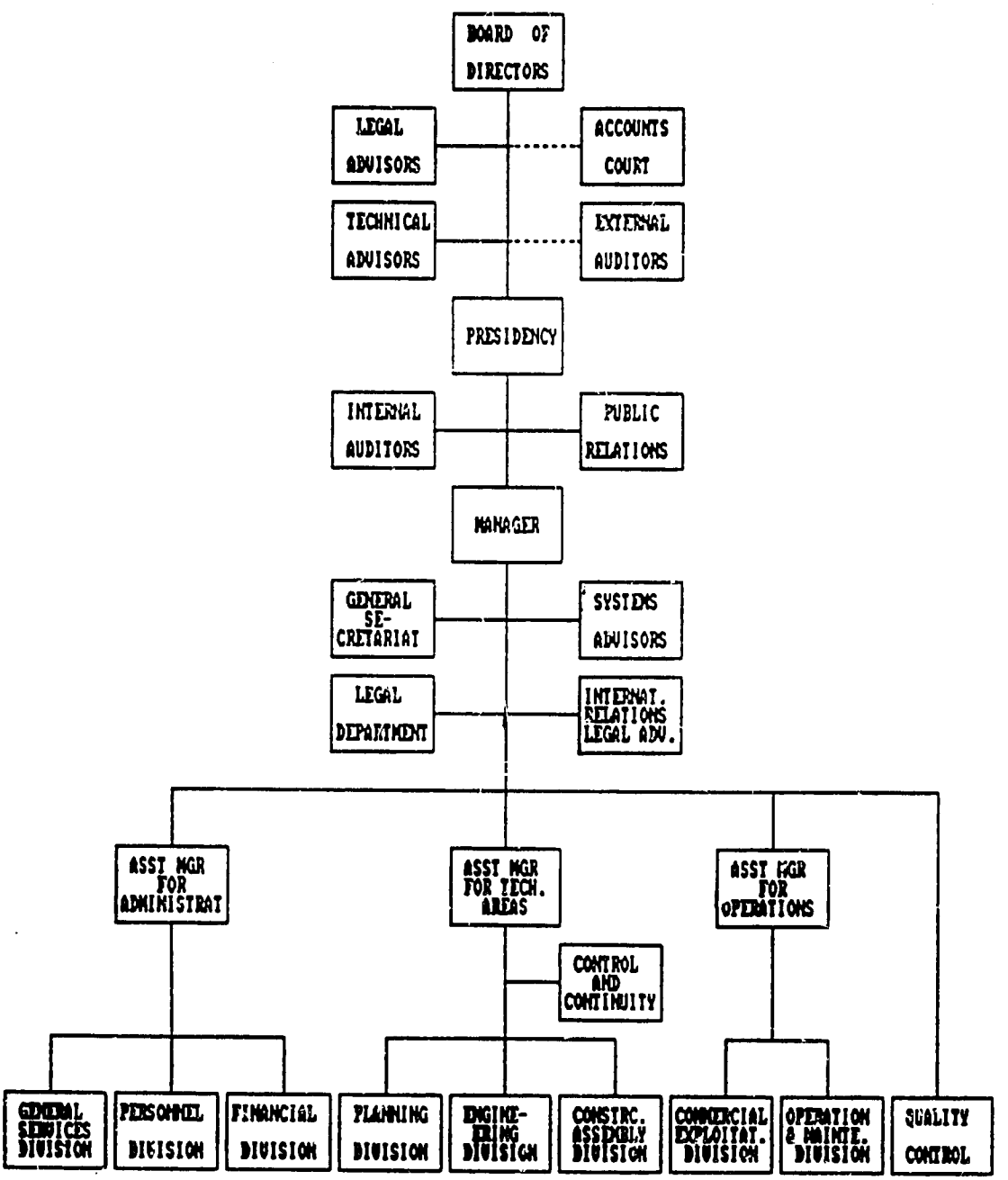
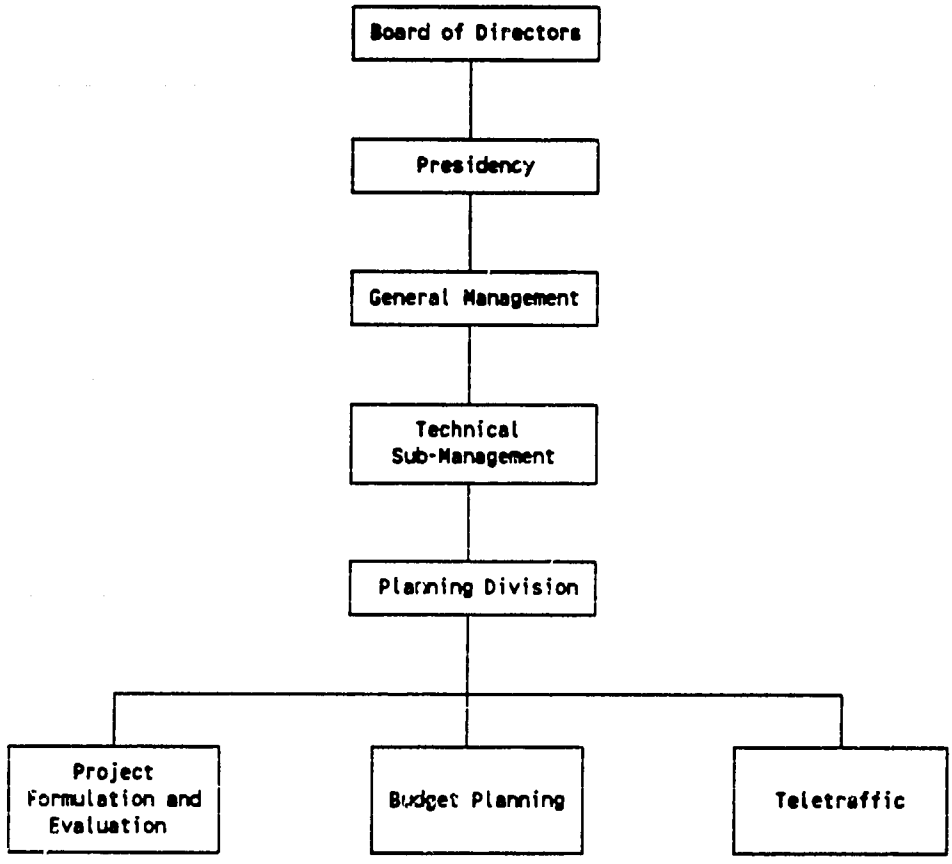
FIGURE IV.A.1

ANTEL ORGANIZATIONAL CHART



-153'

Figure IV.A.2



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- Determine actions for project implementation.

- Supervise development plans.

- Produce needed studies for individual project plans, such as market research, statistics, and traffic measurement.

- Structure and distribute the Telecommunications Master Plan documents.

- Draw up the institution's annual budget.

The Planning Division's most serious problems, according to a senior ANTEL manager, is staff training, lack of computers and computer terminals, and the need for modelling programs. In recognition of the need for additional support in planning, ANTEL recently signed a Technical Assistance agreement with the International Telecommunications Union (ITU) for US$260,000. The objective of this agreement is to prepare, in one year, a Medium- and Long-Term Development Plan, covering technical and corporate planning. Demand studies, project formulation, feasibility studies, investment programs and implementation plans will be included. The program is financed by ANTEL.

The ITU study will serve as a bench mark against which future ANTEL Planning studies can be compared and evaluated.

This study, to be completed by July, 1990. Fourteen members of ANTEL's staff assist the ITU Team Leader, and when sufficient data have been developed, four ITU experts will arrive to produce studies in six areas. The result will be a National Telecommunications Plan for the next 20 years, including a long-term demand analysis considering projected income per capita, income distribution and capacity to pay.

A recent personal visit of an ITU Team introduced a new computer program for modelling, training ANTEL planning staff in its use.

4. Human Resources

ANTEL has approximately 6,000 employees of which 28 percent are executives, professional and technical personnel, 66 percent administrative and service personnel, and 6 percent laborers. ANTEL operates in the 14 departments of the country. Unlike other government bodies, ANTEL offers its staff a series of benefits, such as: group life-insurance, cafeteria service, uniforms, psychological counseling, social services, sports and recreational installations, hospital and medical services in ANTEL's own hospital, etc. This contributes to staff stability although the salary level is no better than the rest of the government.

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ANTEL has a school in San Salvador for training technicians. Training and instruction is given in technical, administrative and operational areas. ANTEL provides national and international courses and seminars provided by the Central American Telecommunications Institute (ALCATEL) and occasionally by international bodies such as the ITU. Training is also offered by supply companies, as part of their contracts with ANTEL, including Siemens, ITT and L. M. Ericsson.

However, the consensus of Maintenance Managers is that the effectiveness of this school is very limited. The school graduates only twenty technicians every eighteen months. Their training is entirely theoretical, and is devoted to the analog technology. At the present time, no technicians are trained in digital technology, nor are there any immediate plans to do so. There are no presently-available instructors in this area, even though two new digital switching centers are scheduled for operation in April, 1990. This serious problem does not seem to be under active consideration at this time.

Currently, the school does not have ITU instructors. A request for instructors qualified to teach digital technology might solve this problem. It is recommended that ANTEL pursue this possibility with the ITU.

Another urgent problem is the high rate of resignations, particularly of those who have acquired sufficient experience and training to have marketable skills. During the past year, operations and maintenance have lost approximately twenty experienced managers and fifty experienced technicians, a severe drain on any company. This figure represents only about seven percent of the total operations/maintenance employees. However, if one considers that only a small part of the total employees are experienced, the problem is much larger. There are three main causes:

- Low pay (technicians pay ranges from approximately 1000 to 1800 colones per month).

- Poor training opportunities, lack of tools and supplies, insufficient vehicles, etc.

- Poor opportunities for advancement . This situation tends to screen out many of those employees whose skills and ambition would have been a benefit to ANTEL had they remained.

The problem also manifests itself in the professional ranks. ANTEL has sent a number of such staff for foreign training, only to have them resign upon their return or shortly thereafter. The solution must lie in the improvement of salaries and opportunities, but this is severely restricted by policy constraints.

By December 1988, ANTEL had a total of 5,677 personnel, and 104,268 lines in service. The above numbers yield the high figure of 54.5

employees per 1,000 lines in service. This is due in part to the national telegraph service using outdated networks and systems. It is also explained by the fact that ANTEL performs a series of functions alien to communications. The most noteworthy of these is a hospital. These functions are reflected in the high number of service personnel working for the organization. In June 88 service personnel amounted to 53 percent of the total. A substantial percentage of these is believed not to be necessary to ANTEL operations. Appendix V.A.1 presents a breakdown of ANTEL's personnel.

For comparison, the telephone industry in the United States had an average of 5.2 employees per 1,000 lines in service in 1989. For individual telephone companies this number can be as low as 4.0 employees per thousand lines, if there is a high degree of automation and digital equipment.

B. INVENTORY

1. System Map

Figure V.B.1 on the following page presents El Salvador's telecommunications network. The telecommunications network in El Salvador includes the following:

- Microwave links (6 and 7 GHZ)
- High capacity radio links
- Low capacity UHF links
- Coaxial cables
- Terminal and repeater station for wave links

Telex and telegraph transmission take place through a radio and wire (10,533km) network shown in Figure V.B.2.

2. Telephone System

a. Commutation

Commutation, the process of routing calls from the calling to the receiving party is handled by local, transit or international exchanges and by outside plant. In El Salvador, commutation is handled by the following equipment.

o Analog Telephone Exchanges

- qty 38 of various models and manufacturers

o Digital Telephone Exchanges

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Figure V.B. 1

El Salvador

TELECOMMUNICATIONS
Salvadoran Phone System

Legend

- 4GHz Microwave Regional Network
- 7GHz Existing Microwave National Network
- 7GHz Microwave National Network
- Coaxial Cable
- 400MHz UHF
- Carrier Waves
- Izalco Satelite Earth Station
- Microwave Terminal Station/Repeater
- Microwave repeater station
- Passive repeater
- Microwave Terminal Station
- Carrier Wave System Terminal

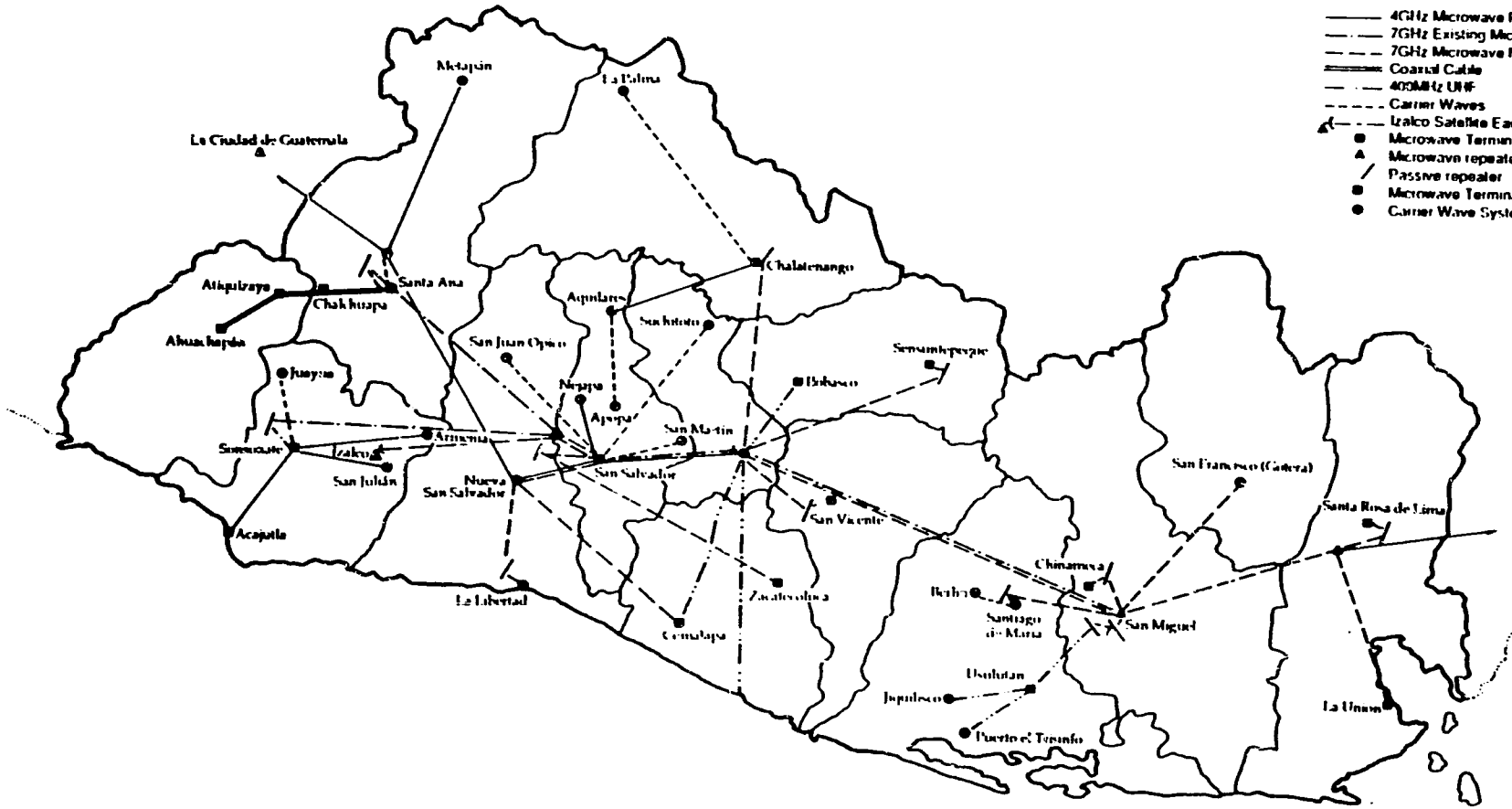


Figure IV.B. 2

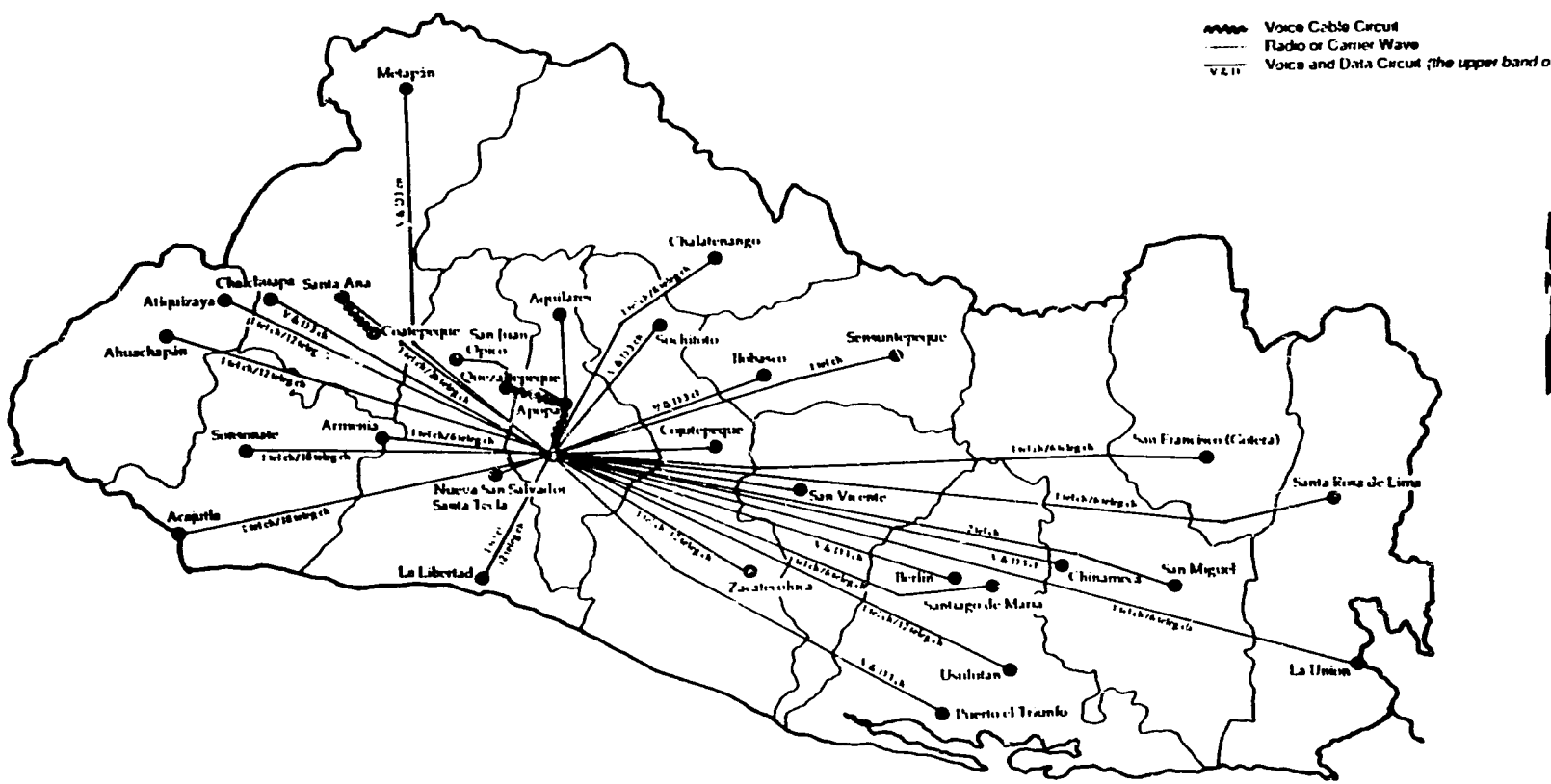
El Salvador

TELECOMMUNICATIONS

Salvadoran Telex System

Legend

- Voice Cable Circuit
- Radio or Carrier Wave
- Voice and Data Circuit *(the upper band of a telephone chanel is used)*



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- qty 19, Ericsson model AXE, digital exchange switch with automatic ticketing and a capacity up to 65,000 lines
- qty 2, Northern Pecom model DMS-10, digital exchange switch.

o Transit Exchanges

- qty 1, Ericsson model ARM-20, exchanges switch

- qty 3, Ericsson model ART-50, exchange switch

o International Analog Exchanges

- qty 1, Ericsson model ARM

o Local/Transit Exchanges

- qty 1, Ericsson model AXE exchange switch with combined local and transit capability and stored program control (SPC)

o Inter-urban/International Exchanges

- qty 1, Ericsson model AXE exchange switch configured for interurban and international operation with stored program control (SPC)

o Central Exchange

- qty 1, Ericsson model LD-2 control exchange with stored program control (SPC) and Ericsson A on digital, automated operation and maintenance supervisory system.

The above exchanges have a nominal capacity of 150,949 lines. Effectively only about 111,000 lines are currently in service and while spare lines (at telephone exchanges) represent almost 30 percent of total lines available, the system is suffering from congestion and there exists a large pent-up demand of unsatisfied requests for lines.

The reasons for the above are the following:

- Some of the equipment is obsolete and cannot support it's nominal capacity.

- ANTEL has had to defer routine maintenance to respond to emergency maintenance needs so as to counter the effects of guerilla sabotage.

- There is an imbalance in the network due to the relative lack of outside plant, thus limiting the actual capacity.

Appendix V.B.1 presents the distribution of the phone lines in the country. It can be seen that:

- Most of the lines (96 percent) are serviced by automatic exchanges.

- The nominal capacity of the San Salvador Metropolitan Area is of 103,672 lines, 66 percent of total. 80,041 or 80 percent of these lines are in use.

- Automatic and central exchanges service mostly urban areas. Rural telephone lines only amount to 2,517 (capacity) or 2 percent of total.

b. Circuits

The number of circuits between the various exchanges determines the overall traffic handling capacity of the network. The following maps (Figures V.B.3, V.B.4 and V.B.5) present the San Salvador Metropolitan Area Network the Analog and Digital long distance networks. As can be seen, the system is essentially radial. Almost all calls involving more than one exchange will have to transit through the LD-2 central exchange. The figures on top of the lines connecting the exchanges indicate the number of available circuits.

International circuits are presented in Figure V.B.6. El Salvador has direct circuits to the U.S., Germany, Switzerland, Costa Rica, Canada, Honduras, Nicaragua, Spain, Mexico, Panama and Guatemala. El Salvador has direct dialing capabilities to another 78 countries or territories, mostly via the U.S. or Spain.

c. Other

There is a need to review ANTEL's routing and hierarchical systems for opportunities to reduce cost and to improve services and decibel levels.

3. Telex and Telegraph

At present, there are 905 telex lines in use in El Salvador for a total capacity of 1,810 lines (see Appendix V.B.1).

The reasons for the discrepancy between number of lines and the capacity are similar to those of telephones. In addition, the introduction of the fax machine has decreased the need for telex. The number of private and government subscribers has decreased to 700 in 1989 from 751 in 1987.

The national telegraph service is using outdated networks and systems. The morse system is still in use to a large extent.

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Figure IV.B. 3

Metropolitan Area Digital Network

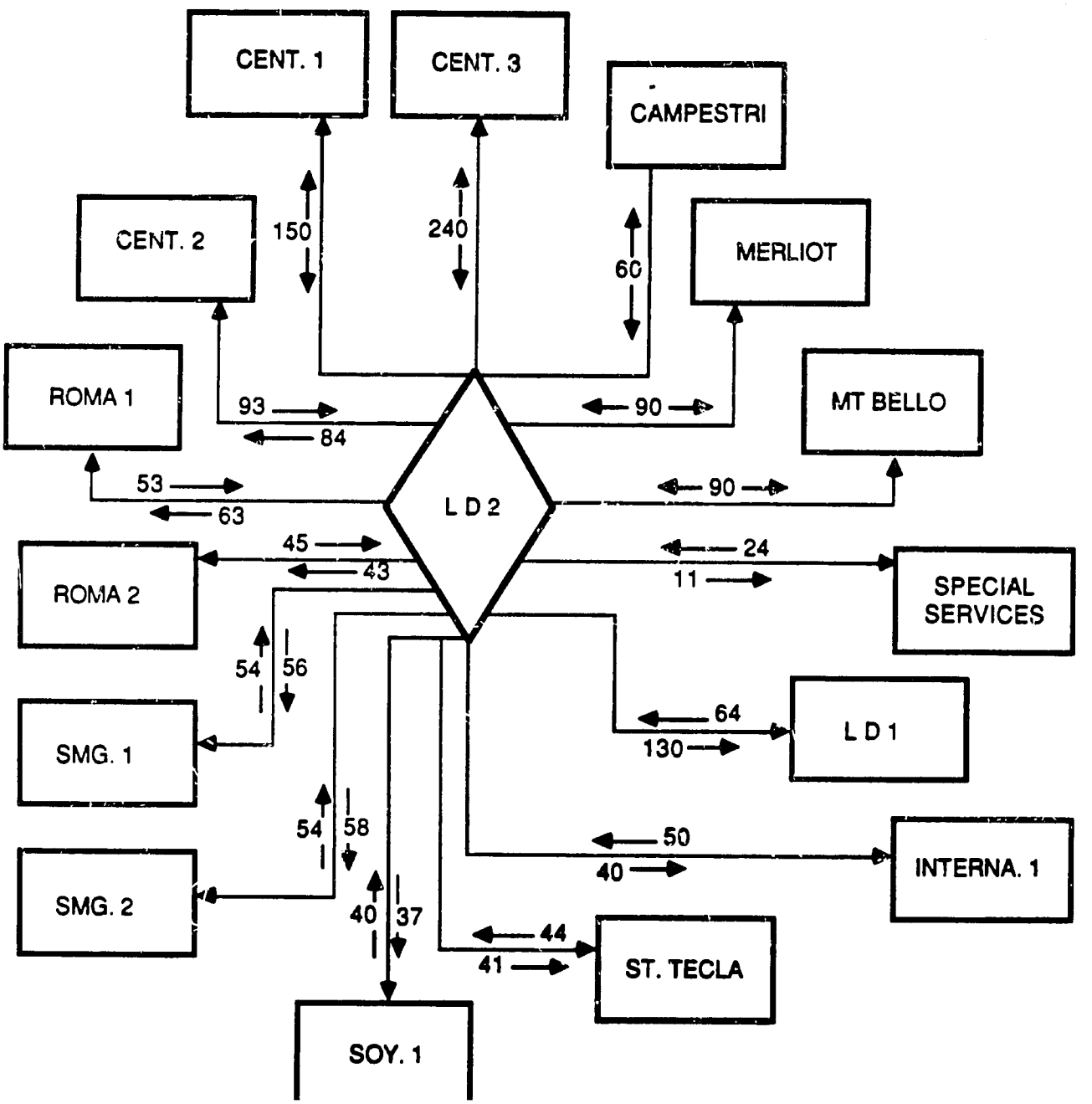
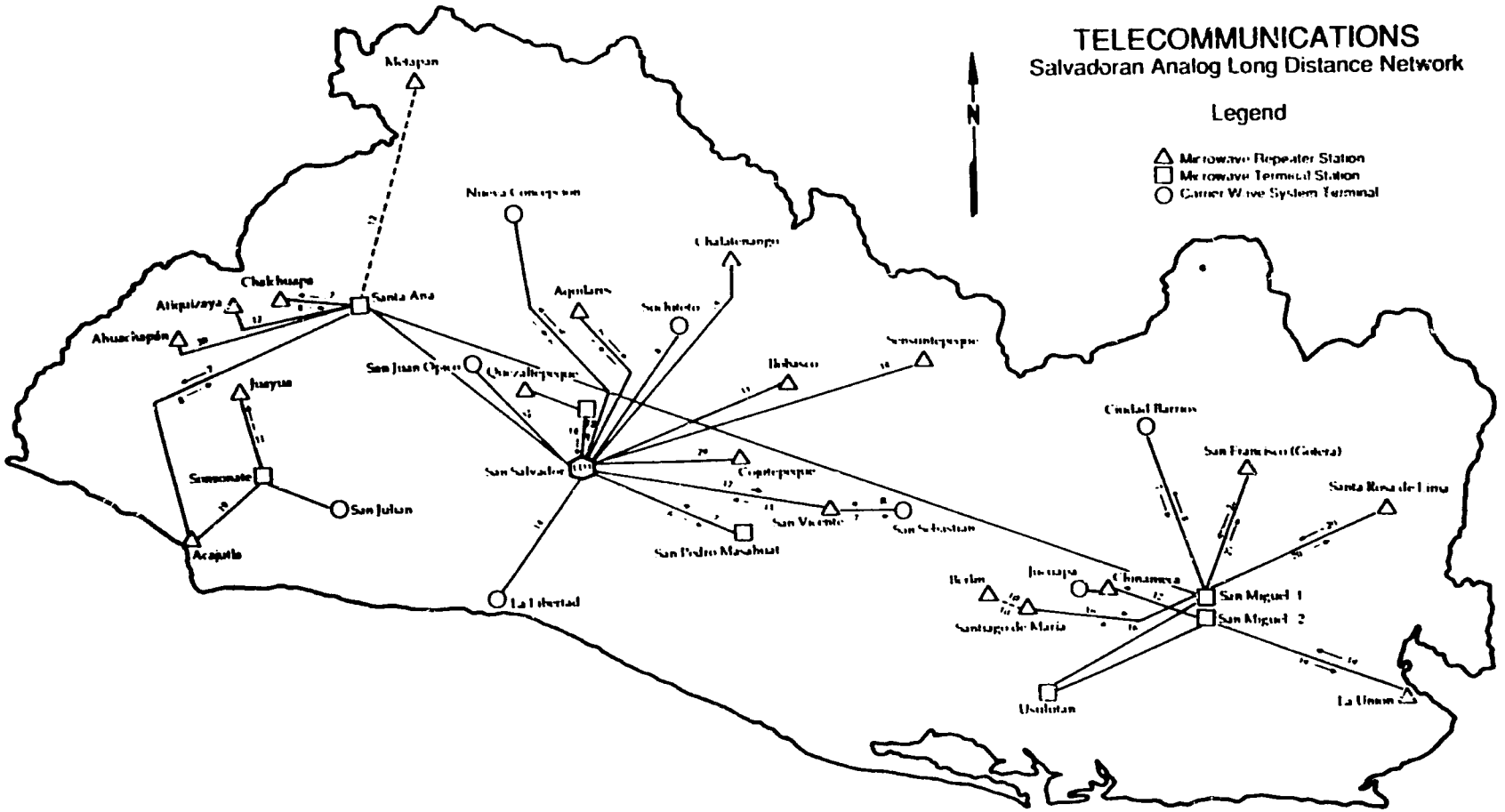


Figure VII 4

El Salvador

TELECOMMUNICATIONS

Salvadoran Analog Long Distance Network



Maintenance and Operations Division
Commutation Department

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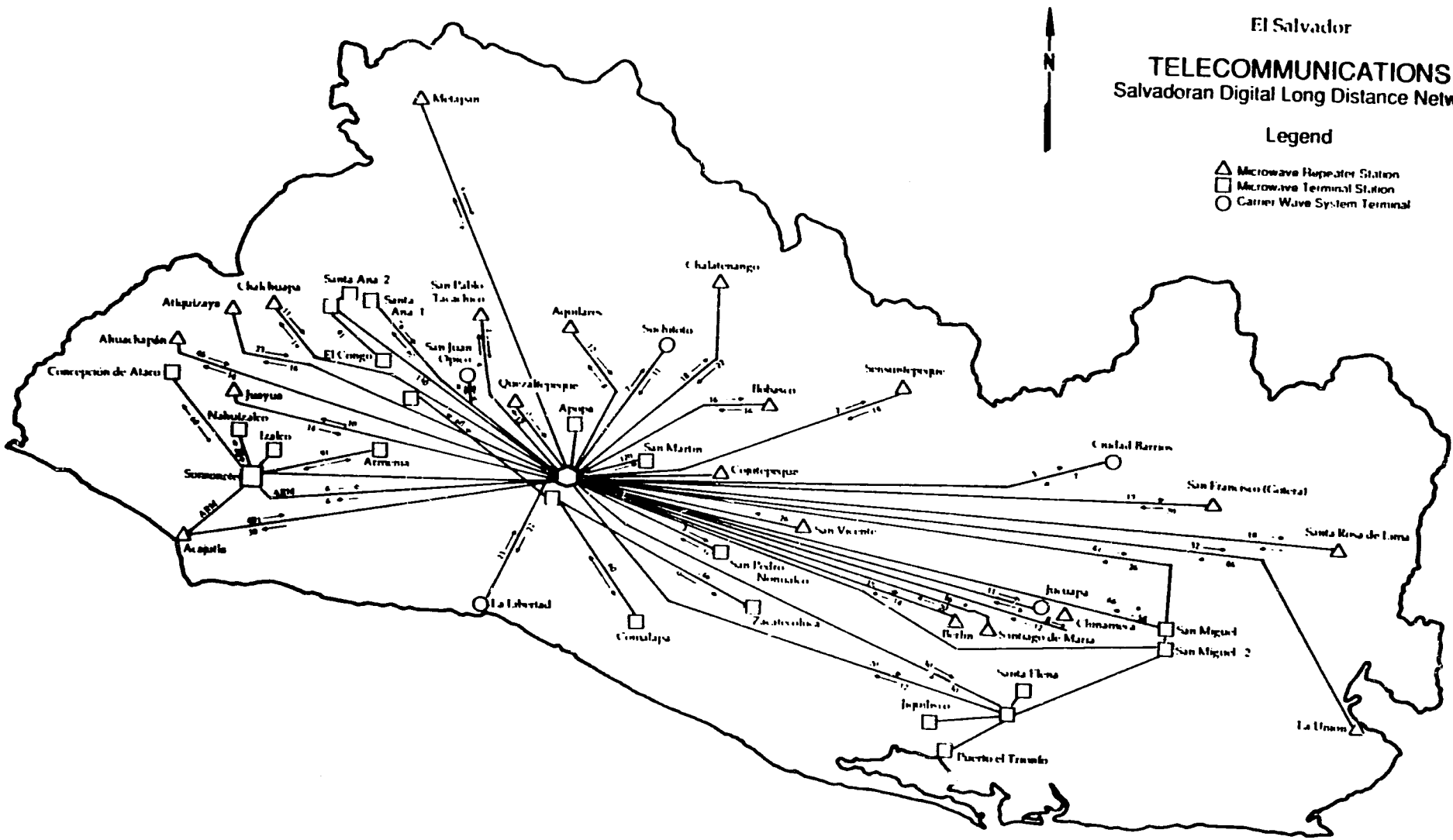
Figure IV.B 5

El Salvador

TELECOMMUNICATIONS
Salvadoran Digital Long Distance Network



Maintenance and Operations Division
Commutation Department

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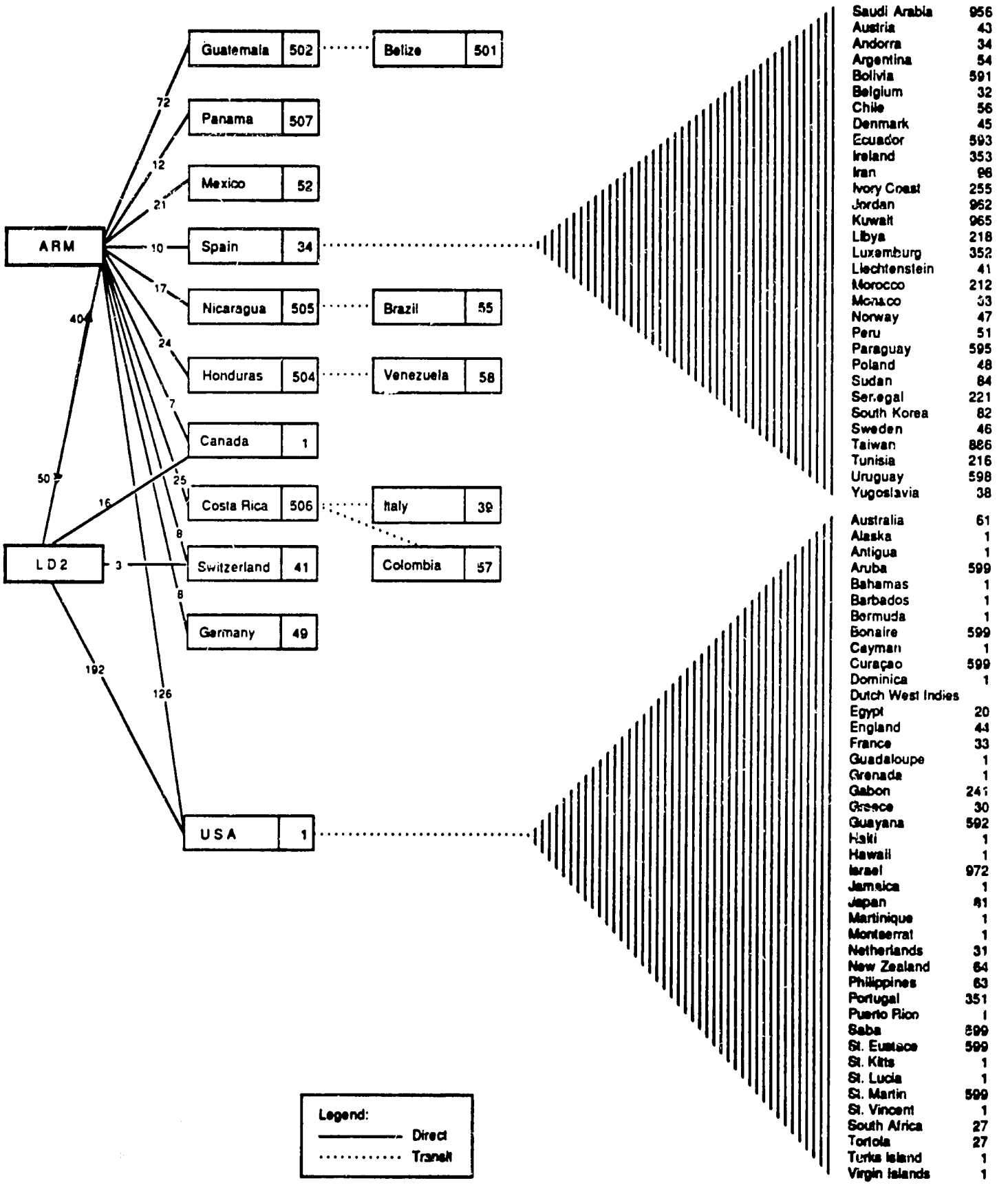
Figure IV.B. 6

Countries or States with which El Salvador has International Direct Dialing



C. PLANNED PROJECTS

1. Plan Document

ANTEL prepared a document entitled "Preliminary General Plan of Investment Projects for ANTEL 1988-1992."

The contents of this document are:

- Justification and impact of telecommunications on the Balance of Trade (considering only the effect of international traffic imbalance).

- Preliminary schedule of disbursements for ANTEL investment projects (1988-1995).

- Loan conditions for the projects being financed.

This document also shows investments began in 1989 and those scheduled for 1989 through 1995. It thus constitutes a preliminary investment program for 1988-1995. The plan currently in preparation with ITU support will try soon make this project list outdated.

Table V.C.1 shows the work progress of current projects through September 1989. Table V.C.2 details the proposed projects, including 22 significant projects for an approximate total of U.S. $282 million. An additional amount of 20 percent is included for unforeseen or miscellaneous expenses, making a total investment of U.S.$338 millions, of which 70 percent corresponds to foreign exchange. No engineering work has yet been done.

ANTEL plans to finance U.S.$76 million of with its own resources. Therefore, funding of U.S.$76 millions will be needed during the 1988-1995 period including miscellaneous expenses.

Significant among the proposed projects are the large number of new lines scheduled to be built, as well as the reinstallation and replacement of the existing phone service.

D. SYSTEM CHARACTERISTICS

El Salvador has had a telecommunications system since 1870, when its first telegraph line was installed. The first telephone system was inaugurated in 1898 consisting of a 200-line switchboard, and

TABLE IV.C.1

ANTEL STATUS OF CURRENT PROJECTS
AS OF SEPTEMBER 24, 1989

PROJECT		COMPLETION DATE	% COMPLETE
Third Project (+ 66,120 lines)	- Transmission	Nov. 1989	75%
	- Switching	Aug. 1989	70%
	- Outside Plant	Aut. 1989	100%
Fourth Project (+ 32,256 lines)	- Transmission	Nov. 1989	35%
	- Switching	Oct. 1989	80%
	- Outside Plant	Mar. 1990	70%
Fourth Project, Oriente Plan	- Outside Plant	Dec. 1989	80%
Transmission Improvement 100pcm Systems	- Transmission	Apr. 1990	55%
3 New Central Offices (+ 4,000 lines) (Digital)	- Switching	Apr. 1990	65%
New Central Office + 5,000 Lines (Digital)	- Outside Plant	Jun. 1989	95%
Long Distance Switching Trunk Relief	- Switching	Oct. 1989	90%
Public Telephone Relief (+ 3,000 Telephones)	- Public Telephones	Jan. 1989	90%
Metropolitan and Interior Zones Trunk - Relief	- Switching	Apr. 1991	90%
Rural Telephone Relief (+ 10,000 lines)	- Switching	Mar. 1991	50%
Service improvement + 10 radio systems	- Transmission	Apr. 1990	55%
Telex Central Office Relief	- Switching	Apr. 1989	30%
Various	----------	Dec. 1989	70%

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TABLE IV.C.2

ANTEL PROPOSED PROJECTS

PROJECT DESCRIPTION	COST IN US$ (In millions)	DESIRED COMPLETION DATE
New Central Offices - Campestre, San Bartolo and San Jose (+ 46,000 lines)	57.5	1994
New Central Offices - Credica, Santa Lucia (+ 16,000 lines)	20.0	1993
Additional lines in Nejapa, Apopa, Guazaltepeque, Giuseppe, San Jose Guayabal, Tonacatepeque, Aguilares (+ 10,000 lines)	14.0	1994
Additional lines in Santa Ana, Sonsonate, Cojutepeque, Chalatenango, Sensuntepeque, Zacatecoluca, San Vicente, (+ 20,000 lines)	22.0	1993
Reconstruction of service destroyed by Terrorism	70.5	1995
Additional Lines in the Eastern Zone (+ 25,000 Lines)	26.5	1993
Digitalization of Satellite Transmission	1.5	1991
Establish a Telecommunications Research and Development Center	2.0	1992
New Long Distance Digital Central Office	4.0	1993
New Central Office - Zacamil (+ 20,000 Lines)	25.0	1992
New Data Network	3.5	1993
Cellular Telephone Network	8.5	1992
Digitalization of the Central American Network	9.0	1993
New Administration Building	6.0	1993
New Technical Administration Building	4.0	1992
Other Projects	8.0	1995
SUB TOTAL	282	
UNFORESEEN EXPENSES 20%	56.4	
TOTAL	338.4	

SOURCE: ANTEL and ISA Consultants

(1) According to ANTEL's preliminary schedule at investment projects for 1988-1995 (+ 5 percent inflation to 1988 dollars).

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in 1951 the first automatic exchange appeared consisting of a 5,000-line installation.
The country now has some 109,000 lines and 120,000 telephones in service. This equates to approximately 2.4 telephones per 100 of population. The figure includes all telephone extensions. The number of lines per 100 inhabitants is of around 2.2.

To put these figures in context, lines per 100 inhabitants in Central America ranges from 1.52 in Honduras to 8.45 in Costa Rica, while the figure for many developed countries is close to 90/100.

At the present time, 68 percent of ANTEL's working lines are located within the metropolitan area of San Salvador, representing a figure of 7 telephones/100 people. However, for the remaining 32 percent the figure is of approximately 1 telephone/100 people.

The busy season for local traffic occurs during the months of October and November, while the busy hours in most central offices is 10-11 A.M. These periods represent times at which traffic is at its highest point. During these peak periods the system is congested, resulting in a decrease in service levels. Note that although local traffic is at its peak during the periods described above, it is still very high at most times of the day.

The busy season for long-distance traffic occurs during the months of July and November, while the busiest hour is between 3 and 4 p.m.

San Salvador's long-distance traffic makes up approximately 10 percent of total traffic. This unusual figure derives from the fact that San Salvador is the only large business center, thus obviating most National long distance calls. International traffic is 75 percent of the total long-distance traffic. This is due to the one million Salvadoran who live in the USA. Data on international telephone traffic is presented in Table V.D.1.

Long-distance traffic is comprised of approximately 56 percent incoming to El Salvador and 44 percent outgoing, instead of the usual 50/50. Much of the outgoing traffic is on a "reversed charges" basis. Salvadorans living in the USA can afford to accept calls from their families. Approximately 85 percent of the total international long distance telephone traffic originates or terminates in the U.S.A. and Canada.

Data from peak periods is normally used to engineer the required quantity of traffic-carrying circuits. In El Salvador, the engineered service objective is to ensure that the probability of lost calls, or calls which encounter a condition which makes completion impossible, should be less than 1 percent for both local and long-distance equipment.

While all circuits (trunks) are engineered at this figure (1 percent), the actual situation encountered in most switching centers (central offices) is well above this, with most

TABLE IV. D. 1

INTERNATIONAL TELEPHONE TRAFFIC

TO/FROM	OUTGOING		INCOMING	
	CALLS	MINUTES	CALLS	MINUTES
USA & CANADA	1,823,095	21,540,637	3,345,211	36,657,729
% REVERSED CHARGES USA & CANADA	41 %	65 %	3 %	3 %
REST OF THE WORLD	1,429,177	9,771,845	429,858	3,060,609
TOTAL	1,234,567	31,312,482	3,775,069	39,718,338

AVERAGE HOLDING TIME / CALL : OUTGOING = 578 SECONDS

INCOMING = 631 SECONDS

% OF TOTAL INTERNATIONAL TELEPHONE TRAFFIC :

OUTGOING = 46 % CALLS

OUTGOING = 44 % MINUTES

INCOMING = 54 % CALLS

INCOMING = 54 % MINUTES

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experiencing heavy congestion during much of the day. No measuring devices are installed with which to monitor local traffic levels. The quality of service is also measured by dial tone delay, or the length of writing time to begin dialing. This is generally engineered with the objective that less than 0.5 percent of originating calls experiencing a delay of greater than 3 seconds during the busy hour of the busy season. No means have been provided to measure this aspect of service, but experience says that the actual delay is much higher than this, and is due to:

- overloaded central offices (too many subscribers served)

- too little traffic carrying equipment

- out-of-service equipment.

Long-distance calls often encounter delays or receive an inappropriate announcement. Moreover, wrong numbers, no ringing signal, crosstalk and poor transmission are frequently encountered. These observations indicate a maintenance problem, due to obsolete equipment. The shortage of fully-trained staff and the lack of appropriate test equipment also contributes to this. Finally, the civil war and the earthquake of 1986 have caused substantial loss of equipment, much of which has not been completely replaced.

These are serious system problems. According to ANTEL maintenance managers, it is likely that these will continue to exist even after additional equipment is installed in early 1990.

Although several local switching centers experience a heavy subscriber overload, a case can be made that it is preferable to provide poor service for many than excellent service for a few. ANTEL's first objective must be to serve as many as it can, even if congestion is a result. However, this is risky without excellent maintenance. Every attempt must be made to keep all available traffic-carrying circuits in operation. As uncorrected problems build-up, more and more congestion results. This is very difficult to correct when the number of faults is very large, as is the case at many switching exchanges.

Switching equipment shortages, obsolete equipment, shortage of proper test equipment, tools, parts and supplies and fully-trained personnel are key causes of these undesirable effects. The obvious answer is to install additional switching equipment, adequate test sets, etc. The importance of attracting and retaining trained and qualified people, both management and technical, cannot be overstated.

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E. DEMAND/TRAFFIC FORECASTS

1. Lines in Service

ISA has produced a detailed population forecast (see Vol 1 -Country Profile Demography) it looks at three points in time, 1988, 2000, and 2010. It is disaggregated by Department and includes the urban and rural populations for all of El Salvador.

ISA forecasts an increase in demand much larger than that of the population. Demand is defined here as the sum of lines in service plus registered applications for lines.

On a preliminary basis, ISA projects phone line demand as in Tables V.E.1.

The number of lines would grow at 11.5 percent per annum through the year 2000, reaching 6 lines per inhabitant. This is comparable to historic trends. As expected, this would result in some catching up with total demand, which would grow at about 8.7 percent per year. In per capita terms, this would mean a growth rate of about 6 percent in lines and 4 percent in total demand.

These preliminary projections should be revised as soon as detailed projections are prepared as part of the ITU-assisted national plan in early 1990.

2. Circuits

The necessary number of circuits for long-distance and international calls is a function of demand and level of service. As described in section D., the main level of service measure is expressed in terms of a call non-completion probability.

Telephone traffic is measured by the number of circuits occupied during a given interval multiplied by the time of their occupation. This is expressed in terms of hundred of conversation seconds (ccs) or in Erlangs. One Erlang is equivalent to 36 ccs.

In 1988 total international traffic during the busiest hour of the busiest day reached 315.96 Erlangs. Assuming a 97 percent traffic coincidence factor, we obtain a traffic of 306.5 Erlangs. San Salvador generated 85 percent of this traffic or 260.5 Erlangs. Since they were approximately 70,000 lines in service in the capital, each line generated about .004 Erlangs. The other 40,000 lines in the country generated 46 Erlangs or .001 Erlang per line.

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TABLE IV.E.1

PRELIMINARY TELEPHONE DEMAND PROJECTIONS

DEMAND PARAMETERS	YEAR 1988	2000
Number of lines	109 (1)	402 (2)
Requested lines (3)	76	
Total demand	185	402
Population	4,999	6,695
Lines/100	2.2	
Demand/100	3.7	6.0
Annual growth Rate (1988-2000)		
Demand	6.7%	
Lines	11.5%	

(1) Another 85,000 lines are expected to be installed by 1990.

(2) If all demand were met

(3) Another 30,000 would probably apply if there were hope of getting a line.

Changes in the demand pattern is usually estimated by a gravity model as follows:

$$D12 = K1K2 \frac{T1 * T2}{d2}$$

Where D12 = is the demand lectures cities 1 and 1
T1,2 = are the number of phones per city
K1 = factor indicating importance of business between the cities
K2 = factors indicating general importance of the cities
d2 = distance, or similar measure, squared

For the purpose of this study, we shall assume that the demand for international calls will continue with the same generation pattern.

F. MAINTENANCE/OPERATIONS COSTS

The ANTEL operations and maintenance (O & M) department has a staff of some 1000 employees divided into six sub departments:

Outside plant	210
Outside plant/maintenance	220
Transmission	140
Power	140
Telex and Telegraphs	145
Switching	150

ANTEL O & M employees work out of three main field offices, San Miguel, Santa Ana and San Salvador.

Managers are faced with a constant barrage of problems including:

- repair of war-damaged facilities
- obsolete telephone and telegraph equipment
- lack of test equipment, tools, parts and supplies
- equipment shortages (following the earthquake)
- lack of training
- resignation of many trained professionals.

The above information implies that current operations and maintenance costs of ANTEL are more a result of fireman-maintenance rather than organized routine and periodic checks with the minimum possible corrective maintenance.

The above comments indicate that current operation-and- maintenance costs experienced by ANTEL do not correspond to those which would have been incurred in a situation of peace with updated equipment. However, the current level of pent-up demand and its expected increase show that the current situation will not significantly

improve during ISA's planning horizon. While the purchase of new equipment will decrease O & M unit costs for new lines, present equipment will continue to be in service, with increasing O & M costs. In conclusion, the present values of O&M costs provide a good approximation of future costs during the ISA's horizon.

The consultants used ANTEL's External Auditors' report for 1988 as a basis for determining operation-and-maintenance costs. It shows that 52.38 percent of the company's total expenditure was applied to operation and maintenance of telephone services. Domestic services accounted for 26.87 percent and international services, 25.51 percent. A brief summary of the report can be found in Table V.H.2.

Total operation-and-maintenance costs reached US$38.7 million in 1986. Since 94691 lines existed in 1986, the unit cost of operation and maintenance per line was US$213.3.

Domestic telephone service = US$38.7 M * 0.2687 = US$10.4 M
International tel. service = US$38.7 M * 0.2551 = US$9.8 M

Thus, costs per telephone for the domestic system amounted to US$108.8 and US$103.5 for the international system. ISA assumes this should have increased by 5 percent through 1988 for a total of $224/line. This number compares favorably with the United States average estimated at $400 per line for total operations. However, the $224/line number is artificially low because minimum maintenance is being accomplished and the in-country labor rate is relatively low.

G. COSTS OF CONSTRUCTION/INSTALLATION

To estimate construction and installation costs for future telephone lines, prior ANTEL project costs and project profiles, some at pre-feasibility level were reviewed.

Among ANTEL's priority projects is the Zacamil switch enter, with a 10,000-line capacity. This project selected as a module for the purposes of this report's calculations. The project in question covers sectors where the service is currently notoriously deficient.

Costs are broken down as follows:

1. Communication Center

These costs include investment in commutation and electromechanical equipment, land and buildings. To make this estimate, ANTEL used

the effective costs for the at Usulutan, Montebello, El Palmar and Merliot, exchanges. The sums were updated, according to currency, date and investment year. For land and buildings, there is no foreign currency component, so the prices are affected only by the internal inflation rate. Electromechanical equipment is entirely imported.

The costs of the above-mentioned completed exchanges show very little relation with exchange capacity. For the purposes of this report, an average price of US$650 per exchange will be used.

Regarding commutation equipment, based on ANTEL's updated historical information, the cost for a 10,000-line exchange is approximately US$3.6 million, or about US$360 per line.

Hence, the following costs form the module for a 10,000-line exchange.

	US$ (in thousands)
Commutation equipment	3,605
Electromechanical equipment	650
Land and buildings	720
TOTAL	4,975

This gives a cost per line of US$498, at 1988 prices.

2. Subscriber's External Plant

The external plant components include items such as cables, terminal boxes, galvanized pipes, inspection wells, connections, and metal fittings, including both materials and labor. Cost is estimated as a function of exchange capacity. The cost for planned projects, is the already-built Atlacatl Exchange, with a nominal capacity of 4096 lines.

Total investment in external plant at 1988 prices is as follows:

	US$ (in thousands)
Imported materials	589
Labor	892
National raw materials	793
Telephone apparatus	94
TOTAL	2,368

Since this exchange has 4,096 lines, the cost of external plant per line is, US$578, or US$555 excluding telephones.

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3. Connection Costs with Other Exchanges

Trunk line or interconnection costs were calculated for the Zacamil exchanges at US$997,776. Since the exchange capacity is 1,000 lines, the cost per line is US$ 99.78. The breakdown of this cost into different component items is presented below:

COST OF COMPONENTS FOR INTERCONNECTION WITH OTHER EXCHANGES

	US$ (in thousands)
PCM systems	301
Cables	118
Wiring and materials	42
Wiring and installation	171
Wells	285
Cable installation	26
Installation of PCM equipment	54
TOTAL	997

Costs were estimated for long-distance transmission and commutation for a project package, including the Zacamil project, which total 46,000 lines.

These costs are based on the already-built exchanges of Atlacatl, Altaurira, Merliot, Montebello and Soyapango II. The project under analysis has 46,000 lines, indicating a requirement for 46,000 * 0.025 = 1150 long-distance and international circuits. Of these, 42.5 percent (489 circuits) are for national long-distance system, and the remaining 57.5 percent (661 circuits) for the international long-distance system. The equipment cost for long-distance international and national commutation is as follows:

National = 489 * 124 = US$60,636
International = 661 * 329 = US$ 217,469

Other costs break down as follows:

- The cost of Multiplex analog equipment (both extremes) for national long-distance is:

  489 * US$555 = US$ 271,395

- Analog-to-digital conversion cost in the Central (exchange) for national long-distance is:

  489 * US$255 = US$ 124,695

The following is the cost breakdown for the international long-distance interconnection.

- The cost of Multiplex Digital for the connection between LD2 and the ground station is estimated at:

661 * US$180 = US$ 118,980

- The cost of analog-to-digital conversion at the ground station is calculated as follows:

  661 * US$ 255 = US$ 168,555

- The cost of MUX SATELITAL at the ground station is estimated at:

  661 * US$ 277.5 = US$ 183,428

In summary, national long-distance interconnection will cost the following:

	US$
Commutation	60,636
Multiplex analog equipment	271,395
Analog-digital conversion	124,695
TOTAL	456,726

And the internal long-distance interconnection will cost the following:

	US$
Commutation	271,469
Multiplex Digital Equipment	118,980
Analog-digital conversion	168,555
MUX-SATELITAL equipment	183,428
TOTAL	688,432

This gives a total of US$ 1,145,158 for the whole package of projects. Since the capacity of the projects is for 46,000 lines, there is a cost per line of US$ 24.9. National and international long-distance costs whether US$9.9 and US$15 respectively per subscriber.

A summary of new line installation costs at 1988 prices is:

	US$
A - Commutation (exchange)	498
B - Subscriber's external plant	578
C - Interconnection with other exchanges	100
D - International/National long distance interconnection	25
TOTAL	1,201

This would be the cost of the installation per single subscriber line. For a project of 10,000 lines, the cost would be approximately:

10,000* US$1,201.= US$ 12 million

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This could be underestimated. For the Zacamil project, with a 10,000 line capacity, ANTEL estimates a cost of US$15 million. This appears to be a better approximation, as the above figures lack pre-investment, engineering and supervision, as well as unforseen expenses. This would bring the figure to US$1,500 per line.

The following shows another breakdown of these costs per line:

	US$	%
Materials	341.4	27.6
Equipment	515.4	24.4
Land & Building	72.0	5.0
Skilled Labor	217.0	14.4
Unskilled Labor	54.2	3.6
Engineering and Supervision	180.0	12.0
Unforeseen Expenses	120.0	8.0
TOTAL	1,500.0	100.0

The construction cost average in the United States is $5,000 per line which reflects the higher labor and land acquisition costs in the U.S.

H. FINANCIAL SITUATION

Even though ANTEL was created as an autonomous institution, this autonomy is to a certain extent only formal. Decisions made are subject to other approval before they can be put into effect. Thus, for example, the institution's budget, like those of other government entities, is drawn up according to central government guidelines, and final budget approval and investment is given by the Ministries of Finance, Planning and finally the Legislative Assembly. Thus, not all of ANTEL's profits are available to re-invest.

1. Balance Sheet

In 1988, total assets reached C1.2 billion, showing a nominal increase of 17.8 percent to over 1987. Net capital represented 71.6 percent of total liabilities, indicating a financially sound institution. See Table V.H.1.

Current assets represented 61.4 percent of total assets, while cash and blank deposits were 29.1 percent of this total. It is unusual for any company to have such a cash position. ANTEL can only invest it, however, with GOES approval.

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TABLE IV.H.1 NATIONAL TELECOMMUNICATIONS ADMINISTRATION
BALANCE SHEETS AS OF DECEMBER
(In Thousands of Colones)

A S S E T	1983	1984	1985	1986	1987	1988
FIXED ASSETS						
Plant in Operation	250,000	273,737	309,550	352,343	396,400	477,810
Less: Depreciation	99,318	113,562	129,007	143,081	162,898	184,130
	150,772	160,175	180,543	209,262	233,502	293,680
Works under construction	53,597	74,534	84,954	63,350	70,186	85,038
INVESTMENTS:						
INTELSAT	509	509	509	1,019	1,019	1,019
Mortgage paper	32,200	30,000	30,000	30,000	30,000	38,913
	237,078	265,218	296,006	303,631	334,707	418,650
CURRENT ASSETS						
Cash in banks	77,700	94,668	129,785	278,584	368,461	356,817
Warehouse and Merchandise in Transit	86,505	91,807	101,769	146,025	184,632	252,886
Unpaid Accounts (Net)	31,924	38,050	55,817	134,471	114,992	143,335
	196,129	224,525	287,371	559,080	668,085	753,038
OTHER ASSETS						
Unpaid Government of El Salvador Accts	8,776	9,843	11,503	18,442	29,070	38,343
Deferred Charges	1,509	2,712	4,414	5,955	8,848	16,123
	10,285	12,555	15,917	24,397	37,918	54,466
TOTAL ASSETS	443,492	502,298	599,294	887,108	1,040,710	1,226,154
LIABILITIES						
NET CAPITAL						
Results of previous years	281,532	331,497	396,102	438,948	546,260	673,647
Results of present years	49,682	61,450	70,543	105,404	127,387	171,749
Results not applicable to present year	283	3,154	2,304	1,908	(22,823)	1,875
Donations	0	162	173	179	180	180
Reserve for fixed assets repositioning	0	0	0	30,000	30,000	30,000
	331,497	396,263	469,122	576,439	681,004	877,451
LONG TERM - Foreign loans and others	38,662	47,455	55,792	98,903	85,480	77,233
CURRENT LIABILITIES						
Foreign loans	8,991	6,488	6,577	12,985	14,430	13,521
Unpaid Accounts	57,857	44,376	58,460	135,538	141,448	143,740
Unpaid Accumulated Expenses	5,180	5,887	7,651	60,895	116,078	112,104
	72,028	56,751	72,688	209,418	271,956	269,365
OTHER LIABILITIES						
Government of El Salvador Debt for Transfer of Fixed Assets	271	271	271	271	271	271
Advanced Payments and Retentions	889	1,408	1,421	1,050	1,188	1,605
Other Deferred Credits	145	150	0	18	811	229
MIPLAN Special Damage Rehab.Fund	0	0	0	1,009	0	0
	1,305	1,829	1,692	2,348	2,270	2,105
TOTAL LIABILITIES	443,492	502,298	599,294	887,108	1,040,710	1,226,154

ANTEL is also different from other institutions in terms of foreign debt, as it can meet its debt service with its own revenue, especially since it earns its own foreign exchange.

Unpaid accounts have increased by C37.6 million in 1988 alone. However, this is not due to any lack of ability to collect unpaid bills. Almost the entire sum relates to services to the Ministries of Foreign Affairs, and Defense. These Ministries have increased their use of communications services, beyond their annual budgets. ANTEL cannot suspend the service nor transfer these debts.

2. Income Statement

During the 1983-1988 period, revenues have increased from C148.0 million in 1983 to C422.2 million in 1988. A similar trend is noted for costs, and hence for operating profit, which increased from C45.9 million in 1983 to C183.0 in 1988. (Table V.H.2 and Figure V.H.1).

Only 17.8 percent of ANTEL's income comes from domestic services and 82.2 percent from international services. This does not mean foreign currency is received in these proportions, since part is paid locally, but it does indicate the importance that international calls. Collect calls always show a positive net balance for El Salvador.

Revenues strongly depend on international services, which generate 82 percent of the income. The percentage breakdown is as follows:

SERVICE		% SHARE OF INCOME
Telephone:	National	16.5
	International	76.5
Telegraph:	National	0.4
	International	0.4
Telex:	National	0.8
	International	4.5
Other Services:	National	0.1
	International	0.8
TOTAL		100.0

Telephone, telex, and other telecommunication services give an operating profit. On the contrary, telegraph services and the ANTEL hospital bring losses.

One aspect thought to be positive by some and negative by others is ANTEL's hospital. The cost of operating this hospital amounted to approximately C11.0 million in 1988. Although its social

TABLE IV.H.2

NATIONAL TELECOMMUNICATIONS ADMINISTRATION

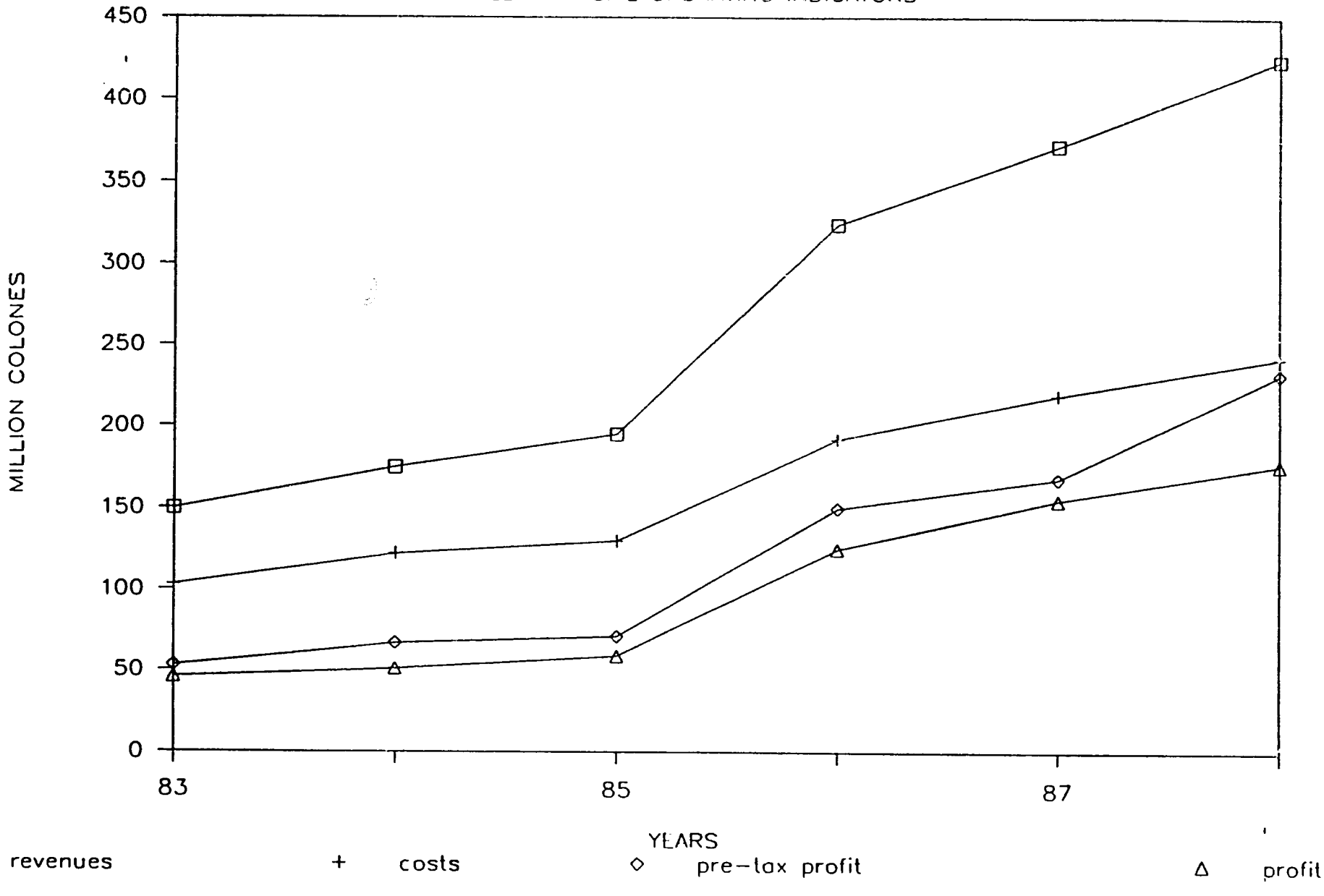
CONDENSED INCOME STATEMENT AS OF DECEMBER 31

(In Thousands of Colones)

REVENUES	1983	1984	1985	1986	1987	1988
REVENUES						
Telephone	130,055	154,013	174,344	289,234	336,535	392,524
Telegraph	3,062	3,164	2,858	3,930	3,851	3,811
Telex	11,651	12,628	12,941	24,666	27,283	21,979
Other Telecommunication Services	3,188	4,539	3,546	4,785	4,555	3,876
TOTAL REVENUES	147,956	174,344	193,689	322,615	372,224	422,190
OPERATING COSTS						
Telephone	79,227	100,771	110,047	165,041	184,511	207,142
Telegraph	10,934	9,589	11,015	12,432	14,390	14,582
Telex	9,862	7,307	7,850	12,534	14,574	14,633
Other Telecommunication Services	2,080	2,344	2,822	3,339	2,610	2,865
TOTAL OPERATING COSTS	102,103	120,011	131,734	193,346	216,085	239,222
OPERATING PROFIT	45,853	54,333	61,955	129,269	156,139	182,968
OTHER INCOME						
Bank Interests	10,808	8,255	9,976	25,333	33,870	33,566
Mortgage Paper Interests	0	4,155	3,900	4,525	3,459	7,931
Hospital Income	1,003	1,147	1,212	1,337	1,224	1,563
Other	280	871	1,315	1,565	10,992	22,801
TOTAL OTHER INCOME	12,091	14,428	16,403	32,760	49,545	65,861
OTHER EXPENDITURES						
Interest on Long-Term Debt	3,349	1,795	1,429	9,015	8,950	7,044
Hospital Operating Expenses	4,913	5,516	6,386	7,074	8,826	11,077
TOTAL OTHER EXPENDITURES	8,262	7,311	7,815	16,089	17,776	18,121
NON OPERATING PROFIT	3,829	7,117	8,588	16,671	31,769	47,740
	49,682	61,450	70,543	145,940	187,908	230,708
(-) Adjustment for exchange-rate diff.	-,-	-,-	-,-	-,-	17,874	-,-
Profit before tax	49,682	61,450	70,543	145,940	170,034	230,708
(-) Provision for Income Tax	-,-	-,-	-,-	40,536	42,647	58,960
Results of current year	49,682	61,450	70,543	105,404	127,387	171,748
Results not applicable to the present year	284	3,154	2,304	1,907	(22,823)	1,876
Donations	-,-	162	11	6	1	-,-
NET PROFIT	49,966	64,766	72,858	107,3[illegible]7	104,565	173,624

FIGURE IV.H.1

ANTEL FINANCIAL OPERATING INDICATORS



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function is recognized, some question whether it is completely unrelated to ANTEL's purpose of providing telecommunications service.

3. Sources and Uses of Funds

The statement of sources and uses of funds indicates a significant level of net revenue re-investment (see Table V.H.3).

I. PRIVATE ENGINEERING/CONSTRUCTION INDUSTRY

1. Procurement and Impacted Equipment

Most telephone equipment is not manufactured in El Salvador. ANTEL uses international public bidding procedures to acquire this equipment. Local representatives of foreign manufactures compete with foreign representatives or manufacturers. Figure V.I.1 presents the steps followed by ANTEL for public bidding.

ANTEL's criteria for equipment procurement include:

- Quality
- Guarantee
- Spare parts included in the offer
- Training of ANTEL personnel
- Schedule of delivery
- Price

In recent years ANTEL purchased equipment from NEC, OKI, ARE, HITACHI, NTI and others.

2. Cable and Wire

ANTEL uses cable and wire manufactured by a local firm (CONECA). Because this is a national product, ANTEL is not authorized to purchase these from another source. Quality control at CONECA, however, is faulty. According to ANTEL maintenance managers, they have received cable with serious defects, such as short circuits, crosses, grounds and open circuits. Meanwhile, purchases are often stored for extended periods, where cables deteriorate. Cables do not stand up well to humidity, resulting in frequent service disruptions during the rainy season.

Most of these problems aren't identified until after the cables are installed, making repairs difficult and sometimes impossible. Unless CONECA can guarantee better quality control, ANTEL should be allowed to purchase cables from the best possible source.

TABLE IV.H.3

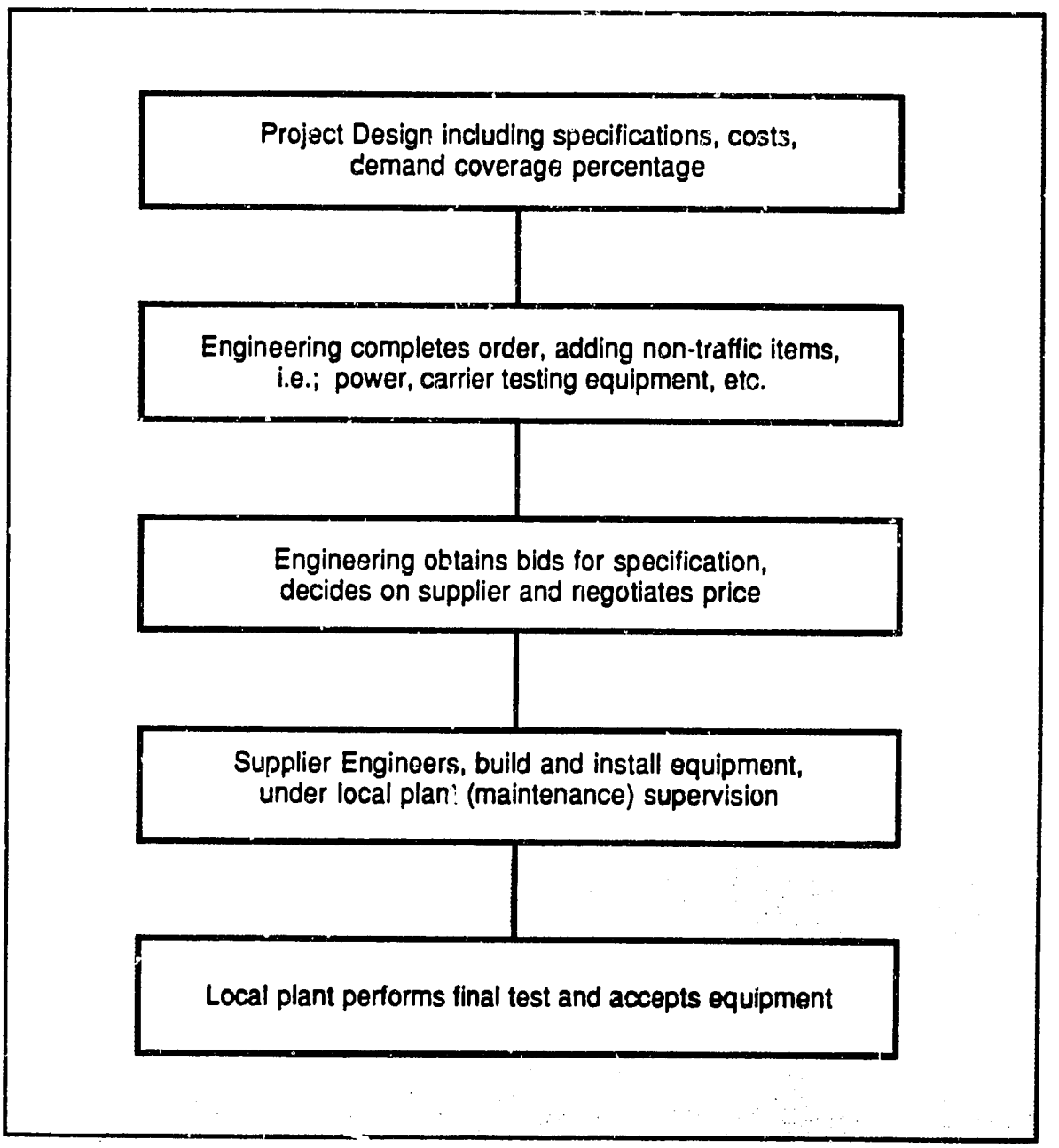
ANTEL'S STATEMENT OF SOURCES AND USES OF FUNDS, 1-1-88/12-31-88

	MILLION COLONES
SOURCE OF FUNDS	
Results of current year	172
Results not applicable to current year	25
Depreciation	21
Other Reductions in Assets	*
TOTAL SOURCES OF FUNDS	218
USE OF FUNDS	
Increase in operating plant	81
Increase in works under construction	15
Increase in mortgage paper	9
Reduction in other liabilities	*
Reduction in long-term liabilities	8
TOTAL USE OF FUNDS	114
INCREASE IN WORKING CAPITAL	104
TOTAL	218

* negligible

Figure IV.I.1

ANTEL Procurement Procedures



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3. Installation

ANTEL uses two methods for network installation, by force account or by contract. Force account is generally used for small works. Major projects are contracted.

A number of national companies have the necessary equipment and personnel to successfully install ANTEL systems. Two major local companies (DYMEL and PRINEL) are currently participating in a project to extend the San Salvador metropolitan network. Siemens, through its local representative, is participating in the installation of exchanges and switching equipment.

J. PROBLEM AREAS

ANTEL's problems stem from a variety of reasons. However, the underlying cause is the failure to keep up with demand and in the training and maintenance areas. The result is a severely restricted out-of-date network. A large injection of investment capital is needed before recognizable change can be seen.

1. Planning

Antel's Planning Department's main problem is its lack of trained and experienced staff. Although headed by an able person, the staff is a young and inexperienced one. Discussions with planning managers reveal that there is a need for training in planning methodology. This is quite understandable. In most telephone companies, the planning Department is comprised of the most experienced people, using the latest planning technologies and utilizing years of empirical data.

ANTEL's decision to hire ITU to help develop a National Plan should not only fulfill planning needs but also provide much of the needed training in planning.

2. Balancing of Investment Projects

Some projects which increase the number of installed subscriber lines do not seem to have coordinated projects in outside plant, transmission, long-distance central offices, and other local central offices. ANTEL once had some 38,000 unassigned lines with insufficient outside plant to serve them. The cost of this lack of facilities is high and the delay in providing subscriber service unnecessary.

3. Project Control Documents

Another area where there is room for improvement is the content of project control documents, which are used to inform all concerned including higher management, of their progress. The present documents, in some cases, do not include:

- project number and date of issue
- priority
- a detailed description of project content
- the contracting company
- what has been changed, deleted or added since the last issue
- reason for rescheduling

4. Operations

ANTEL Operations/Maintenance staff, partly due to the war, have adopted a "fireman" approach to their work. There is little or no time to do preventive maintenance. This results in "quick-fix" maintenance, which leads to additional future problems.

ANTEL managers are fully aware that good preventive maintenance and installation practices would cost less, provide improved service and allow them to address and correct at least some of the following problem areas.

Operations and maintenance is currently broken into teams by equipment type. However, a problem often has to be traced through several types of equipment, and regional teams would thus be more effective.

5. Obsolete Telephone and Telegraph Equipment

Many of ANTEL's problems have their roots in this area. High priority must be given to replacing obsolete equipment and obtaining replacement parts. Every effort should be made to accelerate plans for new and replacement equipment. All such obsolete equipment should be identified.

6. Lack of Test Equipment, Parts and Supplies

To satisfy customers, a telephone company must have adequate equipment with which to quickly locate and repair all types of equipment in service. In ANTEL's case, this is not so. They lack

much in this very important area, making improvisation frequently necessary.

Unfortunately, such improvisation often causes future service problems and additional cost. ANTEL should purchase additional test equipment, parts and supplies.

7. Faulty Cable and Wire

ANTEL is forced to purchase all its cable and wire from CONECA, a local company. Purchases are made as new material purchased abroad. According to ANTEL managers, these products are frequently defective, costly to ANTEL.

8. Lack of Sufficient and Suitable Training

ANTEL has no training plan. The ITU's plan will include detailed proposals on training based on a careful review of needs.

The present system is inadequate and must be improved and expanded. Eighteen-month technician courses are too long, produce too few graduates, do not include digital technology, and consist entirely of theory. This does not equip the student for the real world of telephones.

9. Staff Turnover

Although the loss of experienced people is probably worse in the Operations/Maintenance Department, it is a serious problem throughout ANTEL. The lack of opportunity couple with low salaries, has led to considerable turnover of qualified staff.

10. Damages

The main causes of damages are national disasters (earthquake) and guerrilla warfare. While it is impossible to forecast these damages with any kind of accuracy, broad contingency plans can be made in advance. It is suggested that existing plans be reviewed on a regular basis, identifying sources of repair, equipment, responsibilities, and outside forces requiring coordination. Valuable time might be saved in this manner.

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11. Private Sector

ANTEL presently uses local contractors in certain areas, particularly in outside plants. This may be an answer for some maintenance and construction problems and should be carefully studied. There are several opportunities for involving the private sector:

- specific maintenance areas
- construction
- public phone and fax services
- mobile telephone services
- data transmission services.

This participation would promote the use of ANTEL services.

12. Businesses not related to Telecommunications

ANTEL presently owns and operates several enterprises which do not seem to be directly related to the telephone business. Among these are a furniture factory, a police force, a hospital and a clinic. There is also a vehicle repair garage.

By diverting the attention of management away from what it does best and where there still are many needs, these operations are most likely to weaken ANTEL. Consideration should be given to a possible spin-off of these activities.

K. ECONOMIC EVALUATION AND SOCIAL IMPACT

1. Alternative Methods

The relationship between telecommunications investment and economic activity and development is highly complex. The benefits of a specific telecommunications project or investment program can not readily be identified and measured by the aggregate international comparison of input-output tables, by the analysis of relations between GNP and telephone availability or usage, or, apparently, by analysis of countrywide transport, energy, or locational objectives. Therefore, microeconomic analysis is now being tried as a means to estimate telecommunications benefits. Because of artificial restrictions on the growth of telecommunications and massive unsatisfied demand in developing countries, there may be relatively few cases where the telecommunications sector does not offer scope for expansion according to this criterion. That is,

rates of return to investment in telecommunications tend to be relatively high.

The consumer surplus approaches to compare estimated investment and associated operation and maintenance costs with the estimated benefits to the users of telephone, telex, and other services based on observations of their willingness to pay for access and calls, and perhaps on their observed willingness to incur costs to travel to where service is available, to purchase or rent connections from intermediaries, or to incur higher communications costs in the absence of a telephone or other telecommunications service.

Consumer surplus in telecommunications can be estimated using 3 types of methods:

- methods based on observing the consumption effects of price changes (the price change method)

- methods based on comparing the difference between the cost of carrying out a given communication activity by telecommunications with the cost of the best alternative mean of communication (the best alternative method)

- methods based on estimating more completely costs that telecommunications users actually incur when communicating (the expenditure method).

An assumption underlying this approach is that the amount of money that users are demonstrably willing to spend on telecommunications services is at least a minimum measure of the worth of those services.

Another approach is to estimate the size of the incremental revenues that will be generated by the additional telecommunications investment being proposed (a proxy for benefits), and then compare that with the investment, operating, and maintenance costs that will be incurred to generate those revenues. The use of revenues as an estimate of the benefits that consumer derive from telecommunications services, is usually a minimum estimate of the economic worth of those services because:

- Users may value the service by more than the amount that they are required to pay for it, that is, there might be consumer surplus that is not quantified.

- New telephone subscribers not only incur benefits for themselves, but also increase the benefits of being connected to the system for those who are already connected to the system, that is there are subscriber-related externalities.

- The willingness to pay a given price to make a telephone call reflects only a minimum estimate of the benefits incurred by the caller and does not reflect the benefits received by the caller or those who the caller or caller then contact, that is, there

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are call-related externalities.

2. ISA Calculations

Construction costs for an additional line are shown in Table V.K.1. This total financial cost was broken down by categories and multiplied by the ISA shadow-price conversion factors.

Annual benefits were taken to be the average annual revenue per line in service from 1983 to 1988, which equaled C4,095. This is a conservative estimate. The large pent-up demand indicates that the actual rate Antel is currently charging is well below the market equilibrium price.

Additionally, as tariff increases have not kept pace with inflation, consumers in the past have shown a willingness to pay even more than the current average price would indicate.

Using the actual revenue as benefits and discounting these benefits at 12 percent over an estimated 50 year life, the estimated net benefit to investment ratio is approximately 2.50, with an internal rate of return of over 30 percent.

3. Social Impact

a. Long-Term Impact

As economic development takes place, some form of telecommunications gradually becomes the most cost-effective means of communication for increasing proportions of the population. Telecommunication services can substitute for other forms of communication (mainly postal service and personal travel) and are often more effective and more efficient than other forms in terms of time, energy, materials, information content and quality of the environment. Further, there is some evidence that with a reliable telecommunications system, new communication is generated, and stronger, more complex, and more productive communication patterns build up, partly through direct and indirect interaction with numerous production and distribution functions.

Telecommunications can substitute for some aspects of the transport system and can also bring about more efficient use of transport facilities. This substitution should have increased as transport costs have risen and communications costs declined.

There is virtually no aspect of economic and social development in any one sector of an economy that does not interact with other sectors. One such interaction is how development activities require services from the economy's infrastructure networks, such

TABLE IV.K.1

ECONOMIC EVALUATION
TELEPHONE LINE EXPANSION

INVESTMENT COSTS/LINE

	US $	Financial Colones	Economic Colones
Materials	341	1,707	2,048
Equipment	515	2,577	3,092
Land, Buildings	72	360	335
Labor (Skilled)	217	1,085	1,009 (1)
Labor (Unskilled)	54	271	230
Engineering/Supervision	180	900	837
Miscellaneous	120	600	558
TOTAL	1,500	7,500	8,110

OPERATIONS & MAINTENANCE COST PER LINE 1,603

SUMMARY OF RESULTS

Net Present Benefits (12%)	34,007
Net Present Costs (12%)	21,418
Net Present Value (12%)	12,589
Net Benefits/Investment (12%)	2.55
Internal Rate of Return	30.73%

SENSITIVITY ANALYSIS

Net Benefits/Investment (10%)	3.05
Net Benefits/Investment (15%)	2.05
Net Benefits/Investment (12%) & Costs Increased 10%	2.17

(1) From GTZ, "Estudio sobre la Estimacion de los Parametros Nacionales de El Salvador", and the Consultants' estimate.

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as roads, water, power and telecommunication. This is an important, but not well researched point.

With accessible and reliable telephone service, some of the physical constraints on organizational communication are removed in various sectors of the economy, permitting increased productivity through better management in both the public and private sectors. This makes it possible to adopt different structures and locations, and to aid the evolution of increasingly complex organizations.

Markets gain in effectiveness with improved communication, more rapid responses to market signals become possible, and access to market information is extended at village, town, city, regional, national, and worldwide levels. Also, the efficiency of household operation rises as telecommunication allows improved access to goods and services, and forms of work are supported that require some integration of workplace and residence.

Its usefulness is apparent for business and industry. Industrial developments require the coordination of numerous activities: purchasing, recruitment and coordination of labor, control of stocks, processing of materials, billing, record keeping, delivery of goods to buyers, and general market research activities. Commerce, however, is inherently an information processing activity. Effective buying, selling, brokerage, and transport require a continuous supply of up-to-date information on the availability and prices of numerous goods and services. In the absence of an accessible and reliable telecommunications service, trade suffer a variety of inefficiencies, including the creation of markets in which a few information-rich individuals are able to gain significant advantage over the majority of those who are information poor.

As agricultural development increases marketable agricultural surplus, it gives rise to widespread trade in agricultural commodities, seeds, fertilizers, fuels and other goods and services, which, to be efficient, inevitably require reliable means of communicating rapidly and over long distances. There is need for reliable and rapid information about weather conditions, disease outbreaks, and new agricultural techniques.

Hence, the opportunities for savings in transport and transport-related materials and supplies costs, which can result from increased telecommunications investment, deserve serious attention. More opportunities have opened up for rural telephones with new dramatic changes in telecommunication technology which have lowered its real cost. New power sources are being used, such as solar cells, energy converter generators that burn alcohol or propane, and compact wind turbines. This trend is likely to continue in the foreseeable future.

These effects are impossible to measure given data availability and the very early stage of development of telecommunications in the

country. They do, however, clearly indicate the highly positive benefits brought about by telecommunications development.

b. Short-Term Impact

ISA has measured short-term impact of telecommunications development in terms of direct labor generation. As shown above in Section "G", every line installed cost US$ 217 in skilled labor and US$ 54.2 of unskilled labor. Note that a large part of skilled labor is foreign. For the purpose of this study it is assumed that local skilled labor generated is only $117/line. Using rates of C 19.16/hour for skilled and C 6.95/hour for unskilled labor we obtain a labor generation of:

57.6 person/hours/line for skilled labor
39.0 person/hours/line for unskilled labor

Or 96.6 hours/line which corresponds to 0.04 percent/years. Since each line costs about $10,000, all included, about $375,000 is needed to generate one percent-year of work. Thus, as a capital intensive industry, little labor is generated by telecommunications.

L. SECTOR PROJECT NEEDS

1. New Lines

The economic evaluation indicates that the installation of a phone line, including all necessary switching and transmitting equipment, is worthwhile with an IRR of 30.7 percent. Because of the acute deficiency in the sector, it is assumed that any phone line installed up to a density of about 6 phones/100 persons by the year 2000 would have the same rate of return. The constrain to expansion does not seem to be the rate of return, but rather the priority GOES assign to this sector, the investment budget it approves and the additional funding ANTEL obtains.

2. Planning

ANTEL's planning resources require the most strengthening. In recognition of this need, ANTEL has contracted ITU to prepare a national plan, which will consist of an investment program for long-term growth and a set of fundamental technical plans including plans for long-term numbering, transmission, signaling, routing and other elements of technological development.

This should be continued later with a technical-assistance project. The project components could also include the acquisition of data measuring instruments, since these measurements provide the base for sound planning procedures. ISA proposes the project consider the following:

- Assign long-term technical assistance specialists to the ANTEL Planning Department.

- Provide training in planning methods (see below)

- Consider moving the Traffic Facilities group, or at least part of it, to the Planning group. This is important, as traffic measurements form the basis of all planning when it comes to quantifying equipment sizes and numbers. It is also instrumental in planning trunk networks. Further, its present staff appear to have some expertise in traffic measurements, which could be passed on to other Planning members.

3. Inputs to Planning: Traffic Measurements and Equipment Needs

ISA suggests efforts be made to:

- Ensure that traffic measuring devices are included in all switching centers on a "next time in" basis. Steps should be taken to acquire and use the data that they can furnish.

- Establish a system to determine the subscriber capacity of each switching center. The use of such a system will control the overloading of switchers and help predict when an extension of equipment must be installed. It also can be used to predict future capital expense for new additions.

- Set up a system to predict when additional switchboards must be installed.

- Install a system to forecast trunk network sizes, both local and long distance. In cases where traffic measurement devices are not available, consider manual studies to acquire the necessary data.

- Consider the preparation of a traffic routing plan and a traffic capacity data sheet for each switching center. This information, or traffic specification, should accompany equipment specifications sent to the equipment suppliers, operations/maintenance, engineering and other divisions which require such information. This is especially needed when new switchers are added to a network which still has analog components and may be limited in its ability to handle certain numbering schemes.

Also, some of the digital switchers have a limited number of possible attempts. One call, whether completed or not, counted as an attempt. In a congested network, there are many more attempts than completed calls. When limitations are exceeded, severe switcher problems can result. Staff should be aware of these potential problems and such a traffic specification can serve as the necessary information vehicle.

- Begin preparation for the writing of all equipment specifications. By doing so, ANTEL will have complete control over what it is buying from the contractor.

- Identifying those switching centers that will require coordinating installations when a new switcher is added or other changes are made that require the same.

- Establish a system for the forecasting of demand. Resulting forecasts should be done on switching center basis, and should be updated frequently.

- Meet with other departments on a regular basis so that they can be kept informed of plans and therefore input their experience and needs for inclusion in the plan.

The adoption of these recommendations should assist in the development of a Planning Department that will allocate capital expenditure properly and wisely.

4. Staffing and Training

Every attempt should be made to recruit experienced staff members in several departments (especially Operations/Maintenance). In many cases, non-professionals can be of great help. This approach works well in other countries. It also creates opportunities for the advancement of technical staff.

The present training system is inadequate and must be improved and expanded. The eighteen-month technician course is too long, and consists entirely of theory without equipping the student for the real world. Digital technology is not taught. Also, this course produces too few graduates.

The ITU is helping to prepare a training plan. Meanwhile, recommendations for more rounded technician graduate, to be implemented in a training project are:

- Shorten the eighteen-month course into several practical courses of a few weeks each. This allows the student to assimilate the knowledge that he has learned and to meld actual experience into his understanding. He also learns the use of tools, further improving his skills. It also allows his manager to evaluate his training needs and to fit them to the current job requirements.

- Document and describe each proposed course and ensure that all managers have input to its content.

- Consider rotating instructors through the school, say for two year periods. This approach has these advantages:

  - prevents instructors from becoming out-of-date on newer technology and equipment.

  - spreads the experience that is gained by being an instructor among the management staff.

- Consider a similar technical and management course for new managers. They too must completely understand what their staffs must accomplish and how the work is done. They will also be in a better position to evaluate their people and their training requirements.

- Similar course should be considered for other departments as well, with material tailored to their needs.

- Prepare a planning course, and train instructors its use. Present the course in a local environment to keep costs as low as possible.

- Teach digital technology, as well as analog. These should be separate courses, with the digital course given to students with a good telecommunications foundation, both in theory and in practice. This course is essential to today's needs.

- Establish and train employees in the usage and benefits of an operation and maintenance standards system. Such a system would specify how each job should be performed and what the desired result should be. This is the accepted cost-control means in the telecommunications business.

  Examples of such standards are:

  - distance of wire and cable above streets and roads.
  - methods of attaching apparatus to subscriber buildings.
  - methods and procedures for locating certain trouble spots.

  - methods of future trouble prevention.
  - safety, etc.

- Consider involving equipment supplier in specialized on-site training, possibly as part of the contractual responsibilities. In this manner, job-trained technicians would be available to maintain the new DMS switchers to be installed in 1990.

M. PROJECT IMPLEMENTATION

Figure V.M.1 presents a flow chart which summarizes the procedures used by international telephone companies to provide equipment. Comparing this figure with Figure V.I.1, it is apparent that planning is the most important constraint which ANTEL faces in project implementation.

Because of lack of trained personnel and of testing and measurement equipment, ANTEL's purchases are based on either historical data or on turn-key specifications provided by suppliers. This results in occasional imbalances and system inefficiencies. Balanced purchasing based on the study and measurements of effective capacities of the current inventory, maintenance needs and demand forecasts would yield a larger number of lines in operation for every colon invested.

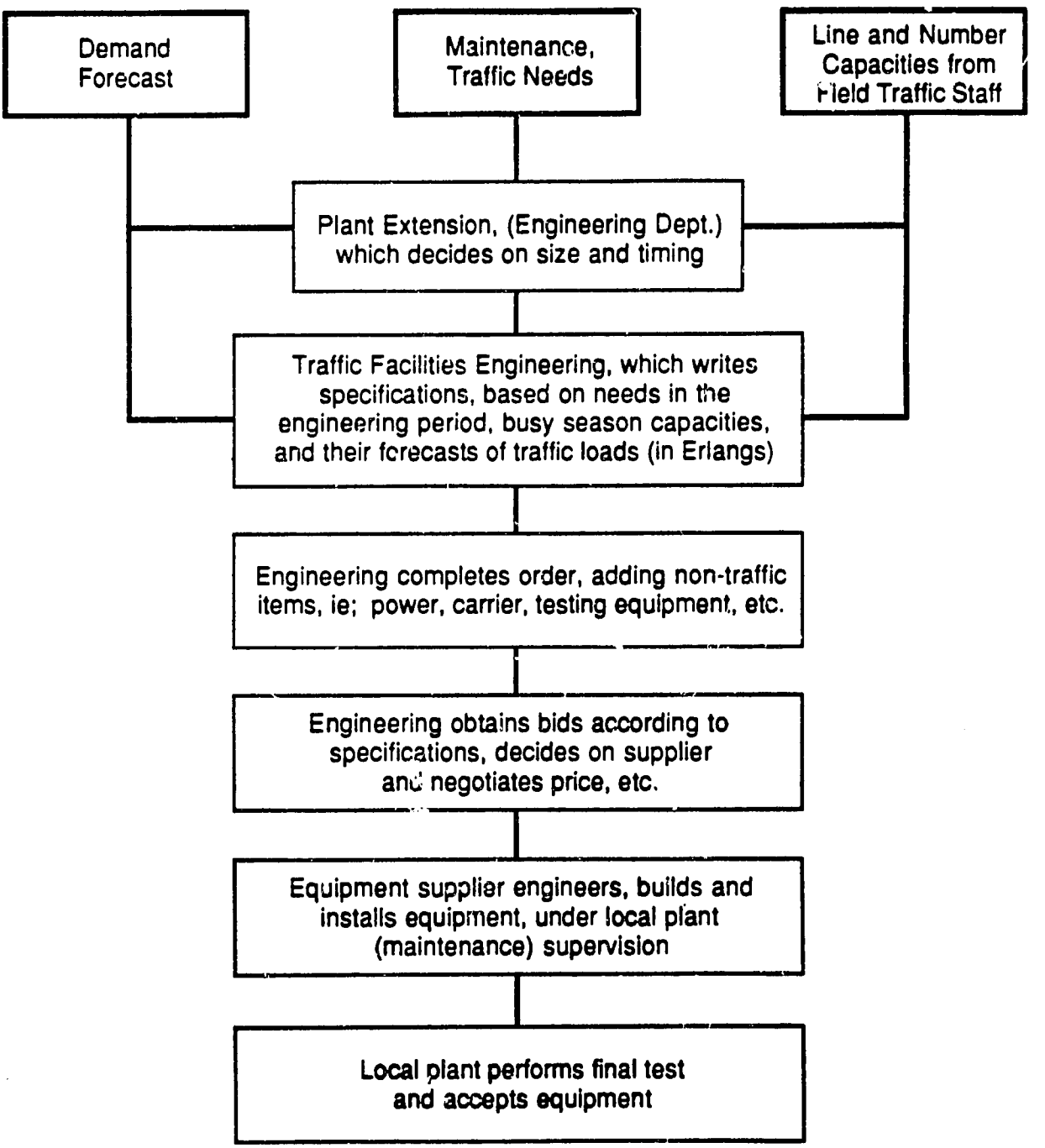
ANTEL has already contracted ITU to assist in system design and operations planning. ANTEL should also continue to use such assistance until it has built up its own planning capabilities.

Contracting procedures for small pieces of equipment or small works are adequate with the exception of present procedures for acquiring cable equipment. Competitive bidding should be allowed in this case or, at least, cable equipment should be subject to stricter control.

For those new projects which have not yet been contracted, necessary tools, test equipment, parts and supplies should be included in the initial purchase. A clause which would guarantee future supplies should be used. This would counter a current lack of these tools. Operations/Maintenance should ensure that its needs are known by Planning and Engineering and included in future contracts.

Figure IV.M. 1

International Telephone Companies Procedure for Providing Equipment and Contracting Equipment Extensions



APPENDIX IV. A. 1

ANTEL PERSONNEL AT NATIONAL LEVEL (JULY 1988)

	EXECUTIVE	PROFESSIONAL	TECHNICAL	ADMINISTRATIVE	SERVICE WORKERS	WORKERS	TOTAL
T O T A L	95	231	1352	809	3166	345	5998
DISTRICT OFFICES							
SAN SALVADOR	1		12	7	158	2	180
LA LIBERTAD	1		3	6	123		133
CABANAS	1			2	43	2	48
CHALATENANGO	1			5	70		76
SAN VICENTE	1	3			52		56
LA PAZ	1		1	4	83		89
CUSCATLAN	1			1	63		65
AHUACHAPAN	1			4	81		86
SANTA ANA	1	1	14	9	139		164
SONSONATE	1		5	6	110		122
USULUTAN	1			4	149		154
SAN MIGUEL	1	1		4	127		133
LA UNION	1			1	71		73
MORAZAN	1			3	43		47

APPENDIX IV.B.1

PHONE LINE DISTRIBUTION

GLOSSARY

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ANTEL - OPERATIONS & MAINTENANCE DIVISION
EXTERNAL PLANT DEPARTMENT

MONTHLY REPORT ON THE USE OF THE CENTRAL COMMUTATION BATTERY, MARCH 1989

Bateria Central - Central Battery

ANTEL - Oficina - ANTEL Office
Tel. Pub. - Public Telephone

Particulares - Private

Cuentas Gob. Directos - Government Accounts

Nuevas Instal. - New Installations

Occup. Actual - Currently in use

Vacantes - Unoccupied

Occup. Planta - In use, exchanges

ANTEL
DIVISION OPERACION Y MANTTO.
DEPTO. PLANTA EXTERNA.

INFORME MENSUAL DE OCUPACION DE CONMUTADORES DE BATERIA CENTRAL MES DE MARZO/89.

		BATERIA CENTRAL	ANTEL			PARTICULARES			CUENTAS GOB. DIRECTOS	NUEVAS INSTAL.	OCUP. ACTUAL	VACANTES	OCUP. PLANTA	%
			OFICINA	TEL.PUB.	SUB-TOTAL	1º	2º	SUB-TOTAL						
SANTA ANA	1	CANDELARIA DE LA FRONTERA	3	6	9	3	64	67	4	—	80	20	100	80.00
	2													
	3	SAN CRISTOBAL LA FRONTERA	2	3	5	1	19	20	5	—	30	—	30	100.00
	4	TEXISTEPEQUE	3	3	6	4	13	17	6	—	29	31	60	48.33
	5													
AHUACHAPAN	6	APANECA	2	3	5	17	75	92	3	—	100	—	100	100.00
	7													
	8	CARA SUCIA	—	4	4	10	61	71	3	—	78	2	80	97.50
	9	JUJUTLA	2	2	4	—	30	30	2	—	36	4	40	90.00
	10	PUENTE ARCE	2	3	5	17	10	27	—	—	32	8	40	42.50
	11	TACUBA	9	2	11	12	75	87	4	—	102	18	120	85.00
	12													
SONSONATE	13	LOS NARANJOS	1	3	4	11	5	16	—	—	20	50	70	28.57
	14													
	15	SAN JOSE LA MAJADA	1	2	3	4	45	49	—	—	52	8	60	86.67
	16	ZONZACATE	1	3	4	1	6	7	—	—	11	5	16	68.75
	17													
SAN SALVADOR	18	GUAZAPA	2	3	5	3	28	31	4	—	40	40	80	50.00
	19	NEJAPA	1	3	4	5	22	27	2	—	33	7	40	80.00
	20	SAN BARTOLO	3	2	5	—	149	149	—	—	154	86	240	64.17
	21	SAN JOSE	3	2	5	—	74	74	—	—	79	21	100	79.00
	22	SANTIAGO TEXACUANGOS (Semiautomatico)	2	3	5	1	120	121	—	—	126	53	179	70.39
	23	SANTO TOMAS (Semiautomatico)	5	3	8	7	81	88	3	—	99	1	100	99.00
	24	TONACATEPEQUE	2	2	4	4	11	15	4	—	23	7	30	76.67
	25													
	26													
LA LIBERTAD	27	COMASAGUA												
	28	COLON	3	2	5	13	17	30	3	—	38	2	40	95.00
	29	JAYAGUE	3	4	7	3	16	19	1	—	27	33	60	57.20
	30	LOURDES	2	6	8	9	39	48	3	—	59	21	80	73.75
	31	SITIO DEL NIÑO	3	4	7	11	59	70	1	—	78	72	150	51.33
	32	ZARAGOZA	3	3	6	—	22	22	3	—	31	9	40	75.00
	33		2	4	6	11	40	51	1	—	58	2	60	96.67
CHALAT.	34	NUEVA CONCEPCION.	2	4	6	—	90	90	—	—	96	4	100	96.00
	35	EL PARAISO	4	3	7	—	3	3	2	—	12	4	16	75.00
	36													
CUSCA	37	SAN RAFAEL CEDROS	2	4	6	58	47	105	2	—	113	87	200	56.50
	38													
	39	LA HERRADURA	3	3	6	8	39	47	5	—	58	32	90	64.44
LA PAZ	40	ROSARIO DE LA PAZ	2	6	8	11	38	49	2	—	59	1	60	98.33
	41		2	[illegible]	[illegible]	[illegible]	22	40	3	—	50	70	120	41.67
	42	SANTIAGO NONUALCO	1	3	4	22	88	110	4	—	118	12	130	90.77
	43	SAN JUAN NONUALCO	3	4	7	8	100	108	3	—	118	2	120	98.33
	44	SAN PEDRO MASAHUAT	3	5	8	7	26	33	3	—	44	26	70	62.86
	45	SAN RAFAEL OBRAJUELO	1	3	4	16	16	32	1	—	37	3	40	92.50
	46													
CABAÑAS	47	SAN ISIDRO	3	3	6	9	40	49	4	—	59	1	60	98.33
	48	TEJUTEPEQUE	2	2	4	2	11	13	3	—	20	10	30	66.66
	49													
SVC.	50	SAN SEBASTIAN												
	51													
	52													
USULUTAN	53	STA. ELENA	4	9	13	15	77	92	6	—	111	9	120	92.50
	54	SAN BUENAVENTURA	1	2	3	—	—	—	—	—	3	23	26	11.50
	55	VILLA EL TRIUNFO	3	3	6	—	30	30	1	2	37	3	40	98.50
	56													
	57	PASAPANA	2	4	6	2	20	22	2	—	30	10	40	75.50
LA UNION	58	PUENTE GOASCORAN	2	1	3	6	15	21	1	—	25	15	40	62.50
	59	SAN ALEJO	2	3	5	—	33	33	4	—	42	18	60	68.40
	60	INTIPUCA	2	3	5	—	19	19	—	—	24	5	29	82.76
	61													42
		TOTAL	102	140	242	311	1773	2684	95	—	2421	761	3182	7608

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ANTEL - OPERATIONS & MAINTENANCE DIVISION
EXTERNAL PLANT DEPARTMENT
STATISTICS AND CONTROL UNIT

MONTHLY REPORT - SUBSCRIBERS FROM LOCAL BATTERY AND OTHER RURAL NETWORK SERVICES

Clasificacion de Servicios - Type of Service

Servicio de Enlace a Conmutador - Commutation Link Service

Cant. Ofic. con Conmutador - Offices with switchboards

Telef. Part. 1a cat. - First grade private phones

Telef. Part. 2a cat. - Second grade private phones

Telef. Oficiales - Official phones

Telef. Pub. Rurales - Rural public phones

Telef. Pub. Urbanos - Urban public phones

Telef Pub. en Oficina - Office public phones

Numeros ocupados - numbers in use

Numeros vacantes - Unused numbers

Capacidad Conmuntador - Exchange capacity

Troncales manuales - Manual trunk lines

Troncales automaticos - automatic trunk lines

Onda portadora - Carrying wave

Servicio PBX - PBX switchboard service

Linea Telegrafica - Telegraph line

Oficina con radio enlace - Office with radio link

ANTEL
SUBDIVISION OPERACION Y MANTTO.
DEPARTAMENTO PLANTA EXTERNA
UNIDAD DE ESTADISTICA Y CONTROL

INFORME MENSUAL DE CANTIDAD DE ABONADOS DE BATERIA LOCAL Y OTROS SERVICIOS DE RED RURAL.

	DEPARTAMENTO	CLASIFICACION DE SERVICIOS											SERVICIO DE ENLACE A CONMUTADOR							SERVICIOS INTERDEPARTAMENTALES
		CANT OFIC. CON CONMUTADOR	TELEF PART. 1a CAT.	TELEF. PART. 2a. CAT.	TELEF. OFICIALES	TELEF. PUB. RURALES	TELEF. PUB. URBANOS	TELEF. PUB. EN OFICINA	NUMEROS OCUPADOS	NUMEROS VACANTES	CAPACIDAD CONMUTADOR	TELEF. PUB. INTER.	TRONCALES MANUALES	TRONCALES AUTOMATICAS	ONDA PORTADORA	SERVICIO P.B.X.	LINEA TELEGRAFICA	OFICINA CON RADIO ENLACE	NUEVAS INSTALACIONES	
1	AHUACHAPAN	10	24	109	20	7	—	13	173	47	220	—	9	14	3	—	5	1	—	
2	SONSONATE	10	14	42	5	4	3	21	89	35	124	—	1	—	—	—	—	—	—	
3	SANTA ANA	11	22	75	24	16	—	13	150	—	150	—	17	14	3	—	2	—	—	
4	LA LIBERTAD	11	12	63	14	4	1	22	116	42	158	—	7	7	1	—	—	—	—	
5	SAN SALVADOR	3	1	34	6	—	—	9	50	—	50	—	—	5	—	—	—	—	—	
6	CHALATENANGO	17	13	76	26	13	—	25	153	129	282	—	7	9	3	—	—	—	—	
7	CUSCATLAN	11	6	77	4	12	16	16	131	58	189	—	7	10	—	—	5	—	—	
8	LA PAZ	17	26	135	25	11	—	29	226	44	270	—	20	10	2	—	1	1	—	
9	SAN VICENTE	11	24	96	24	5	2	19	170	—	170	—	20	10	2	—	1	1	—	
10	USULUTAN	7	13	55	15	3	—	14	100	10	110	—	6	9	—	—	1	—	—	
11	CABAÑAS	4	2	15	11	1	1	8	38	2	40	—	2	2	2	—	2	—	—	
12	MORAZAN	9	1	154	18	4	8	19	204	61	265	—	10	4	—	—	—	—	—	
13	SAN MIGUEL	14	35	74	22	6	4	20	161	108	269	—	13	7	3	—	7	—	—	
14	LA UNION	11	6	122	20	6	4	19	177	43	220	—	13	10	—	—	—	—	—	
	TOTAL	146	199	1127	234	92	39	247	1938	579	2517	—	132	111	19	—	24	4	—	

MONTHLY REPORT ON USE OF AUTOMATIC CENTRAL OFFICES

Most terms translated on previous pages

Cap. - capacity

Ocup. - in use

Prueba - for testing

ANTEL

SUB-DIVISION DE OP. Y MANTTO.
DEPTO. PLANTA EXTERNA

INFORME MENSUAL DE OCUPACION DE CENTRALES AUTOMATICAS DEL PAIS

SECCION ADMINISTRATIVA
UNIDAD DE ESTADISTICA Y CONTROL

N°	CENTRALES AUTOMATICAS	PREFIJOS	ANTEL P.B.X	ANTEL OFICINAS	ANTEL TEL. PUB CAP	ANTEL TEL. PUB OCUP	ANTEL PRUEBA	ANTEL SUB TOTAL	PARTICULARES CATEGORIAS 1a	PARTICULARES CATEGORIAS 2a	PARTICULARES P.B.X	PARTICULARES SUB-TOTAL	CUENTAS GOB. DIRECTO	CUENTAS GOB. P.B.X	CUENTAS GOB. SUB TOTAL	NUEVAS INSTALAC.	RETIROS	OCUPACION	VACANTES	CAPACIDAD	% OCUPAC.
1	CENTRO	8	–	9	280	–	21	310	–	–	–	–	–	–	–	–	–				
2	CENTRO I	21	–	28	60	–	4	92	620	2290	2	2912	12	–	12	22	–	310	6738	7406	04.17
	CENTRO II	22	6	222	200	146	74	502	3618	4285	554	8457	479	210	689	–	–	3016	6984	10000	30.16
	CENTRO III	71	–	198	122	53	7	327	2233	2083	54	4370	219	–	219	3	–	9648	352	10000	96.41
	[illegible] I	23	35	134	200	139	77	446	2621	6166	562	9349	183	22	205	1	–	4916	1228	6144	80.0
	[illegible] II	24	13	105	140	34	52	310	2234	4009	292	6535	155	–	155	3	–	10,000	–	10000	1.00.00
	[illegible] III	55	–	–	81	–	5	86	325	776	–	1101	–	–	–	78	–	7000	–	7000	100.0
	SN MIGUELITO I	25	6	46	200	144	76	328	1376	7838	142	9356	132	182	314	6	–	1187	861	2048	57.9
	SN MIGUELITO II	26	–	43	200	35	75	318	1659	7763	116	9538	111	24	135	5	–	9998	2	10000	99.9
10	SOYAPANGO I	27	4	26	100	81	39	169	854	3575	266	4695	119	17	136	7	–	9991	9	10000	99.91
11	SOYAPANGO II	77	–	3	60	12	4	67	112	332	9	453	2	–	2	26	–	5000	–	5000	1.00.00
12	SANTA TECLA	28	22	52	60	46	25	159	1125	3448	104	4677	102	29	131	1	–	522	2550	3072	16.99
13	ALTAMIRA	73	–	5	60	11	13	78	228	2677	9	2914	9	–	9	8	–	4967	33	5000	99.34
14	MONTEBELLO	74	–	11	102	21	6	119	588	4241	12	4841	5	–	5	6	–	3001	583	3584	83.73
15	ATLACATL	76	–	1	74	–	5	80	225	2160	–	2385	10	–	10	61	–	4965	155	5120	96.97
	[illegible]	76	7	10	60	11	4	81	416	2481	66	2963	1	–	1	1	–	2475	1621	4096	60.42
	[illegible]	79																3045	155	3200	95.16
																				2000	
	[illegible] JOSE	30	–	1	6	–	3	10	15	134	–	149	2	–	2	7	–				
	[illegible]	31	8	6	8	7	12	34	92	261	7	360	6	–	6	–	–	161	223	384	41.93
	QUEZALTEPEQUE	31	8	1	6	4	24	39	66	172	–	238	14	–	14	–	–	400	–	400	100.00
	[illegible]	31	8	7	4	2	21	40	28	110	–	138	13	–	13	–	–	291	9	300	97.00
	[illegible]LARES	31	7	5	2	2	13	27	33	30	–	63	8	–	8	–	–	191	9	200	95.50
	[illegible]	31																98	2	200	98.00
	COJUTEPEQUE	32	8	43	20	10	5	76	233	637	–	870	47	–	47	–	–			50	
	[illegible]	32	8	4	4	4	25	41	81	253	–	334	12	–	12	–	–	993	7	1000	99.30
	SENSUNTEPEQUE	32	8	11	8	4	32	59	109	196	–	305	36	–	36		–	387	3	400	99.75
	SN VICENTE	33	8	17	16	9	9	50	198	480	–	678	72	–	72	1	–	400	–	400	100.00
	ZACATECOLUCA	34	8	13	12	10	12	45	230	515	–	745	50	–	50	3	–	800	200	1000	80.00
	SN PEDRO NONUALCO	34	8	5	4	2	26	43	6	45	–	51	6	–	6	9	–	840	1208	2048	41.02
34	SUCHITOTO	35	8	3	2	2	18	31	18	62	–	80	9	–	9	–	–	100	100	200	50.00
	CHALATENANGO	35	9	11	4	4	20	43	36	67	–	103	42	–	42	7	–	120	–	120	100.00
	LA LIBERTAD	35	8	3	12	4	29	52	82	167	–	249	15	–	15	11	–	168	212	[illegible]	31.33
37	SAN MARTIN	36	1	5	10	4	8	24	34	296	–	330	–	–	–	22	–	316	284	600	52.67
	COMALAPA	39	–	1	12	5	3	16	–	4	–	4	–	–	–	–	–	334	646	1000	33.40
																		20	620	640	03.13
	EL PALMAR	40	–	7	80	6	6	93	347	2006	2	2355	18	1	19	24	–				
42	STA ANA II	40	–	3	40	31	4	47	388	1088	1	1477	11	–	11	–	–	2467	3677	6144	40.15
43	STA ANA I	41	16	73	80	19	28	197	1001	2348	78	3427	121	10	131	125	–	1535	513	2048	75.00
	METAPAN	42	4	10	4	4	31	49	99	288	–	387	22	–	22	1	–	3755	245	4000	93.80
	AHUACHAPAN	43	8	13	12	2	19	52	229	546	3	778	54	–	54	61	–	458	142	600	76.33
	CHALCHUAPA	44	8	19	12	6	17	56	296	416	–	712	23	–	23	6	–	884	716	1600	55.25
	ATIQUIZAYA	44	–	5	4	3	32	41	54	139	–	192	12	–	12	–	–	791	209	1000	79.10
	EL CONGO	45	2	2	10	–	4	18	40	186	–	226	3	–	3	–	–	245	555	800	30.63
	[illegible]	[illegible]	–	1	6	3	3	10	15	114	–	129	–	–	–	–	–	247	265	512	48.24
	SONSONATE	51	32	26	40	34	13	113	694	1582	11	2287	65	11	76	8	–	139	245	[illegible]	36.20
	IZALCO	51	4	5	6	4	2	17	48	250	–	298	10	–	10	–	–	2476	1620	4096	60.45
	NAHUIZALCO	51	4	5	6	4	2	17	34	93	–	127	3	–	3	–	–	325	59	384	84.64
	SAN JULIAN	52	4	4	2	2	16	26	33	98	–	131	5	–	5	–	–	147	109	256	57.42
	ARMENIA	52	4	3	4	4	31	42	60	175	–	235	6	–	6	–	–	162	38	200	81.00
55	JUAYUA	52	8	3	4	4	31	46	69	197	–	266	5	–	5	10	–	283	229	512	55.27
	ACAJUTLA	52	8	7	8	8	12	36	150	208	19	377	18	–	18	–	–	317	283	600	19.50
57																		430	970	1400	30.71
58																					
59	SAN MIGUEL	61	13	62	60	58	28	163	863	1755	16	2634	196	7	203	–	–				
60	USULUTAN	62	8	15	12	8	13	48	286	200	5	491	61	–	61	–	–	3000	–	3000	100.00
61	JIQUILISCO	62	8	13	4	1	31	56	25	114	–	139	5	–	5	–	–	600	–	600	100.00
62	PUERTO TRIUNFO	52	8	3	2	2	14	27	39	23	–	62	5	–	5	–	–	200	–	200	100.00
	STGO. DE MARIA	63	8	5	10	10	13	36	116	316	4	436	17	–	17	–	–	94	6	100	94.00
	BERLIN	63	8	3	6	6	31	48	45	186	–	231	15	–	15	–	–	489	111	600	81.50
	GOTERA	64	8	8	12	4	40	68	46	88	–	134	26	–	26	14	–	294	106	400	73.50
	STA ROSA DE LIMA	64	16	3	12	3	34	65	80	158	–	238	13	–	13	39	–	228	172	400	57.00
67	LA UNION	64	8	11	8	8	12	39	148	406	5	559	41	2	43	–	–	316	284	600	52.67
68	CHINAMECA	65	8	4	4	4	11	27	44	120	–	164	9	–	9	–	–	641	359	1000	64.10
	[illegible]APA	65	–	6	8	4	31	45	33	112	–	145	9	–	9	–	–	200	–	200	100.00
																		199	201	400	49.75
			392	350	2585	1043	1256	5583	24,777	70,764	2339	97880	2644	515	3159	592	–	106,522	38,628	145,250	73.4

ELABORO ESTADISTICA MES DE MARZO DE 19 89

ANTEL

SUB-DIVISION DE OP. Y ANTTO.
DEPTO. PLANTA EXTERNA

INFORME MENSUAL DE OCUPACION DE CENTRALES AUTOMATICAS DEL PAIS

SECCION ADMINISTR.
UNIDAD DE ESTADIS. Y CONTROL

	CENTRALES AUTOMATICAS	PREFIJOS	ANTEL P.B.X	ANTEL OFICINA	ANTEL TEL.PUB CAP	ANTEL TEL.PUB OCUP	ANTEL PRUEBA	ANTEL SUB TOTAL	PARTICULARES CATEGORIAS 1a	PARTICULARES CATEGORIAS 2a	PARTICULARES P.B.X	PARTICULARES SUB-TOTAL	CUENTAS GOB. DIRECTO	CUENTAS GOB. P.B.X	CUENTAS GOB. SUB TOTAL	NUEVAS INSTALAC.	RETIROS	OCUPACION	VACANTES	CAPACIDAD	% OCUPAC.
1	CENTRO	8	—	9	280	—	21	310	—	—	—	—	—	—	—	—	—	310	6738	7400	04.19
2	CENTRO I	21	—	28	60	—	4	92	620	2290	2	2912	12	—	12	22	—	3016	6984	10000	30.16
3	CENTRO II	22	6	222	200	146	74	502	3618	4285	554	8457	479	210	689	—	—	9648	352	10000	96.48
4	CENTRO III	71	—	198	122	53	7	327	2233	2083	54	4370	219	—	219	3	—	4916	1228	6144	80.0
5	[illegible]	23	35	134	200	139	77	446	2621	6166	562	9349	183	22	205	1	—	10.000	—	10000	1.00.00
6	[illegible] II	24	13	105	140	34	52	310	2234	4009	292	6535	155	—	155	3	—	7000	—	7000	100.00
7	[illegible]	55	—	—	81	—	5	86	325	776	—	1101	—	—	—	78	—	1187	861	2048	57.96
8	[illegible]	25	6	46	200	144	76	328	1376	7838	142	9356	132	182	314	6	—	9998	2	10000	99.98
9	[illegible] II	26	—	43	200	35	75	318	1659	7763	116	9538	111	24	135	5	—	9991	9	10000	99.91
10	SOYAPANGO I	27	4	26	100	81	39	169	854	3575	266	4695	119	17	136	7	—	5000	—	5000	100.00
11	SOYAPANGO II	77	—	3	60	12	4	67	112	332	9	453	2	—	2	28	—	522	2550	3072	16.99
12	SANTA TECLA	28	22	52	60	46	25	159	1125	3448	104	4677	102	29	131	1	—	4967	33	5000	99.34
13	ALTAVIRA	73	—	5	60	11	13	78	228	2677	9	2914	9	—	9	8	—	3001	583	3584	83.73
14	MONTELLO	74	—	11	102	21	6	119	588	4241	12	4841	5	—	5	6	—	4965	155	5120	96.97
15	[illegible]	76	—	1	74	—	5	80	225	2160	—	2385	10	—	10	61	—	2475	1621	4096	60.42
16	[illegible]	76	7	10	60	11	4	81	416	2481	66	2963	1	—	1	1	—	3045	155	3200	95.15
17	[illegible]	79																		2000	
18																					
19																					
20																					
21																					
22																					
23																					
24	SAN JOSE	30	—	1	6	—	3	10	15	134	—	149	2	—	2	7	—	161	223	384	41.93
25	[illegible]	31	8	6	8	7	12	34	92	261	7	360	6	—	6	—	—	400	—	400	100.00
26	[illegible]	31	8	1	6	4	24	39	66	172	—	238	14	—	14	—	—	291	9	300	97.00
27	[illegible]	31	8	7	4	2	21	40	28	110	—	138	13	—	13	—	—	191	9	200	95.50
28	[illegible]	31	7	5	2	2	13	27	33	30	—	63	8	—	8	—	—	98	2	100	98.00
29	[illegible]	31																			
30	[illegible]	32	8	43	20	10	5	76	233	637	—	870	47	—	47	—	—	993	7	1000	99.30
31	[illegible]	32	8	4	4	4	25	41	81	253	—	334	12	—	12	—	—	387	3	400	96.75
32	[illegible]	32	8	11	8	4	32	59	109	196	—	305	36	—	36		—	400	—	400	100.00
33	[illegible]	33	8	17	16	9	9	50	196	480	—	676	72	—	72	1	—	800	200	1000	80.00
34	[illegible]	34	8	13	12	10	12	45	230	515	—	745	50	—	50	3	—	840	1208	2048	41.02
35	[illegible]	34	8	5	4	2	26	43	6	45	—	51	6	—	6	9	—	100	100	200	50.00
36	SUCHITOTO	35	8	3	2	2	18	31	18	62	—	80	9	—	9	—	—	120	—	120	100.00
37	[illegible]	36	8	11	4	4	20	43	36	67	—	103	42	—	42	7		188	212	600	31.33
38	[illegible]	35	8	3	12	4	29	52	82	167	—	249	15	—	15	11	—	316	284	600	52.67
39	SAN MARTIN	36	1	5	10	4	8	24	34	296	—	330	—	—	—	22	—	354	646	1000	35.40
40	TOMALAPA	35	—	1	12	5	3	16	—	4	—	4	—	—	—	—	—	20	620	640	03.13
41																					
42																					
43	EL PAYAN	40	—	7	80	6	6	93	347	2006	2	2355	18	1	19	24	—	2467	3677	6144	40.15
44	[illegible] II	40	—	3	40	31	4	47	388	1088	1	1477	11	—	11	—	—	1535	513	2048	75.00
45	STA ANA I	41	16	73	80	19	28	197	1001	2348	78	3427	121	10	131	125	—	3755	245	4000	93.88
46	METAPAN	42	4	10	4	4	31	49	99	286	—	387	22	—	22	1	—	458	142	600	76.33
47	AHUACHAPAN	43	8	13	12	2	19	52	229	546	3	778	54	—	54	61		884	716	1600	55.25
48	CHALCHUAPA	44	8	19	12	6	17	55	296	416	—	712	23	—	23	6		791	209	1000	79.10
49	ATIQUIZAYA	44	—	5	4	3	32	41	54	138	—	192	12	—	12	—	—	245	555	800	30.63
50	EL CONGO	46	2	2	10	—	4	18	40	186	—	226	3	—	3	—	—	247	265	512	48.24
51	[illegible]	80	—	1	6	3	3	10	15	114	—	129	—	—	—	—	—	139	245	384	36.20
52	[illegible]	51	32	26	40	34	13	113	694	1582	11	2287	65	11	76	8	—	2476	1620	4096	60.43
53	VALLE	51	4	5	6	4	2	17	48	250	—	298	10	—	10	—	—	325	59	384	84.64
54	[illegible]	51	4	5	6	4	2	17	34	93	—	127	3	—	3	—	—	147	109	256	57.42
55	SAN JUAN	52	4	4	2	2	16	26	33	98	—	131	5	—	5	—	—	162	38	200	81.00
56	[illegible]	52	4	3	4	4	31	42	50	175	—	235	6	—	6	—	—	283	229	512	55.27
57	JUAYUA	52	8	3	4	4	31	46	69	197	—	266	5	—	5	10	—	317	283	600	19.50
58	ACHUTLA	52	8	7	8	8	12	33	150	208	19	377	18	—	18	—	—	430	970	1400	30.71
59																					
60																					
61	SAN MIGUEL	51	13	62	60	58	28	163	863	1755	16	2634	196	7	203	—	—	3000	—	3000	100.00
62	USULUTAN	62	8	15	12	8	13	48	286	200	5	491	61	—	61	—	—	600	—	600	100.00
63	JOCOLISCO	62	8	13	4	1	31	56	25	114	—	139	5	—	5	—	—	200	—	200	100.00
64	PUERTO TRIUNFO	52	8	3	2	2	14	27	39	23	—	62	5	—	5	—	—	94	6	100	94.00
65	[illegible]	53	8	5	10	10	13	36	116	316	4	436	17	—	17	—	—	489	111	600	81.50
66	[illegible]	63	8	3	6	6	31	48	45	186	—	231	15	—	15	—	—	294	106	400	73.50
67	[illegible]	64	8	8	12	4	40	68	46	88	—	134	26	—	26	14	—	228	172	400	57.00
68	[illegible]	64	16	3	12	3	34	65	80	158	—	238	13	—	13	39	—	316	284	600	52.67
69	LA UNION	54	8	11	8	8	12	39	148	406	5	559	41	2	43	—	—	641	359	1000	64.10
70	[illegible]	68	8	4	4	4	11	27	44	120	—	164	9	—	9	—	—	200	—	200	100.00
71	[illegible]	65	—	6	8	4	31	45	33	112	—	145	9	—	9	—	—	199	201	400	49.75
			392	350	2585	1043	1256	5583	24,777	70764	2339	97880	2644	515	3159	592	—	106,522	38628	145,250	73.4

ELABORO ESTADISTICA MES DE MARZO DE 19 89

CENTRAL TELEX EDX. MONTHLY ACTIVITY REPORT
(July, 1989)

ZONE	CAPACITY AVAILABLE	PRIVATE	GOVT.	ANTEL	ACTUAL ACTIVITY	% ACTIVITY
Metropolitan & Central	1610	565	84	159	808	50.18
Sonsonate	50	8	4	6	18	36.00
Santa Ana & Ahuachapan	75	15	7	16	38	50.66
Oriente	75	2	15	24	41	54.66
TOTAL	1810	590	110	205	905	50.00

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APPENDIX V.C.1

ANTEL CURRENT PROJECTS AND THE CURRENT STATE OF COMPLETION
as of 24th September, 1989

PROJECT		PROGRAMMED COMPLETION DATE	COMPLETE %
Third Project (+ 66,120 lines)	- Transmission	Nov. 1989	75%
	- Switching	Aug. 1989	70%
	- Outside Plant	Aug. 1989	100%
Fourth Project (+ 32,256 lines)	- Transmission	Nov. 1989	35%
	- Switching	Oct. 1989	80%
	- Outside Plant	Mar. 1990	70%
Fourth Project, Oriente Plan	- Outside Plant	Dec. 1989	80%
Transmission Improvement 100pcm Systems	- Transmission	Apr. 1990	55%
3 New Central Offices (+ 4,000 lines) (Digital)	- Switching	Apr. 1990	65%
New Central Office + 5,000 Lines(Digital)	- Outside plant	Jun. 1989	95%
Long Distance Switching Trunk Relief	- Switching	Oct. 1989	90%
Public Telephone Relief (+ 3,000 Telephones)	- Public Telephones	Jan. 1989	90%
Metropolitan & Interior Zones Trunk - Relief	- Switching	Apr. 1991	90%
Rural Telephone Relief (+ 10,000 lines)	- Switching	Mar. 1991	50%
Service Improvement + 10 radio Systems	- Transmission	Apr. 1990	55%
Telex Central Office Relief	- Switching	Apr. 1989	30%
Various	------	Dec. 1989	70%

APPENDIX V.C.1

LIST OF UNFUNDED ANTEL PROJECTS

PROJECT DESCRIPTION	DESIRED COMPLETION DATE	COST IN $US (in millions)
New Central offices - Campestre, San Bartolo and San Jose (+ 46,000 lines)	1994	69.0
New Central Offices - Credisa, Santa Lucia (+ 16,000 lines)	1993	24.0
Additional lines in Nehapa, Apopa, Quezaltepque, Giuseppe, San Jose, Guayabal, Tonacatepeque, Aguilares (+ 10,000 lines)	1994	16.5
Additional lines in Santa Ana, Sonsonate, Cojutepeque, Chalatenango, Sensuntepeque, Zacatecoluca, San Vincente (+20,000 lines)	1993	26.5
Reconstruction of service destroyed by Terrorism	1995	84.5
Additional Lines in the Eastern Zone (+25,000 Lines)	1993	31.5
Digitalization of Satellite Transmission	1991	2.0
Establish a Telecommunications Research and Development Center	1992	2.5
New Long Distance Digital Central office	1993	5.0
New Central Office - Zacamil (+20,000 Lines)	1992	30.0
New Data Network	1993	4.0

Digitalization of the Central American Network 1993	11.0
Cellular Telephone Network 1992	10.0
New Administration Building 1993	7.0
New Technical Administration Building 1992	5.0
TOTAL	$328.5 million

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