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OUTLINES OF CENTRAL AMERICAN ELECTRIC POWER SUBSECTOR PROJECTS INCLUDED IN THE UNITED NATIONS SPECIAL PLAN FOR ECONOMIC CO-OPERATION

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CONTENTS

INTRODUCTION

This document has been prepared for the purpose of providing members of the international community interested in supporting the United Nations Special Plan for Economic Co-operation [1/] for Central America with information on Central American electric power systems, as well as a description and justification of the outlines of electric power subsector projects included in that Special Plan.

Its preparation was based on information validated by the various national electric power companies and previously published. [2/] It includes such data on the components of Central American electric power systems as: a) certain indicators relating to the electric power subsector and recent consumption behaviour by subsectors; b) composition of demand, installed capacity and recent generation performance, and c) various characteristics and situation of electric power transmission networks. In addition, a commentary of the characteristics of the project outlines included in the Special Plan for Co-operation and a conceptual summary of the latter are presented.

Outlines of the projects were organized into three groups: a) urgent energy needs; b) priority investments in the electric power subsector, and c) support to the formalization and initiation of activities of the Central American Electrification Council (CEAC). The first two are contained in the Special Plan, while the third is dealt with only from a conceptual standpoint in that document. As this last-mentioned initiative is considered to be of prime importance for the integrated development of the electric power subsector in the Central American Isthmus, a more detailed description of the origin and objectives of that Council is offered in this paper.

Although the benefitting electric power companies in general have detailed information on the outlines considered here at their disposal, this study is limited to presenting only a general framework of facts that will allow possible donors to form an opinion as to the objectives of the plan. Once a country or bilateral or multilateral organization evidences interest

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1/ The Special Plan forms part of the initiatives aimed at achieving firm and lasting peace in the region, and is based on Resolution 42/204, approved by the General Assembly of the United Nations, 11 December 1987.

2/ See CEPAL, Algunos planteamientos para orientar el apoyo internacional al subsector eléctrico de Centroamérica, en el marco del Plan Especial de Cooperación Económica de las Naciones Unidas (LC/MEX/R.103/Rev.1) (CCE/SC.5/GRIE/XI/1/Rev.1), 15 March 1988.

in offering its co-operation, more detailed information will be supplied as required.

The first version of this document - presented under the same title and with symbol LC/MEX/R.112 - has been expanded, based on the exchange of impressions with officials of the national electric power companies during the mission carried out in the six countries of the Central American Isthmus during June 1988.

1. Background

As a result of the recent initiatives and agreements adopted by the governments of the five countries of Central America with a view to achieving a firm and lasting peace in the region, the United Nations General Assembly entrusted to the Secretary General the promotion of a special plan for economic co-operation, addressed to Central America, that would help to reinforce those initiatives and agreements. Within the framework of that special plan, the governments identified, as one of the priority headings for international co-operation, the electric power subsector in general and, in particular, the need to ensure a short-term supply of electric power, which has been insufficient in recent years owing to persistent drought.

An ECLAC-UNDP technical mission visited the Central American countries for the purpose of drafting the outlines of the project. Professionals from the electric power companies of each country took part in those preparatory efforts, which made use of simulation and optimization models available in those nations. In drawing up the Special Plan, the outlines were subdivided in the convential manner into: a) urgent power needs; b) priority investments in the electric power subsector, and c) strengthening and support of the initiation of activities of the Central American Electrification Council (CEAC). Efforts were aimed in all three cases at selecting projects that would combine high priority with high profitability and short-term benefits to electric power companies over a period of approximately three years.

It should be noted that the six countries of the Central American Isthmus closely co-ordinate the operation and planning of their national electric power systems, which are interconnected in two blocs: a) Guatemala-El Salvador, and b) Honduras, Nicaragua, Costa Rica and Panama. The information provided therefore covers all six countries, despite the fact that the Special Plan is aimed at Central America and does not include Panama.

2. Characteristic data of Central American electric power systems

During the eighties, additions to the generation capacity of electric power systems in the Central American Isthmus have been owed to major hydroelectric projects in certain countries. Currently, with the exception of Honduras,

which still has a surplus of hydroelectric power, demand in the rest of Central America has surpassed hydroelectric and geothermal production capacity. In other words, there is a deficit in the economical power supply from hydroelectric and geothermal sources that has forced all the countries, with the exception of Honduras, to import hydrocarbons for the production of electric power.

Table 1 presents a brief summary of certain indicators related to the electric power subsector in the Central American Isthmus for the past four years. Despite the economic crisis, consumption rates have increased, and in some cases (Guatemala and Costa Rica) have even reached very high levels, while installed capacity has remained stable. Installed capacity in the Central American Isthmus amounts to 3,900 MW and maximum non-coinciding demand for 1988 is estimated at 2,522 MW, which might be viewed as indicating self-sufficiency (see Table 2). This, however, is not the case, at least from the viewpoint of power, as will be seen later. (See detailed information from the power stations included in Annexes I and II.)

As noted above, the electric power systems operate in two interconnected groups. Electric power production and the exchanges between the power companies of the northern bloc are shown in Table 3, where the figures cover the last three years. Data from the southern bloc is presented in Table 4. In both tables, the information is presented in terms of net generation, that is, subtracting the amounts consumed by the power generation stations themselves. At the user level, behaviour of the demand by subsectors is shown in Table 1.

As regards the electric power transmission networks, interconnections came about gradually as the result of bilateral agreements, and were not owed to any integrated study of the region. This fact, together with the characteristics of the national power systems themselves - which have very few voltage control centers (generating plants) and in which transmission lines cover remarkably long distances to join the scattered consumption centres concentrated in the main cities - makes the electric power systems markedly longitudinal (see Diagram 1).

Electric power systems of this type are subject to serious technical problems involving voltage control and dynamic performance (transient and dynamic instability) that have repercussions on transmission limits, reducing them to levels far lower that the thermal limit of conductors and the usual

Table 1

CENTRAL AMERICAN ISTHMUS: LEVEL OF ELECTRIFICATION AND DEMAND BY ELECTRIC POWER SUBSECTORS

	Population (thousands of inhabitants)	Level of electrification (%)	Internal demand (GWh)				
			Total	Residential	Industrial	Commercial	Public lighting
COSTA RICA							
1984	2 600	82.2	2 345	1 053	673	542	77
1985	2 674	83.3	2 471	1 122	675	593	81
1986	2 747	84.4	2 671	1 242	738	609	82
1987 a/	2 816	85.5	2 893	1 359	792	656	86
EL SALVADOR b/							
1984	4 723	40.6	1 415	461	484	182	288
1985	4 772	42.7	1 486	474	499	195	318
1986	4 866	44.4	1 549	503	503	213	330
1987 a/	4 934	45.6	1 684	539	556	231	358
GUATEMALA c/d/							
1984	7 740	27.1	1 188	363	500	256	69
1985	7 963	28.2	1 245	377	534	261	73
1986	8 195	29.2	1 364	414	591	278	81
1987 a/	8 434	29.9	1 571	454	685	341	91
HONDURAS							
1984	4 231	28.0	978	291	437	151	99
1985	4 372	29.0	1 065	330	448	181	106
1986	4 510	30.0	1 058	340	410	193	115
1987 a/	4 656	31.0	1 145	371	410	230	134
NICARAGUA e/							
1984	3 163	48.5	988	285	493	71	139
1985	3 272	48.4	979	302	475	69	133
1986	3 385	47.3	973	300	469	70	134
1987 a/	3 501	45.9	1 037	324	484	87	142
PANAMA							
1984	2 134	55.9	1 846	522	229	574	521
1985	2 180	57.2	2 005	560	252	610	583
1986	2 227	57.7	2 116	607	268	647	594
1987 a/	2 274	58.8	2 265	666	308	680	611

Source: ECLAC, based on official figures.

a/ Preliminary figures.

b/ Figures for El Salvador public lighting include government and other consumption.

c/ Does not include isolated systems in Guatemala.

d/ Figures for INDE industrial demand include other high consumption levels, and those for public lighting include block sales to municipal electric power companies.

e/ For Nicaragua, Public lighting heading includes government consumption, and Industrial heading includes irrigation and pumping.

Table 2

CENTRAL AMERICAN ISTHMUS: INSTALLED CAPACITY AND REGISTERED AND ESTIMATED NET PEAK LOAD-OF a/ INTERCONNECTED NATIONAL ELECTRIC POWER SYSTEMS

(MW)

	TOTAL	INDE	CEL	ENEE	INE	ICE	IRHE b/
Installed capacity c/	3 943.6	778.5	650.9	545	325	748	896.2
Hydroelectric	2 634.5	486.0	388.5	431	100	678	551.0
Geothermal	130.0	-	95.0	-	35	-	-
Thermal (bunker)	646.2	116.0	88.2	80	175	32	155.0
Thermal (diesel)	532.9	176.5	79.2	34	15	38	190.2
Peak load d/							
1985	1 990.0	301.6	318.4	220	215	511	424.0
1986	2 152.0	334.3	339.5	234	221	565	458.0
1987	2 362.0	375.0	379.8	266	234	612	495.0
1988	2 454.0	407.0	400.0	276	249	670	452.0 e/
1989	2 616.0	434.0	415.0	304	260	730	473.0

Source: ECLAC, based on official figures.

Note: Abbreviations for the titles of Central American national electrification agencies are as follows:
INDE - National Electrification Institute (Guatemala)
CEL - Executive Commission for the Lempa River Hydroelectric Project (El Salvador)
ENEE - National Electric Power Enterprise (Honduras)
INE - Nicaraguan Energy Institute (Nicaragua)
ICE - Costa Rican Electricity Institute (Costa Rica)
IRHE - Hydraulic Resources and Electrification Institute (Panama)

a/ Net peak load corresponds to power delivered to the system; i.e.: gross generation minus power consumed by plant services themselves.

b/ Does not include Canal Zone.

c/ Annexes I and II present a detailed account of installed capacity by plants.

d/ Peak loads are registered (actual) for 1985-1987, and estimated for 1988 and 1989.

e/ Peak loads registered since the March-April 1988 crisis have been on the order of 416 MW. It is estimated that this figure may reach 452 MW by December 1988.

Table 3

CENTRAL AMERICAN ISTHMUS, NORTHERN BLOC: PRODUCTION AND EXCHANGE OF ELECTRIC POWER BY THE ELECTRIC POWER SYSTEMS OF GUATEMALA AND EL SALVADOR

(GWh)

	Net generation		Net exportation a/	
	INDE	CEL	INDE	CEL
1985	1 493.2	1 650.5		
Hydroelectric	675.2	1 165.8	-	-
Geothermal	-	379.7	-	-
Bunker	467.5	72.3	-	-
Diesel	350.5	32.7	-	-
1986	1 729.5	1 623.8	88.0	-88.0
Hydroelectric	1 715.1	1 226.3	88.0	-88.0
Geothermal	-	333.7	-	-
Bunker	4.9	32.3	-	-
Diesel	9.5	31.5	-	-
1987	1 866.0	1 832.5	8.8	-8.8
Hydroelectric	1 698.3	1 129.0	-	-
Geothermal	-	398.5	-	-
Bunker	54.3	260.5	-	-
Diesel	113.4	45.7	-	-

Source: Information provided by national electric power companies.
Note: Demand on each system is obtained by subtracting exportation from generation.
a/ Minus sign denotes importation.

Table 4

CENTRAL AMERICAN ISTHMUS, SOUTHERN BLOC: PRODUCTION AND EXCHANGE OF ELECTRIC POWER AMONG THE ELECTRIC POWER SYSTEMS OF HONDURAS, NICARAGUA, COSTA RICA AND PANAMA

(GWh)

	Net generation				Net importation a/			
	ENEE	INE	ICE	IRHE b/	ENEE	INE	ICE	IRHE c/
1985	1 345	976	2 510	2 378	127.9	-187	60	-23
Hydroelectric	1 299	256	2 499	1 918	127.9	-	-	-
Geothermal	-	301	-	-	-	-	-	-
Bunker	46	412	11	359	-	-	-	-
Diesel	-	7	-	101	-	-	-	-
1986	1 435	1 141	2 647	2 547	160.6	- 71	-77	-15
Hydroelectric	1 431	284	2 641	2 088	-	-	-	-
Geothermal	-	261	-	-	-	-	-	-
Bunker	1	583	6	371	-	-	-	-
Diesel	-	13	-	88	-	-	-	-
1987	1 753	1 219	3 073	2 700	343.7	- 84	-171	-118
Hydroelectric	1 751	393	2 992	2 115	-	-	-	-
Geothermal	-	234	-	-	-	-	-	-
Bunker	1	574	70	445	-	-	-	-
Diesel	1	18	9	140	-	-	-	-

Source: Information provided by electric power enterprises.
Note: Demand on each system is obtained by subtracting exportation from generation.
a/ Minus sign denotes importation.
b/ Does not include Canal Zone.
c/ Includes exchanges with Panama Canal Company.

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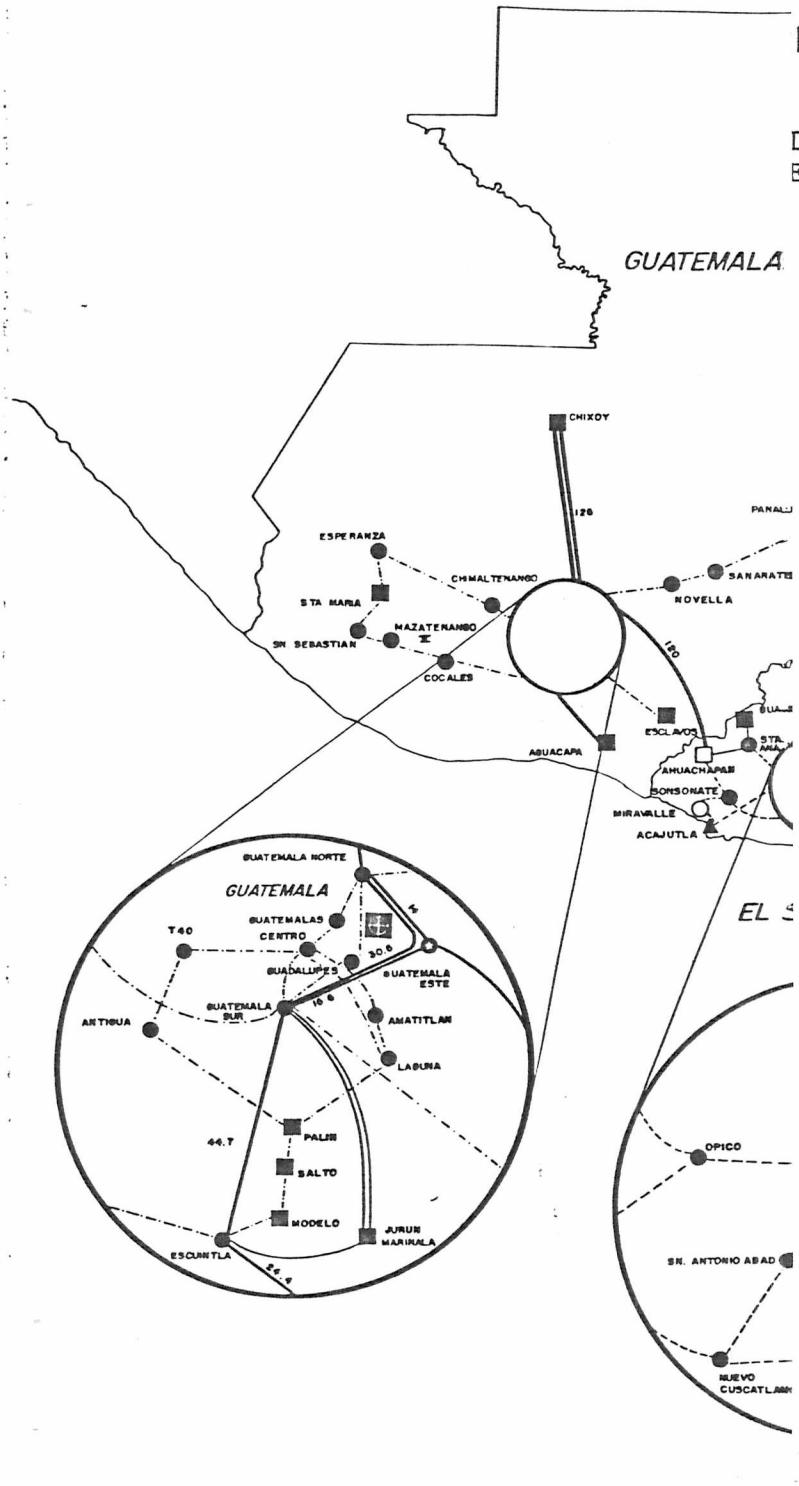

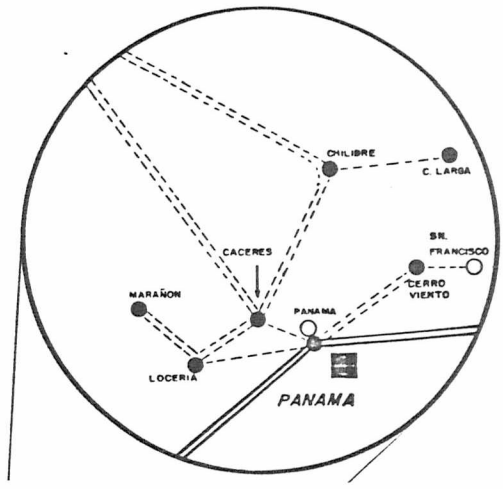

limits for similar tension levels in transmission networks belonging to "sturdy" electric power systems (heavily gridded and with numerous power generation stations). In longitudinal electric power systems, like those of Central America, the use of compensation schemes (capacitors in series, capacitors in parallel, reactors in parallel and VARS static compensators) is highly advisable. Their use would improve voltage regulation and make it possible to increase transmission capacity, which in turn would permit the postponement of investments in new transmission lines and, in some cases, even make their construction unnecessary.

At present, application of these compensation schemes is limited in Central America, as reactors exist only in the transmission line and in tertiary autotransformers and banks of shunting capacitors at the distribution level, although a number of studies have been made on the acquisition and putting into service of this type of capacitors at the subtransmission level. It is estimated that the inclusion of reinforcements of this type, together with some additional 230 kV circuits, would strengthen the regional interconnection network and make it possible to use the existing electric power infrastructure to better advantage.

As mentioned above, the electric power systems of the Isthmus are interconnected in two blocs. All that remains is to interconnect the El Salvador-Guatemala bloc with the Honduras-Nicaragua-Costa Rica-Panama bloc in order to effect the unification of electric power systems of all six countries of Central America. Existing technical studies amply justify the interconnection of El Salvador with Honduras, which would lead to such benefits as the reduction of water spills in Guatemala and El Salvador that generally occur during the rain season owing to the limited reservoir capacity of the two systems, and to the fact that the rainy and dry seasons in the two countries coincide. During that period, energy from Guatemala and El Salvador could be stored in the El Cajón of Honduras reservoir, and the benefits later shared among the three countries in accordance with a mechanism established by joint agreement. Although this interconnection project has reached an advanced stage, it would be advisable to speed up arrangements for its financing, since the sooner it is put into service the greater the benefits will be to the countries involved.

Diagram 1 shows, in simplified form, the present configuration of transmission networks in the Central American Isthmus and also includes the

future interconnection line between El Salvador and Honduras. The diagram also shows the length of the 230 kV transmission lines. A study of the diagram quickly reveals the longitudinal nature of the interconnected electric power systems.

The technical difficulties encountered in the operation of longitudinal systems of this type are outweighed by the technical and economic benefits to be derived from interconnecting the power systems so as to make them mutually supportive and permit power transactions. The promotion and reinforcement of multinational interconnections are still to be recommended, including in terms of profitability. To deal with the technical difficulties that arise in the operation of longitudinal electric power systems, and to obtain the maximum benefit from interconnections, it is imperative to train and assign groups of local technicians to the study and systematic analysis of the operation and planning of interconnected electric power systems.

3. Projects related to urgent power needs

The most important and urgent problem of the subsector in the region is possibly the imbalance between the supply and demand of electric power in four of the five countries. This stems from the lack of power sources capable of satisfying the demand at acceptable production costs. The latter is owed, in part, to the delays that occurred in putting some major hydroelectric projects into service and, in large measure, to the relatively low runoffs registered in the last two years. This situation is made worse by the intensive use that has perforce been made of thermal power stations, which in turn has resulted in supply problems, faulty maintenance and, in some cases (in Guatemala and Nicaragua, for example), the need for overall rehabilitation of the facilities. The imbalance between supply and demand described above gives rise to additional fuel requirements that form part of the urgent short-term (1988 and 1989) electric power needs.

In order to evaluate fuel needs for electricity production during 1988 and 1989, use was made of simulation and, as required, optimization digital programmes available in the countries themselves. Technicians responsible for planning the operation of national electric power systems took part in the studies. As previously mentioned, the systems operate in two blocs; the results of these studies are therefore presented in separate sections covering the northern and southern blocs.

It should be noted that this deficit in economical power will occur sometime after 1988 and 1989, as no significant additions to generation are expected until at least 1992.

a) Northern bloc: Guatemala-El Salvador

The electric power systems of Guatemala-El Salvador have been interconnected in their operations since September 1986. To date, power exchanges have been few in number owing to the lack of economical power in the two countries, for although the entry into service of the El Chixoy hydroelectric power station brought a marked increase in hydroelectric production in Guatemala, demand - which had been limited by a variety of factors - also rose sharply (see again Table 3).

Although installed generation capacity in both countries far exceeds supply needs - from a capacity viewpoint -, there are serious difficulties in meeting energy demand, owing both to the present condition of thermal power facilities and to the low water storage levels in reservoirs.

Fuel requirements were calculated in accordance with the actual availability of thermal power facilities, as well as ability to supply the fuel (storage and mobilization capacity). (See Table 5.) It should be noted that there are two sources of uncertainty in these evaluations: i) estimation of the demand, and ii) hidraulicity; of the two, the second would have the greater impact. To indicate the results spread in national outlines dealing with urgent energy needs in Guatemala and El Salvador (INDE/1 and CEL/1), other scenarios that might occur were included.

b) Southern bloc: Honduras, Nicaragua, Costa Rica and Panama

Although Panama does not form part of the co-operation initiatives for Central America, it should be stressed that the electric power systems of the four countries that make up the southern bloc are operating in an integrated manner. Consequently, Panama should be included in the evaluation of power exchanges. It should also be noted that it is the existence of agreements covering the exchange of electric power among the four countries that has enabled Panama to purchase electric power from Honduras.

Fuel requirements for Nicaragua and Costa Rica during 1988 and 1989 as a result of the drought (see again Table 5) were calculated in the same manner as for the northern bloc, but without studying a variety of scenarios; here,

Table 5

CENTRAL AMERICA: URGENT FUEL NEEDS FOR THE SUPPLY OF ELECTRIC POWER, 1988 AND 1989

	Costa Rica	El Salvador[a/]	Guatemala	Honduras[b/]	Nicaragua[c/]
		1988			
Estimated demand (GWh)	3 536	2 019	2 090	1 515	1 406
Generation (GWh)	3 369	2 019	2 090	-	1 286
Hydroelectric	2 974	1 051	1 800	-	242
Geothermal	-	381	-	-	233
Bunker	209	321	71.8	-	771
Crude	-	-	205.8	-	-
Diesel	186	266	12.4	-	40
Importation (GWh)	166	-	-	-	50
Fuel requirements (thousands of dollars)	19 367	38 461	14 898	-	32 535
Bunker (thousands of Bbl)	415	616.2	162.6	-	1 600
Crude (thousands of Bbl)	-	-	434.1	-	-
Diesel (thousands of Bbl)	513	834.6	29.6	-	124.5
		1989			
Estimated demand (GWh)	3 854	2 144	2 207	1 626	1 475
Generation (GWh)	3 688	2 144	2 207	-	1 344
Hydroelectric	3 301	921	1 800	-	300
Geothermal	-	332	-	-	233
Bunker	204	510	241.9	-	771
Crude	-	-	137.3	-	-
Diesel	183	381	27.7	-	40
Importation (GWh)	166	-	-	-	50
Fuel requirements (thousands of dollars)	19 005	57 334	20 701	-	32 535
Bunker (thousands of Bbl)	405	978.3	450.4	-	1 600
Crude (thousands of Bbl)	-	-	245.4	-	-
Diesel (thousands of Bbl)	505	1 212.5	66.9	-	124.5

Source: Information provided by national electric power enterprises.

a/ CEL considered this a critical year for hydraulicity. Average annual hydroelectric power for the past three years was 1,173 GWh.

b/ ENEE will use hydroelectric power to supply the entire energy demand. In addition, it will export approximately 500 GWh to the other three countries in 1988.

c/ A non-covered deficit is expected for 1988 and 1989.

the studies were based on average annual power needs. In the case of Nicaragua, this approach is justified because hydroelectric power covers only 25% of annual needs, and because the Lago de Apaná - storage reservoir for the country's two hydroelectric plants in cascade - is used for a number of purposes. Taken together, these two factors indicate that estimates of fuel requirements can only be termed approximate. It should also be mentioned that here, just as in the northern bloc, the 1987 rainy season ended abruptly in September, leaving water levels in the reservoirs lower than usual.

In the case of ICE, recent hydroelectric power production statistics (compare with Tables 4 and 5) were taken into consideration, together with the fact that El Arenal, the country's main storage reservoir - and quite possible the factor of greatest impact on estimates - is interannual. This makes it possible to absorb possible differences in calculations with a view to obtaining the average annual level of hydroelectric power, particularly if it is considered that the deficit of economical power faced by ICE will continue until at least 1992, when a 55 MW geothermal power stations in Miravalles is expected to go into operation.

Surplus hydroelectric power produced in Honduras was assigned on the basis of estimates provided by Nicaragua and Costa Rica. Panama's needs should also be included in those estimates.

The only generation project scheduled to go into operation during the period under study (1988-1989) is the Asturias pumping stations in Nicaragua, which will permit an annual increase of 60 GWh in the hydroelectric power produced by the Centroamérica and Carlos Fonseca plants. ICE planning also includes the acquisition of diesel-burning gas turbines to generate the additional power needed for dealing with the deficit in economical power.

The project outlines included in the section of the Special Plan for Economic Co-operation which deals with urgent energy needs are summarized in Table 6. As this table shows, with the exception of the case of Honduras and that of outline INE/3 presented by Nicaragua, all the other projects outlined require financing for the purchase of fuel. In Nicaragua, there is a critical lack of economical electric power. Even with all possible generation resources taken into account, in 1989 there will be a deficit in this area which, if no solution is found, will make it necessary to restrict demand (see again Table 5). One feasible solution would be to establish a financing mechanism that would allow Nicaragua to obtain a steady supply of

Table 6

CENTRAL AMERICA: URGENT POWER NEEDS

Code No.	Title of the project	Country	External financing[a/] required (thousands of dollars)	Level of definition of project (%)
ICE/1	Assurance of electric power supply for 1988 and 1989	Costa Rica	38 400	100
CEL/1	Assurance of short-term electric power supply (1988-1989)	El Salvador	81 000	100
INDE/1	Assurance of short-term electricity supply	Guatemala	16 400	100
ENEE/1	Tools for planning the distribution of electric power	Honduras	310[b/]	90
ENEE/3	Two 12.5 MVA, 69/34.5 kV mobile substations	Honduras	1 400	100
INE/1	Electric power supply for Nicaragua, 1988-1989	Nicaragua	32 500	100
INE/3	Changing tension of Honduras-Nicaragua interconnection line from 138 to 230 KV	Nicaragua	250	100
Total			170 260	

Source: UNITED NATIONS, The situation in Central America: Threats to international peace and security and peace initiatives. Special programmes of Economic Assistance (A/42/949), 26 April 1988.

a/ Amounts may vary as they are based on forecasts of both consumption and rainfall.

b/ Includes technical assistance.

power from Honduras. The two Honduras project outlines (ENEE/1 and ENEE/3) have to do with initiatives aimed at improving the country's level of electrification that are already under way, but required a number of transformers for which no financing is available. As the mobile substations are accorded top priority, it is possible that by the time some response is forthcoming from the Special Plan the ENEEP may have already obtained financing for this project. In that case, it is proposed that collaboration be channeled towards the other elements required for reinforcing transformation capacity.

Another high-priority problem in the southern bloc is the need to convert the Honduras-Nicaragua interconnection line from 138 to 230 kV. This circumstance has impeded the full and optimum utilization of surplus hydroelectric power from Honduras. Last year, owing in part to this limitation, the volume of water spilled was approximately equivalent to 80 GWh, with a cost approaching 3 million dollars. The interconnection line is operating at 138 kV due to the lack of terminal electrical equipment in the León, Nicaragua substation. It is estimated that the cost of standard, non-sophisticated equipment of this type, the purchase of which would require financing, would not exceed 250,000 dollars (see again Table 6).

In the northern bloc there are no transmission network problems to impede the utilization of overall generation resources. Nevertheless, acts of sabotage occurring in El Salvador make it necessary to employ more costly resources in generation and frequently affect the charge, which results in very substantial losses to the economy of the country for which no technical solution exists. As peace initiatives are put into effect, they should be accompanied by the drafting of national reconstruction projects to which international co-operation efforts might also be directed.

4. Projects related to priority investments in the electric power subsector

In this group of projects, emphasis was placed on those which would result in the short term in increasing the production of electric power by existing power stations, both hydroelectric and thermal, as well as in improving the availability and efficiency of thermal power plants.

The set of projects was carefully selected by professionals employed by the benefitting electric power enterprises, on the bases of the aforementioned criteria (see Table 7).

Since the beginning of the eighties, electric power production in Costa Rica has been predominantly hydroelectric. Because of this, thermal installations have basically been used for back-up purposes and maintenance resources have been concentrated on hydraulic plants. As of 1987, hydroelectric power proved insufficient to meet local demand and thermal installations regained importance. However, the lack of replacement parts and trained maintenance personnel substantially reduced the availability of those facilities.

The high consumption rates registered in recent years make it obligatory to improve the utilization of ICE thermal plants. In addition to the 70 MW installed capacity reported in Table 2, plants capable of producing a further 70 MW are in need of major repairs. As mentioned previously, ICE is in the process of acquiring gas turbines so as to be able to meet demand during the coming four years. Consequently, ICE project outlines are mainly concentrated on the acquisition of replacement parts and the training of operation and maintenance personnel for the thermal power stations. In order to attend the large demand for repair of both hydraulic and thermal plant equipment, the projects outlined also include the construction of a workshop for the repair of generation plant equipment (ICE/4). This is a top priority project for ICE, as it will prevent substantial outlays of foreign exchange for repairs carried out outside the country. Detailed lists of the shop equipment required have now been prepared and the functional organization of the shop has been planned. Technical assistance is needed for determining the detailed technical specifications and planning the long-term evolution of the workshop in accordance with additions to generation capacity. Once in operation, the shop could offer its services to other electric power enterprises in Central America, as no other shop of the type currently exists in the region. The rapid rise in demand has also added to the burden placed on installed transformation capacity. As a result, that capacity must also be strengthened and a project outline to that effect has been included (see again Table 7).

In El Salvador, the following aspects of the projects outlined were dealt with: a) availability of geothermal energy and possible initiatives

Table 7

CENTRAL AMERICA: INVESTMENTS REQUIRED IN ENERGY SECTOR

Code No.	Title of project	Country	External financing required (thousands of dollars)	Level of definition[a/] of project (%)	Other requirements
ICE/2	Electrical and mechanical replacement parts for preventive and corrective maintenance of thermoelectric plants	Costa Rica	2 005	90	Financing
ICE/3	Electrical and mechanical training of personnel handling equipment installed in electric power generation plants of the Instituto Costarricense de Electricidad (ICE)	Costa Rica	100	90	Financing
ICE/4	Construction of a workshop for the repair of generation plant equipment	Costa Rica	1 481	50	Technical assistance and financing
ICE/5	Reconditioning of Gas Unit No. 4 in San Antonio Thermal Plant	Costa Rica	700	100	Financing
ICE/6	Power transformer requirements for Costa Rican electric system	Costa Rica	2 283	90	Financing
CEL/2	Inspection and repair of motogenerator sets, Miravalle Thermal Power Station	El Salvador	2 350	100	Financing
CEL/3	Major repairs to 35 MW turbine (Fuji Electric) of Unit 3, Ahuachapán Geothermal Power Station	El Salvador	1 500	100	Financing
CEL/4	Repair of boilers, Acajutla Units 1 and 2, and replacement of tubing	El Salvador	4 000	100	Financing
CEL/5	Substitution of Automatic Voltage Regulators (AVR), Units 1,2,3,4 and 5 of "5 de Noviembre" Power Station	El Salvador	500	100	Financing
CEL/6	Energy audit of thermoelectric plants of the Comisión Ejecutiva Hidroeléctrica del Río Lempa	El Salvador	55	60	Technical assistance and financing
CEL/7	Automatic ontrol of a boiler in Acajutla Thermoelectric Plant	El Salvador	543	100	Financing
CEL/8	Banks of capacitors for Soyapango and San Antonio Abad substations	El Salvador	681	100	Financing

/Continues

Table 7 (conclusion)

Code No.	Title of project	Country	External financing required (thousands of dollars)	Level of definition[a/] of project (%)	Other requirements
CEL/9	Drilling and connection of wells in Ahuachapán geothermal field	El Salvador	8 337	60	Financing
CEL/10	Installation of a binary cycle plant in the Ahuachapán Geothermal Power Station	El Salvador	3 500	50	Financing
CEL/11	Substitution of monitoring equipment in Cerrón Grande Hydroelectric Power Station	El Salvador	200	80	Financing
CEL/12	Installation of photovoltaic systems for communications system of the Comisión Ejecutiva Hidroeléctrica del Río Lempa	El Salvador	560	80	Financing
CEL/13	Replacement of master station of real time monitoring system in System Operation Centre	El Salvador	1 844	100	Financing
CEL/14	Cogeneration of electric power using sugar cane bagasse	El Salvador	4 800	20	Technical assistance and financing
INDE/2	Radial gates for Pueblo Viejo (Chixoy) dam	Guatemala	2 000	80	Technical assistance and financing
INDE/3	5 MW pilot geothermal plant (Zunil I)	Guatemala	3 700	80	Financing
INDE/4	Hydroelectric improvement Hondo River	Guatemala	7 200	40	Technical assistance and financing
INDE/5	Channeling of flow from the upper basin of the Cahabón River into the Pueblo Viejo dam reservoir	Guatemala	1 600	40	Technical assistance and financing
INDE/6	Construction of San Sebastian Reu substation	Guatemala	6 750	100	Financing
INDE/7	Planning of National Electric Power System	Guatemala	300	40	Technical assistance and financing
ENEE/2	Installation of power stabilizers (PSS) in the four El Cajón generators	Honduras	250	90	Financing
INE/2	Project for Rehabilitation of the National Interconnected System (PRESIN)	Nicaragua	9 000	90	Technical assistance and financing
Total			66 239		

Source: UNITED NATIONS, The situation in Central America: Threats to peace..., op.cit.

a/ The level of definition is an estimated figure based on requirements for bringing projects to completion.

towards completion of the projects for increasing that availability already under way (the annual plant factor of generation at Ahuachapán is low, owing to problems in the geothermal wells), and b) determination of maintenance requirements for thermal facilities and, in particular, requirements for the rehabilitation of the Miravalle thermal plant and repairs to the Acajutla thermoelectric plant and Unit 3 of the Ahuachapán geothermal power station. In view of the importance of geothermal generation to El Salvador, it is proposed that project outline CEL/3, which refers to Unit 3 of the Ahuachapán power station, be handled by the manufacturer. As a general comment, it may be noted that hydroelectric power production in the last five years has been lower than the design estimates. A review of generable power in hydroelectric plants may make it necessary to revise plans for future additions to generation capacity.

Other aspects taken into account in the determination of CEL projects included the urgent need to provide plants and the national electric power system with adequate control equipment, owing both to the obsolescence of existing controls and to the fact that many are not working due to the consequent unavailability of replacement parts. It was also considered essential to provide for effective utilization of cogeneration resources and to improve efficiency in CEL plants themselves.

The El Salvador metropolitan area accounts for 75% of the country's total demand. This imposes severe restrictions on the transmission limits of the 115 kV lines and affects voltage regulation, as both active and reactive power must be sent through them. It also limits the effective use of hydroelectric generators, as they must be left a margin for the generation of reactive power. Occasionally, thermal plants in the metropolitan area must be used for generation, even when a margin exists in the hydraulic plants. With a view to solving these problems, CEL has made studies and has drafted a project for the installation of banks of shunting capacitors in the Soyapango and San Antonio Abad substations (see again Table 7). In general, except for CEL/14, all of El Salvador's project outlines are of priority nature and are fully defined; all that is needed for carrying them out is financing. Furthermore, it should be stressed that, owing to the nature of the Special Plan, only projects that could be executed in the short term (up to about 3 years) were proposed. Nevertheless, the power deficit is not simply a consequence of the current situation, but rather a problem whose effects will

be particularly important if an upswing occurs in the country's economy. Support should therefore be given to projects that really signify a more definitive solution.

In the case of El Salvador, it is recommended that, for the purpose of channeling co-operation, consideration be given to the "San Marcos" and "El Tigre" hydroelectric projects. The first would consist of two 26 MW bulb-type turbines. It would be situated downstream for the 15 de Septiembre plant on the Lempa River and would generate 276 GWh in an average year. The second, in its first stage, would consist of two 135 MW units, with a 1,500 million cubic metre reservoir, and would produce 1,240 GWh per year. This project, which would undoubtedly contribute to regional integration, is a very attractive one, since in addition to its low estimated cost, it would be a binational project between El Salvador and Honduras, flooding land in both countries. As a first step, financing is required for feasibility studies.

Honduras' main short-term needs are addressed in the two project outlines (ENEE/1 and ENEE/3) listed in Table 6, under the heading of urgent energy needs. Project outline ENEE/2, listed under the heading of investments required in the energy sector, deals with the installation of power stabilizers in the El Cajón generators. It should be noted that the lack of such stabilizers has been an obstacle to better utilization of the systems interconnection and also presents a risk to equipment, as the automatic voltage regulators of the El Cajón generations must be manually operated.

Projects dealing with priority investments for Guatemala are oriented to increasing the production of electric power, particularly hydroelectric power. Owing to their high profitability and short-term effect on energy production, the following INDE project outlines are of special importance: a) installation of radial gates in the Chixoy dam, and b) installation of wellhead units in wells of the Zunil geothermal project. The first represents an increase of 85 GWh in annual El Chixoy production, at a cost of somewhat more than 3 million dollars; the project requires some 2 million dollars of external financing. The second project, also very profitable, is designed to permit utilization of the steam from exploratory wells that is presently being vented into the atmosphere.

A group of INDE professionals has been formed for the purpose of drawing up the civil and hydraulic design of the radial gates for El Chixoy and is

currently at work. To supplement their efforts, a "monitoring" hydrometeorological measuring network should be designed so that safety measures can be taken to control particularly high waters and prevent risks to the plant. It is proposed that, in co-ordination with INDE, technical advisory services be obtained for the purpose of reviewing the report presented by the local group and for preparing the design and specifications of the aforementioned monitoring network.

The INDE/5 project for utilization of the Cahabón River is still in a very preliminary stage; a preparatory stage should be carried out, and technical assistance is required for this purpose.

Western Guatemala is densely populated and is the country's most productive farming area. At present, electric power is supplied to this important zone through two 69 kV transmission lines, and this has a marked effect on the continuity and quality of the service. INDE plans for additions to the network call, among other things, for the construction of a line from Escuintla to San Sebastián that will provide a 230 kV interconnection between the western region and the metropolitan area and thereby improve the quality and continuity of the supply of electricity to users in that zone. Negotiations for financing the line are at an advanced stage; external support is still required, however, for the construction of the 230/69 kV substation in San Sebastián. Project outline INDE/6 is directed towards that end; construction of this substation is of critical importance to the success of efforts to supply demand in the western portion of the country. The project is fully defined, and the only remaining need is financing. In addition, INDE needs to strengthen its professional capacity to carry out the planning of the interconnected electric power system. To that end, it drew up a project (INDE/7) which includes, as a first step, the use of technical assistance (see again Table 7). In Guatemala's case, no project outlines on maintenance of thermal facilities were presented because a rehabilitation project, financed by the World Bank, is already under way.

Electric power system installations in Nicaragua - generation plants, substations and transmission lines - are in a state of serious deterioration owing to a number of causes. In 1986, the Nicaraguan Energy Institute (Instituto Nicaragüense de Energía, or INE) drew up a Programme for the Rehabilitation of the National Interconnected System (PRESIN). One of its major components deals with the repair and maintenance of thermal facilities.

PRESIN is a comprehensive programme, consisting of a variety of projects, that will have a total cost of 20 million dollars. Financing to cover 11 million of the cost is already in hand; the remaining 9 million is dealt with in project outline INE/2. However, if any agency or country should decide to finance part of this project, an independent project could be formulated on the basis of one or another of the elements of PRESIN.

As mentioned previously, the imbalance between the supply of electric power at appropriate prices and the demand is not a circumstantial, but a structural problem. In Nicaragua's case this situation is even more critical than elsewhere. Installed capacity in this country is 325 MW, and demand has already reached 240 MW; generable hydroelectric power represents only 25% of present demand. The main thermal generation units have been in service for more than 10 years and have not received proper maintenance, owing both to the economic situation of the country and to the lack of replacement parts. The PRESIN project will improve the availability of thermal equipment, but the supply-demand imbalance will nonetheless persist, as the only additions to the system foreseen for the next three years are the "Asturias" pumping project, representing an additional 60 GWh per year, and a second, 35 MW geothermal unit at the "Patricio Argüello" plant which is expected to go into operation in late 1989. It is proposed that international support be oriented to generation projects that will provide a more effective solution to the problem mentioned above. In that respect, INE has completed feasibility studies for the following three hydroelectric projects, all offering high profitability: a) "Los Calpules", 12 MW, which would produce 29 GWh per year, and require two years for construction and an investment of 25 million dollars; b) "Larreynaga", 40 MW, 85 GWh per year and an investment of 40 million dollars, and c) "Paso Mariano", 16.6 MW, 39 GWh per year, 20 months for construction and 26 million dollars. In addition, another feasibility study is required for a geothermal plant in Monte Galán. Furthermore, a deep-water port is being built at Blue Fields to serve deep-draft vessels; to supply power demand at the port, a 69 kV line must be erected between the "Corocito" substation and Blue Fields. Financing is needed for the construction of this line. None of these projects were proposed for the Special Plan for Economic Co-operation, as the latter is restricted to projects that address immediate needs.

5. Support for the formalization and initiation of activities of the Central American Electrification Council (CEAC)

It is deemed of prime importance that a duly established and organized counterpart exists in the countries to ensure that international economic co-operation with the electric power sector is used to best advantage and oriented to priority needs in each country, and that is appropriately supplements ongoing national initiatives. It is therefore proposed that the international community consider lending its support to the formalization, establishment and organization of CEAC. That support could take shape as an institutional reinforcement project that might include: a) intensification of action aimed at achieving legislative ratification in countries where this is still lacking; b) co-operation in developing the organizational infrastructure of CEAC; c) co-operation in the physical-formal establishment of CEAC (installations, library, computers and others); d) promotion of regional technical groups that would form part of CEAC, etc. To provide the international community with information on CEAC, the background and objectives of this regional body are described below. Also included are some ideas as to possible initiatives that might be introduced by CEAC, once it is in operation.

The state-owned electric power enterprises of the Central American Isthmus agreed, during the Sixth Meeting of Managers and Chairmen, held in Panama City, Panama, 29-30 March 1979, on the creation of a Central American Electrification Council (CEAC). This agreement was put into effect via draft articles of agreement for the establishment of the Council that were approved during the Ninth Meeting of Managers and Chairmen, held in San José, Costa Rica, 18 April 1985.

The draft articles of agreement establish, as the basic objective of this regional body, the achievement of a more effective utilization of the energy resources of the member States by means of an efficient, rational and appropriate generation, transmission and distribution of electric power among the countries of Central America. In addition, the aforementioned articles establish the following CEAC objectives:

a) To promote the making of bilateral or multilateral agreements for the interconnection of electric power systems among the countries of Central America and others;

b) To promote and carry out the studies necessary for obtaining better planning and co-ordination of interconnection operations, and to support the implementation of those studies;

c) To lend scientific, technical, administrative and material assistance to any of the member institutions, as well as to co-ordinate such assistance efforts as may be required among the member institutions themselves for the fulfillment of the basic objective mentioned above;

d) To advise and assist, as necessary, in the obtaining of financing capital for the development of projects related to the production, transmission or distribution of electric power;

e) To establish an information centre capable of providing data on the condition, production and sale of electric power furnished by firms specializing in the provision of services, supply or works construction in the electric power field, on rate aspects, economic and financial negotiations of Central American institutions, behaviour of the world financing capital market, credit policies and international strategies, development plans of the different countries of the area that include an electric power aspects, and other data related to the activities carried out by the member institutions;

f) To promote the establishment and development of an applied research centre that will contribute to the technological development of the regional electric power sector, and to obtain financing for the centre through contributions from the member countries and interested institutions;

g) To promote and establish centres for the basic and advanced training of personnel in those specialties in which the transmission of technical expertise in the operation, development and administration is both desirable and necessary, or to design training mechanisms that will permit the transfer of more advanced technology within the energy field;

h) To establish mechanisms for the dissemination of detailed information on the provision of fuel for the production of electric power, the situation of petroleum on the world market, and possible substitutions for petroleum in the generation of electric power, preferably natural steam;

i) To contribute to technical and economic feasibility studies related to projects for the production of electric power that are of interest to the

institutions that comprise the Council and, preferably, are designed to benefit two or more countries;

j) To carry out studies, in conjunction with the institutions that comprise CEAC, on the ecological implications of the production of electric power, as well as to disseminate information on studies or experience in ecological matters currently being pursued by member States or other States;

k) To establish relations with other regional agencies or bodies belonging to the energy sector or to any related field;

l) To promote the co-ordination and compatibilization of positions of common interest taken by the representative institutions that comprise the body in their dealings with third parties, and

m) To carry out any other activities that will contribute to the attainment of general CEAC objectives.

To date, the draft articles of agreement have been ratified by the legislative assemblies of the governments of El Salvador, Honduras, Nicaragua and Panama, and steps are being taken towards their ratification by the governments of Costa Rica and Guatemala.

It should be noted that the formal integration of CEAC would facilitate the implementation of two regional projects that have already obtained financing. The first of these, PARSEICA-OE, is aimed at strengthening the technical capacity of the national electric power enterprises in the operation of their electric power systems. Financing for this project has already been approved by the IDB, and its implementation will begin this year. The second project is for the reinforcement of the regional interconnection network. Studies for this project are being financed by the Government of Spain, via the National Electricity Enterprise (Empresa Nacional de Electricidad, or ENDESA).

Projects with a regional scope that would be managed by CEAC include the following: addition of power stations larger than those currently contemplated in the countries' programmes for additions to generation; establishment of a regional centre for specialized training in electric systems, and creation of a regional electrical testing laboratory.

a) Addition of power stations larger than those currently contemplated in the countries' programmes for additions to generation

It is considered advisable, owing to the economies of scale involved and to the fact that projects of this nature have already been identified, to plan for the installation of hydroelectric power stations larger than those currently foreseen in the countries' projects, as the larger stations would prove more economical. Joint investment projects of this type include the following: a) the binational Honduras-El Salvador project for the "El Tigre" hydroelectric plant; b) the "Boruca" hydroelectric project in Costa Rica, and c) the "Copalar" hydroelectric project in Nicaragua. Construction of these power stations has been postponed - at least for the period up to the year 2000 - because their size is far larger than warrented by national demand. On the other hand, it should be mentioned that deficit in economical electric power (hydro and geo) are foreseen in the immediate future in five of the six countries, which will consequently be forced to increase their imports of hydrocarbons.

b) Establishment of a regional centre for specialization in electric/power systems

There is a varying but widespread scarcity in the region of human resources trained in operations engineering and planning of electric power systems. Formerly, engineers from the different countries were sent abroad for specialized training in those fields. At present, however, the economic crisis makes this very expensive, and as a result a level of domestic competence (private firms-national agencies) is being perceived, together with a constantly increasing mobility of trained human resources. The countries with the greatest problems of this type are Nicaragua, Honduras, El Salvador and Guatemala. For this reason, it would be advisable to establish in the area a regional centre for specialization in electric power systems.

c) Creation of a regional electrical testing laboratory

At present, electrical testing is contracted out to the manufacturers or to consultants from outside the region, a situation that results in the flight of foreign exchange and, in some cases, to the transfer of little or no knowledge or technology to the countries of the area. The establishment

of a regional testing laboratory would make it possible to perform the work required in such areas as: i) reception of equipment; ii) performance testing, and iii) quality control.

It is considered that the information presented on CEAC will serve to show the international community the importance of orienting international support to its formalization and the beginning of its activities. The amounts of financing required would be determined on the basis of the area of interest to the donor agency. This is viewed as an initiative of the highest priority, as CEAC, once it is constituted as an agency with its own legal status and funding, would serve to further regional integration of electric systems.

In view of the priority assigned by the six national electrification agencies of Central America to the formalization and establishment of CEAC, the Twelfth Meeting of Managers and Chairmen, held in San José, Costa Rica, 4 December 1987, agreed to set up a commission, formed by representatives of the countries that have already ratified CEAC, which is to visit the legislative assemblies of the countries which have not yet done so for the purpose of promoting its early ratification.

6. Conclusions and recommendations

During the past three years, hydraulic contributions to power reaching the Central American watersheds in which hydroelectric power stations exist have fallen below expected average levels. This has compelled the intensive use of available thermal facilities. In addition, some major hydroelectric projects (for example, Chixoy, in Guatemala) suffered delays or defects in being put into service that also led to the obligatory use of thermal facilities. Furthermore, consumption growth rates during those same years have generally been high, in some cases (Guatemala and Costa Rica) even higher than expected. Finally, the biggest projects have had a marked impact on external indebtedness of both the electric subsector and the national economies. The electric subsector debt represents a high percentage of the countries' overall foreign debt. This has made it necessary to programme additions to generation very carefully, which in turn has led to maintaining lower margins of energy reserves for handling the contingencies that can normally occur in the planning of electric systems, as well as for dealing with low hydraulicity levels like those which have been registered in recent

years. In some countries, the combination of these factors has even caused restrictions in the supply of electric power, with the consequent damage to the national economy that this represents. At present, some countries of the Central American Isthmus are undergoing electric power restrictions owing not only to lack of fuel, but also to defects or failures of the generation equipment and to the lack of spare parts for its maintenance.

To aid the countries in dealing in the short term (1988-1989) with the problems described in the preceding paragraph, an evaluation has been made - in consultation with the national electrification agencies of Central America - of fuel requirements. The evaluation was based on realistic data concerning expected growth, hydraulicity levels and the availability of thermal plants. As Table 5 shows, only Honduras currently has surplus hydroelectric power, and it is estimated, given average hydraulicity levels, that this country will only be able to supply its energy needs on a basis of 100% hydroelectric generation until 1991. The surplus power mentioned is currently being exported to the other three countries that are interconnected with the Honduran electric system.

Owing to the low water volume in the reservoirs, all expectations point to an intensive use of thermal facilities to generate the power required to supplement hydroelectric and geothermal production, despite the fact that those facilities are in a state of deterioration due to overuse. Repairs and maintenance are therefore urgently needed, and replacement parts, technical co-operation, tools, materials and equipment are required for this purpose. To orient international support to these urgent needs, a number of projects were drawn up with the direct participation of the national electrification agencies. These project outlines were included in the Special Plan, and are summarized in Table 7.

The interconnection between Honduras and Nicaragua was put into service in 1985. It consists of a 230 kV line that has been operating provisionally at 138 kV, with a transmission limit of between 50 and 60 MW. At present, Honduras' surplus power volume amounts to about 400 to 600 GWh per year, in accordance with hydraulicity levels. The very low transmission limit of the interconnecting line means that it must operate at saturation point throughout the 24 hours of the day. This impedes a better economical use of surpluses, as power generated at a higher cost cannot be displaced during high-load hours. There is even a risk that water may have to be spilled from

the El Cajón and Lago de Yojoa reservoirs in Honduras. In addition, operation under these conditions leads to serious risks and technical problems (of instability and voltage regulation). To change tension from 138 to 230 kV on the interconnection line between the Pavana (Honduras) and León (Nicaragua) substations, all that is required is electrical equipment in Nicaragua that would have a total cost of some 500,000 dollars. Only 250,000 dollars in financing is needed. The Special Plan for Co-operation with Central America includes a project outline on this subject.

Rehabilitation projects for thermal plants have been drawn up in Guatemala and Nicaragua. Despite their very high priority, however, these can only be expected to show results in the medium term. Thus, immediate attention should be given to urgent repairs which, in most cases, have so far been impossible owing to the lack of replacement parts that are generally imported.

It should be noted, moreover, that no projects for significant improvements to generation capacity are foreseen in any of the five countries of Central America; consequently, the problems described are not of a circumstantial or temporary nature, but rather may be expected to prevail until at least 1995, and even beyond that date unless decisions are taken soon to begin the construction of larger plants. As the Special Plan is aimed at attending the immediate needs of the region, it does not include project outlines dealing with additions to generation. It is worth emphasizing, nevertheless, that the electric power supply-demand balance is a problem that will persist over a far longer period, so that it is urgent to begin drawing up projects for a large-scale generation sufficient to meet existing and future demands. One obstacle to this lies in the type of financing received, which has generally been granted under unfavourable conditions and for very short terms as compared to the actual useful life of the projects. Once peace measures take effective shape and the economies of the region are reactivated, this situation would become critical due to the inability to attend the increased demand for electric power that would accompany that reactivation. The case of Nicaragua is the most serious; this document includes comments on three hydroelectric projects for that country for which feasibility studies have already been made an which require appropriate financing for their implementation.

In the electric power subsector, it is highly recommendable to orient co-operation towards the strengthening of institutions. An outstanding case in point is the formal integration of CEAC, a body whose regional scope would make it a very representative counterpart for defining and undertaking regional and multinational electric power projects. Regional projects particularly worthy of mention include: a) the Programme of Regional Activities in the Electric Power Subsector of the Central American Isthmus (PARSEICA-OE), for which non-reimbursable financing to the amount of more than two million dollars has already been approved by the IDB, and b) studies for the reinforcement of the regional electric power transmission network, for which financing amounting to approximately one million dollars has been granted by the Government of Spain.

The formal establishment of CEAC would facilitate the formation of working groups to handle such priority technical aspects as: a) procedures and organization for the maintenance of plants and transmission networks; b) stability and adjustments in voltage and velocity control subsystems; c) protection diagrams for electric power systems; d) interconnection studies, and others.

The formal constitution of CEAC would also facilitate the undertaking of studies on such binational projects as the El Salvador-Honduras interconnection and the El Tigre hydroelectric plant, involving the same two countries. In addition, studies could be made on joint investment projects that would afford security in meeting future power demands at lower production costs, thanks to economies of scale; these include such hydroelectric projects as the Boruca project in Costa Rica, the Copalar project in Nicaragua and the Changuinola project in Panama. Last, but by no means least, it would permit the definition and implementation of initiatives aimed at the establishment of such regional institutions for technical and professional support as an electrical testing laboratory and a centre for specialization in electric power systems engineering.

Annexes

Annex 1

CENTRAL AMERICAN ISTHMUS: GENERATION STATIONS AND INSTALLED CAPACITY BY NATIONAL ELECTRIC POWER ENTERPRISE, 1988

	Installed capacity		Available in 1988 (MW)	Fuel	
	MW	Percentages		Type	kWh/gallon
COSTA RICA (ICE)	748.2	100.00	748.2		
Hydraulic	678.2	90.50	678.2		
Arenal (3X52.5)	157.4		157.4		
Corobicí (3X58)	174.0		174.0		
Cachí (2X32+1X36.8)	100.8		100.8		
Río Macho (2X15+3X30)	120.0		120.0		
Garita a/ (2X15+2X48)	126.0		126.0		
Thermal and gas	70.0	9.50	70.0		
San Antonio-steam (2)	10.0		10.0	Bunker	
Colima (6)	12.0		12.0	Diesel	
San Antonio-gas (1)	18.0		18.0	Diesel	
Barranca (1)	18.0		18.0	Diesel	
Moín (4)	12.0		12.0	Bunker	
EL SALVADOR (CEL)	650.9	100.00	506.7		
Hydraulic	388.5	59.69	381.6		
Guajoyo (1X15)	15.0		15.0		
Cerrón Grande (2X67.5)	135.0		135.0		
5 de Noviembre (4X15+1X21.9)	81.9		75.0		
15 de Septiembre (2X78.3)	156.6		156.6		
Geothermal	95.0	14.60	51.1		
Ahuachapán (2X30+1X35)	95.0		51.1		
Thermal	69.6	9.80			
Acajutla (1X30+1X33+1X6.6)	69.6		30.0	Bunker	11.70
Turbines and internal combustion	97.8	15.02	44.0		
Soyapango (2X16.7+1X20.5)	53.9		24.0	Diesel	7.75
San Miguel	25.3		20.0	Diesel	7.69
Miravalles (3X6.2)	18.6			Bunker	15.69
GUATEMALA (INDE)	778.5	100.0	581.0		
Hydraulic	486.0	62.40	427.0		
Chixoy (5X60)	300.0		280.0		
Aguacapa (3X30)	90.0		60.0		
Jurún Marinalá (3X20)	60.0		60.0		
Esclavos (2X6.5)	13.0		13.0		
Minor plants	23.0		14.0		
Thermal (steam)	116.0	14.90	30.0		
Escuintla (1X30+1X42)	83.0		0.0	Bunker	9 y 12.4
Laguna (2X3.5+2X13)	33.0		30.0		
Turbines and internal combustion	176.5	22.70	124.0		
Escuintla (2X12.5+2X25+1X42)	117.0		82.0	Diesel	9.00
Laguna (1X12.5+2X23.5)	59.5		42.0	Diesel	

/Continues

Annex I (Conclusion)

	Installed capacity		Available in 1988 (MW)	Fuel	
	MW	Percentages		Type	kWh/gallon
HONDURAS (ENEE)	544.6	100.00			
Hydraulic	431.0	79.14			
Cajón (4X75)	300.0				
Cañaveral (2X14.25)	28.5				
Río Lindo (4X20)	80.0				
Níspero (1X22.5)	22.5				
Thermal	85.0	15.60			
Ceiba (4X5)	20.0		20.0	Bunker	13.3
Alsthom Thermal Plant (4X7.5)	30.0		7.5	Bunker	13.5
Sulzer Thermal Plant (4X7.5)	30.0		7.5	Bunker	13.8
Santa Fe (2X2.5)	5.0		-	Diesel	12.3
Gas	28.6	5.26			
La Puerta (1X15)	15.0		12.0	Diesel	6.8
Miraflores (1X13.6)	13.6		-	Diesel	6.1
NICARAGUA (INE)	325.0	100.00			
Hydraulic	100.0	30.76			
Centroamérica (2X25)	50.0				
Carlos Fonseca (2X25)	50.0				
Geothermal	35.0	10.77			
Patricio Argüello (1X35)	35.0				
Thermal	175.0	53.85			
Nicaragua (2X50)	100.0			Bunker	12.6
Managua (2X15+1X45)	75.0			Bunker	9.8 y 13.3
Gas	15.0	4.61			
Germán Pomares (1X15)	15.0			Diesel	7.6
PANAMA (IRHE)	896.2	100.00	770.0		
Hydraulic	551.0	61.48	551.0		
Fortuna (3X100)	300.0		300.0		
Bayano (2X75)	150.0		150.0		
Estrella (2X21)	42.0		42.0		
Los Valles (2X24)	48.0		48.0		
Minor plants	11.0		11.0		
Steam thermal	155.0	17.29	110.0		
Bahía las Minas (1X24+3X40)	144.0		101.0	Bunker	11.28 y 12.8
San Francisco U3 (1X11)	11.0		9.0	Bunker	9.67
Gas thermal	190.2	21.22	141.0		
Panama substation (2X21.4)	42.8		36.0	Diesel	8.91
Pielstick (4X7)	28.0		-		
Bahía Las Minas (2X36)	72.0		72.0	Diesel[b/]	
Monte Esperanza (1X21.4)	21.4		15.0	Diesel	8.44
Minor diesel plants	26.0		18.0		

Source: Information provided by national electric power enterprises.
a/ Includes ICE 96 MW Ventanas-Garita project which went into service in 1987.
b/ Marine diesel.

Annex II

CENTRAL AMERICAN ISTHMUS: BASIC CHARACTERISTICS OF PRINCIPAL EXISTING HYDROELECTRIC PROJECTS, 1988

Hydroelectric projects	Type of regulation	Capacity (MW)	Turbine	Generation in GWh		Storable energy (GWh)
				Average year	Dry year	
Costa Rica				2 483	2 072	
Cachí b/	Seasonal	100.8	Francis	685	468	25
Río Macho b/	Run of river	120.0	Pelton	518	332	-
Ventanas-Garita	Run of river	126.0	Francis			
Arenal b/	Interannual	157.4	Francis	616	616	783
Corobicí b/	Run of river	174.0	Francis	664	656	829
El Salvador		388.0		1 565		220
Guajoyo b/	Annual	15.0	Kaplan	50	-	40
Cerrón Grande b/	Annual	135.0	Francis	475	-	180
5 de Noviembre b/	Run of river	81.4	Francis	500	-	-
15 de Septiembre b/	Run of river	156.6	Kaplan	540	-	-
Guatemala		463.0		1 970	1 500	500
Chixoy	Annual	300.0	Pelton	1 450	1 100	450 a/
Aguacapa	Daily	90.0	Pelton	320	240	-
Jurún Marinalá	Annual	60.0	Pelton	150	120	50
Esclavos	Run of river	13.0	Francis	50	40	-
Honduras		431.0		2 268	1 370	2 209
El Cajón	Interannual	300.0	Francis	1 477	910	1 607
Río Lindo b/	Daily	80.0	Pelton	529	310	432
Cañaveral b/	Annual	28.5	Francis	191	105	170
Níspero	Daily	22.5	Francis	71	45	-
Nicaragua		100.0		397	300	317
Centroamérica b/	Annual	50.0	Francis	202	164	180
Carlos Fonseca b/	Annual	50.0	Francis	195	136	137
Panama		540.0		2 357	1 804	562
Estrella b/	Run of river	42.0	Francis	237	173	-
Los Valles b/	Run of river	48.0	Francis	273	215	-
Fortuna	Run of river	300.0	Pelton	1 242	1 071	-
Bayano	Annual	150.0	Francis	605	345	562

Source: ECLAC, based on official figures.
a/ Estimated value.
b/ Plants in cascade.