DOE/RG-0033

ELECTRICITY EXCHANGES

MASTER

UNITED STATES/MEXICO

MAY 1980

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United States / Mexico
ELECTRICITY EXCHANGES

prepared by

United States Department of Energy
Washington, D.C.

Comision Federal De Electricidad
Mexico, D.F.

MAY 1980

ELECTRICITY EXCHANGE BETWEEN THE UNITED STATES AND MEXICO

PREFACE

During February, 1979, the President of the Estados Unidos Mexicanos, Lic. Jose Lopez Portillo, and the President of the United States of America, President Jimmy Carter, reached an agreement in which Mexico and the United States would undertake a joint study to analyze the possibilities of increasing the international electricity exchanges between both countries. Subsequently, responsibility to organize and coordinate a study of the border area in both countries, and to present a report thereon, was jointly assigned to the United States Department of Energy (DOE) and to the Direccion de Energia de Mexico (DEM) through the Comision Federal de Electricidad (CFE).

Two international groups were formed for the development of this study: a "Western" group and an "Eastern" group. The representation for the United States in these groups of regional study involved the individual regional electric power utilities, since it will be at the level of the individual utilities that electric power exchanges will be carried out. Mexico was represented by the Direccion de Energia and by the staff from the main and regional offices of CFE.

The United States representatives of the "Western" group were assigned by the Western Systems Coordinating Council (WSCC) which selected officials from the electric power utilities located near the border. The United States representatives for the "Eastern" group

were appointed by the Electric Reliability Council of Texas (ERCOT). Similarly, the Mexican representatives for the Eastern and Western groups were selected from the respective CFE operational regions. The Western group was responsible for the corresponding study in the geographical area covered from the Pacific Ocean to El Paso-Ciudad Juarez. The Eastern group, in turn, was responsible for the rest of the border area to the Gulf of Mexico. The United States Department of Energy and the staff from the main office of the CFE were responsible for the overall coordination. Appendix A lists the individuals directly involved.

The study had the following aims:

- To help understand the situation and problems associated with the current electric power exchange between both countries.

- To point out the opportunities and constraints associated with increased electric power exchanges between the two countries.

- To supply information on the actual and future situations on the electric systems.

- To point out those joint projects and specific exchanges which should be subject to future detailed study.

- To highlight the existing legal and regulatory restraints associated with electric power exchanges between both countries.

With the support of both governments, and a high degree of cooperation between the two countries, work on the study has been completed within fourteen months. The completion of the study has been a major step in broadening the base of bilateral energy relations. The study highlights the opportunities for increased electricity exchanges, which could increase cooperation along the common border. Expansion of electricity interchange could offer substantial economic benefit to both countries, both directly and indirectly. Direct benefits include increased reliability of electric power and cost savings through economies of scale and diversity of peak demand patterns. Indirect benefits include improved economic and employment opportunities, especially in the border areas of both countries.

The report provides background on the history of past exchanges and the characteristics of the United States and Mexico electric systems, a summary of opportunities and incentives, and suggestions for procedures to remove obstacles and constraints.

Both countries look forward to continued cooperation in implementing the recommendations of the study on a timely basis.

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1. EXECUTIVE SUMMARY

As a result of the agreement between the Presidents of the Estados Unidos Mexicanos and the United States of America, a joint study was undertaken to analyze the possibilities of increasing the international electricity exchange between the two countries. Responsibility for this undertaking was assigned to the United States Department of Energy (DOE) and to the Direccion de Energia de Mexico (DEM) through the Comision Federal de Electricidad (CFE). Representatives from Mexico and the United States were chosen from the regional utilities along the border between the two countries and made up working groups which participated in the study. A detailed report has been prepared, which is summarized below.

OPPORTUNITIES

With a common border between the United States and Mexico of over 2,500 kilometers (1,500 miles), there are significant opportunities for the exchange of electric power in the future for the benefit of both countries. Significant geothermal resources exist in the Baja Norte region of Mexico in excess of anticipated Mexican needs. This surplus Mexican geothermal generating capacity can provide a valuable source of electricity to the United States utilities in California.

At other locations, large power plants are being installed on both sides of the border which will have some excess capacity until local requirements increase. Arrangements for the utilities in one country to purchase this excess capacity from plants in the other country will be mutually beneficial.

There are numerous communities and industrial plants near the border in one country which can be supplied at less cost from the other country. Cooperation in supply of such areas will be mutually beneficial.

Growth in the need for electricity in Mexico is forecast at 10 percent annually. This will require a very significant construction program. Experience has shown that unforeseen delays can occur in programs of this magnitude. In the United States, future developments may cause problems in fuel availability. Additional electrical interconnections between the two nations provide the opportunity for each to render emergency assistance to the other in meeting the uncertainties of the future.

The time of maximum use of electricity in adjacent areas in the two countries differs. This diversity in peak use makes possible the use of generation or transmission capacity in one country to help meet peak needs of the other.

BACKGROUND

The exchange of electricity between the United States and Mexico began in 1905, reached a maximum in the mid-1970s, and has declined sharply since 1977. Past cooperative efforts have included participation by both countries in the development of the hydroelectric resources of the Rio Bravo (called the Rio Grande in the United States) with dams at Falcon and Amistad. Because of technical problems, the existing electric transmission ties between the two countries are not normally used.

Since 1977, the Mexican electric power system has been integrated through installation of a 400-kilovolt (kV) transmission grid. At present, the entire country is operated as a single system with the exception of the Baja California region and the Yucatan region. The United States electric power system is operated on a coordinated basis. Two systems abut on Mexico: the Western Systems Coordinating Council (WSCC) in California, Arizona, and New Mexico, and the Electric Reliability Council of Texas (ERCOT). A significant technical constraint exists because, under present conditions, the CFE, ERCOT and WSCC will not operate properly if directly interconnected with alternating current lines. This necessitates isolating segments of the Mexican and United States systems from their normal sources when they are to be supplied from the other country. This situation, which has existed since 1977, has been a factor in limiting electric power exchanges between the two nations.

Institutional differences also limit electric power exchanges. The Mexican system is planned and operated by CFE, which provides centralized administration and simple negotiating and approval procedures. In the United States, a large number of utility organizations are involved and governmental approval procedures are significantly more complicated, caused in part by overlapping Federal and State jurisdictions. Therefore the time required to obtain the necessary approvals and permits is considerably longer in the United States than in Mexico.

SUGGESTED ACTIONS

In view of the significant potential benefits of increased electricity exchanges to both countries, the report recommends that steps be taken

by the governments of both nations, by the electric utilities, and by their coordinating organizations to overcome the existing technical and institutional constraints. The report also suggests that joint planning studies of a number of specific projects be initiated.

Some of the short-term actions suggested in the report are:

- Expedited regulatory processing in the United States consistent with the statutory public interest requirements for the proposed 230 kV transmission lines between the San Diego Gas and Electric Company (SDG&E) and CFE to provide for increased electric energy exchange, and for the purchase of electricity from the CFE geothermal plants by SDG&E and the Southern California Edison Company.

- Development of a joint United States/Mexico transmission plan for power delivery from the Amistad Dam on the Rio Bravo where both countries are installing hydroelectric generation.

- Joint development by CFE and the ERCOT utilities of procedures and internal system reinforcements to increase the use of existing interconnections for electric energy interchange.

- Coordinated arrangements to supply loads along the border in both countries in the most effective manner.

- Joint investigation by the ERCOT utilities and CFE of the advantages and arrangements for the purchase by the ERCOT utilities of some of CFE's new generating capacity at the Rio Escondido and Rio Bravo power plants during initial years of operation.

- Joint investigations by the United State utilities and CFE of diversity in peak loads between the two countries and the mutual assistance that this diversity makes possible.

- Establishment by CFE, ERCOT and WSCC of two international committees, one covering system planning and one covering system operations, to provide the basis for future cooperative efforts.

- Participation of CFE in the activities of the ERCOT and WSCC Regional Reliability Councils.

- Agreement within one year between CFE and the United States utilities on system planning and operating criteria and procedures.

Some specific long-term suggestions are:

- Exchange of fuel for electric power, with one country providing fuel and the other returning electricity, provided the United States' dependence on imported oil is not increased.

- Exchange of electric energy, delivered at one geographic location, for electric energy returned at another location.

- Coordination of future generation and transmission developments, especially in the border region.

- Expedited governmental regulatory actions consistent with statutory public interest requirements in each nation such that electricity exchanges and permits for international electric power transmission lines are issued as rapidly as possible.

All participants have agreed to continue cooperative efforts in the future to investigate the many opportunities to achieve benefits to both countries through increased electric power exchanges.

2. BACKGROUND

HISTORY OF ELECTRICITY EXCHANGES

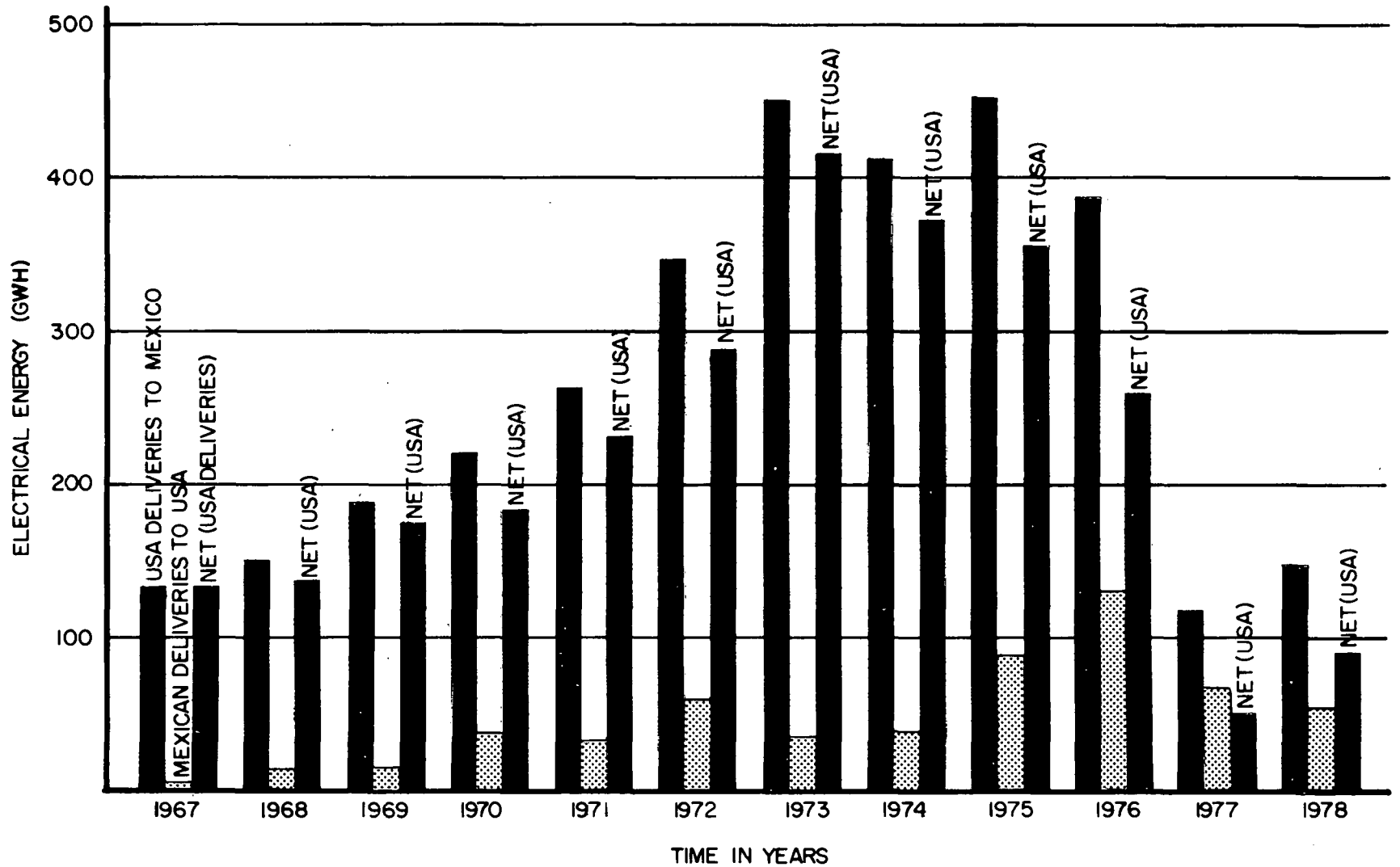
The exchange of electric energy between the United States and Mexico has been influenced by geographic, economic and political factors from time to time. During the early stage, the Mexican-United States electricity exchanges were few and of minor amount. Throughout the middle of the twentieth century, however, demographic and economic conditions led to a significant increase in electric energy transactions. Since 1977 the international electric energy exchanges have decreased drastically as a result of developments in the Mexican and United States systems. Figure 2.1 shows the recent history of Mexican-United States electric energy interchanges.

The increased potential for mutually beneficial electricity exchanges, as well as change in the world situation, has caused both governments to take an in-depth look at what can be done to organize, in a systematic and feasible fashion, further Mexican-United States cooperation and coordination.

In 1905 the United States and Mexico began electricity imports and exports. Low voltage lines were constructed in order to serve the bordering towns of Northern Mexico and the Southwestern portions of the United States. These sparsely populated areas needed very little electricity and were far from any major Mexican or United States sources. Privately owned utilities in Mexico and the United States were able to make the arrangements to meet the demand. Those early interconnections were generally of low voltage and low capacity design to meet the short-term needs in the immediate border region.

FIGURE 2.1

RECENT HISTORY OF MEXICO-USA ELECTRIC ENERGY INTERCHANGE



The Comision Federal de Electricidad (CFE) was created in 1937 by the Mexican Government for the purpose of providing electricity to all its citizens. CFE, as the electric utility of Mexico, negotiated with individual United States utilities. Examples of interconnections established in the late 1930's, 1940's and 1950's are:

- San Diego Gas and Electric Co. lines to Tecate and Tijuana.
- Between Nogales, Arizona, and Nogales, Sonora, 13.8 kV distribution connection.
- From Naco, Arizona to Naco, Sonora, 12.5 kV line.
- Falcon Dam's energy shared between the United States and Mexico.
- 69 kV El Paso-Ciudad Juarez interconnections.

In 1967 the Western Systems Coordinating Council (WSCC) was formed in the United States. The utilities operating in the portion of Canada bordering the Pacific Northwest region of the United States are also members of WSCC. With the establishment of this regional council, along with the founding of the Electric Reliability Council of Texas (ERCOT) in 1970, the United States is now in a position to coordinate with CFE on a regional basis.

WSCC and CFE share a common border of about 1310 km (810 miles). WSCC areas encompass approximately 4.1 million square kilometers (1.6 million square miles). WSCC utilities on the border of Mexico are in the states of California, Arizona, and parts of New Mexico and Texas. CFE electric systems on this border with the United States are in the Mexican states of Baja California, Sonora and Chihuahua.

ERCOT, a Texas Reliability Council comprised of 77 municipalities and electric cooperatives, a state agency, and eight investor owned utilities, was established in 1970. The utility systems in the United States along the 1200 km (750 miles) of the Texas/Mexico border are:

Central Power & Light Co.	West Texas Utilities Co.
City of Brownsville	Southwest Power Administration
Medina Electric Cooperative	South Texas Electric Cooperative

CFE electric systems along this common border are in the states of Chihuahua, Coahuila, Nueva Leon and Tamaulipas.

The locations of the various utilities in the regions of interest are shown in Figure 2.2. In the past, the United States utilities have provided short-term firm energy at the distribution voltage level. Exchanges of electricity at the transmission voltage level have also occurred mainly between Central Power & Light Co. of ERCOT and CFE as shown in Figure 2.3.

Table 2.1 shows the division of international exchange between the Eastern (ERCOT) and the Western (WSCC) regions. It shows that prior to 1977 the bulk of the energy flow to Mexico was via the Western region while the bulk of energy flow to the United States was via the Eastern region. In the Eastern region, CFE has generally returned the energy received from the United States.

The sharp reduction, starting in 1977, of energy exports from the United States to Mexico via the Western region was the result of the installation of a new 230 kV supply by CFE to the Ciudad Juarez, accompanied by other major CFE transmission reinforcements. These changes significantly reduced the need for electricity imports by Mexico in this region.

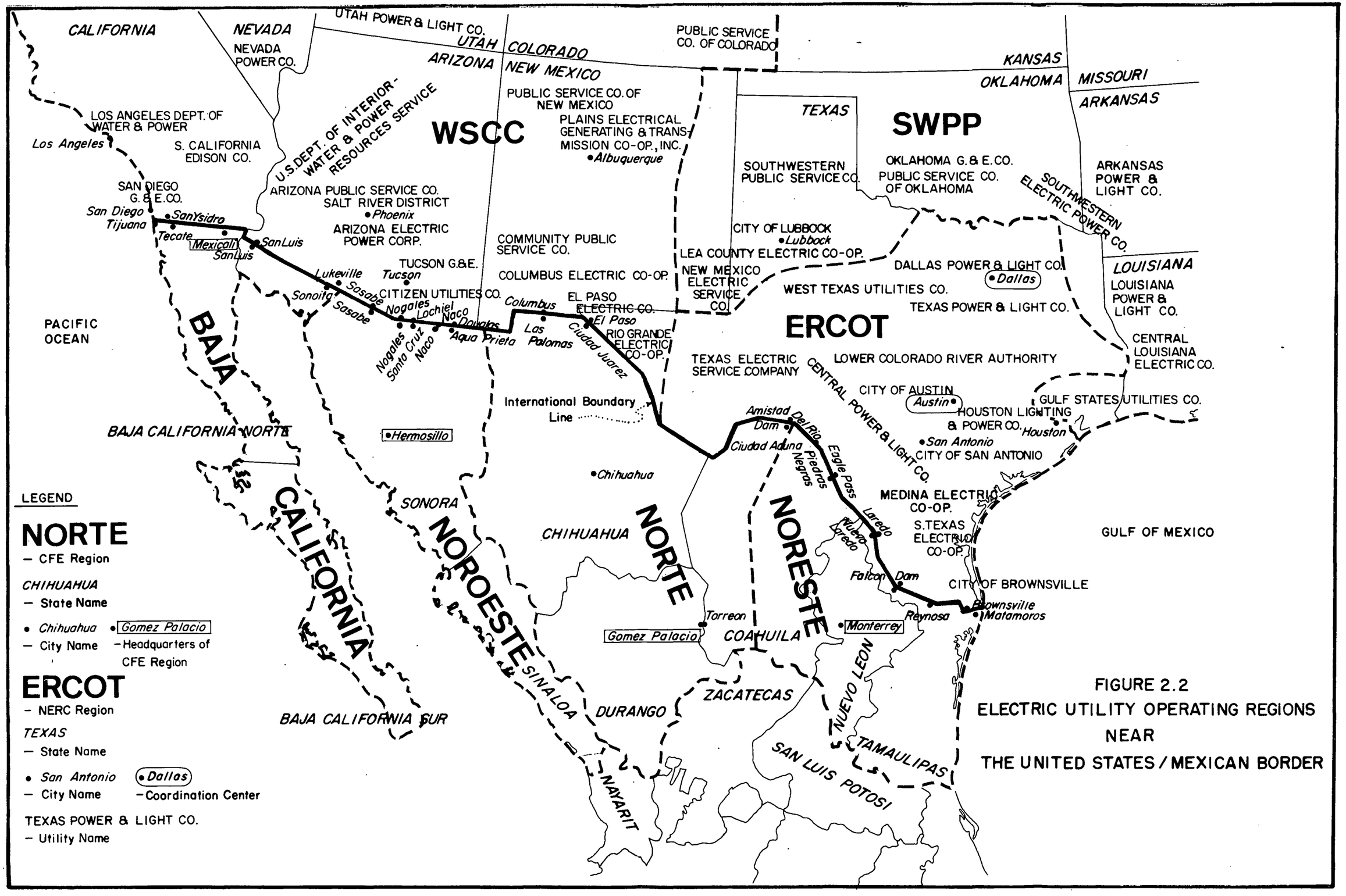


FIGURE 2.2
ELECTRIC UTILITY OPERATING REGIONS
NEAR
THE UNITED STATES / MEXICAN BORDER

FIGURE 2.3
RECENT HISTORY OF
ERCOT (CENTRAL POWER & LIGHT) - COMISION FEDERAL DE ELECTRICIDIAD
ELECTRIC ENERGY INTERCHANGE

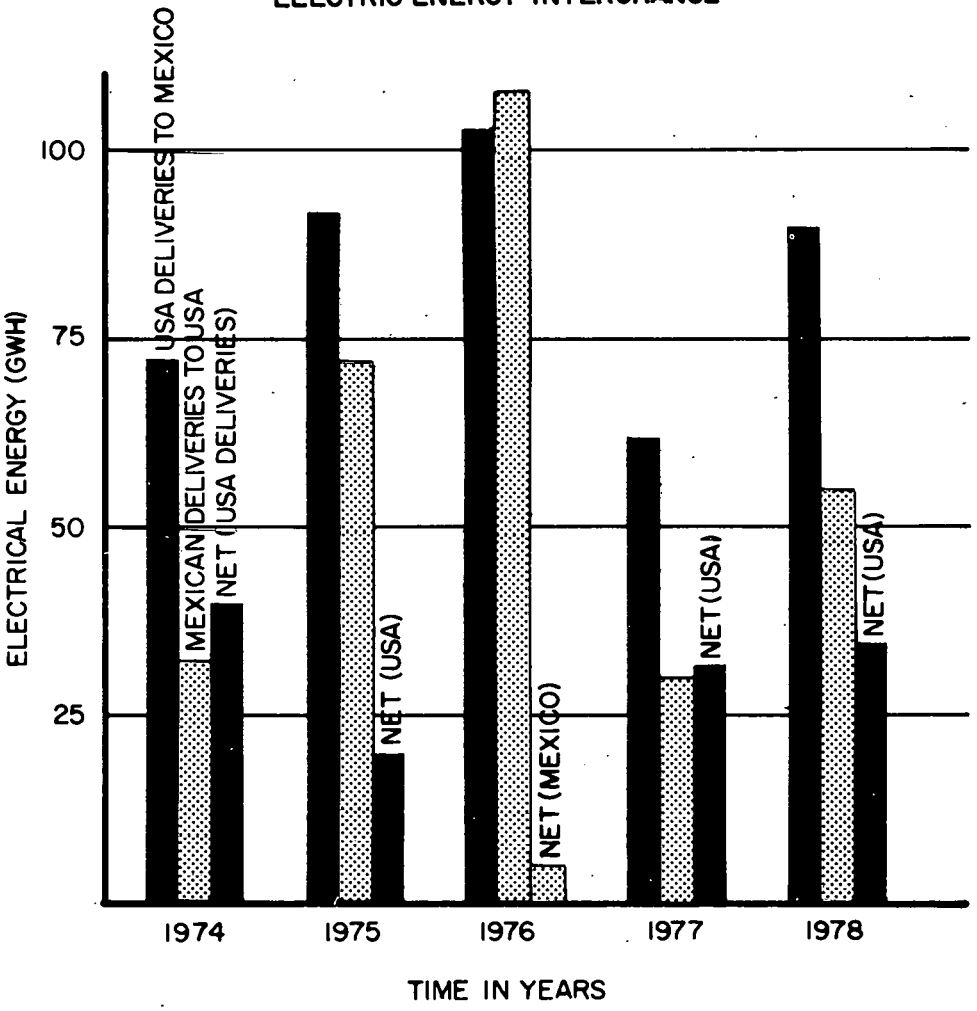


TABLE 2.1

DISTRIBUTION OF EXCHANGES BETWEEN EAST AND WEST GROUPS

	GWH*				
	1974	1975	1976	1977	1978
Total to Mexico	411	446	388	119	144
Via East (ERCOT)	72	92	103	62	101
Via West (WSCC)	339	354	285	57	43
Total to United States	39	89	127	52	55
Via East (ERCOT)	32	72	108	30	55
Via West (WSCC)	7	17	19	22	0
Net to Mexico	372	357	261	67	89
Via East (ERCOT)	40	20	-5	32	46
Via West (WSCC)	332	337	266	35	43

*One GWH (Gigawatt hour) = 1,000,000 KWH (Kilowatt hour)

EXISTING INTERCONNECTIONS

All existing interconnections between Mexico and the United States are listed in Table 2.2. Figure 2.4 shows the existing bulk power transmission interconnections, and Figure 2.5 shows the planned interconnections. There are a total of 10 interconnections from the WSCC region to Mexico, three at 69 kV and the rest at lower voltage. Four transmission interconnections exist from the ERCOT region to Mexico, three 138 kV ties from the Central Power & Light Co. (CP&L) system to CFE and one 69 kV tie from Brownsville to CFE.

None of these interconnections are operated closed for two principal reasons. First, they are no longer required for normal supply as a result of internal reinforcement in the Mexican system. Second, the existing ties are too small to connect effectively the Mexican and United States bulk power systems in synchronism.

When two large alternating current systems are connected, they must both operate at precisely the same frequency and are said to be operating in synchronism. If the interconnecting ties are not sufficiently strong compared to the size of the systems involved, they will not be able to hold the two dynamic systems together resulting in electrical conditions that will cause opening of circuit breakers and disconnection. Such disconnections can cause major problems in the two systems and interruptions of service to consumers.

The inability to operate the ERCOT system in synchronism with the Mexican national interconnected system has existed since the Mexican system was unified in 1978 by the installation of 400 kV transmission lines between the northern and southern region of the country. As a

TABLE 2.2

EXISTING UNITED STATES-MEXICO INTERCONNECTIONS

	United States Terminal	Mexican Terminal	Voltage	Capacity(MW)
WSCC				
1.	San Ysidro, California	Tijuana, Baja California	69 kV	40.0
2.	Nogales, Arizona	Nogales, Sonora	13.8 kV	15.0
3.	Naco, Arizona	Naco, Sonora	12.5 kV	5.0
4.	Douglas, Arizona	Agua Prieta, Sonora	12.5 kV	6.0
5.	San Luis, Arizona	San Luis, Sonora	34.5 kV	5.0
6.	Lukeville, Arizona	Sonoita, Sonora	21 kV	1.5
7.	Lochiel, Arizona	Santa Cruz, Sonora	13.8 kV	0.2
8.	Sasabe, Arizona	Sasabe, Sonora	2.3 kV	0.2
9.	El Paso, Texas	Ciudad Juarez, Chihuahua	2-69 kV	80.0
10.	Columbus, New Mexico	Las Palomas, Chihuahua	13.2 kV	0.3
ERCOT				
11.	Falcon Dam, Texas	Falcon, Tamaulipas	138 kV	150.0
12.	Laredo, Texas	Nuevo Laredo, Tamaulipas	138 kV	
13.	Eagle Pass, Texas	Piedras Negras, Coahuila	138 kV	
14.	Amistad Dam, Texas	La Amistad, Tamaulipas	12 kV	5.0
15.	Del Rio, Texas	Ciudad Acuna, Coahuila	13.8 kV	5.0
16.	Brownsville, Texas	Matamoros, Tamaulipas	69 kV	20.0

FIGURE 2.4
EXISTING BULK POWER INTERCONNECTIONS

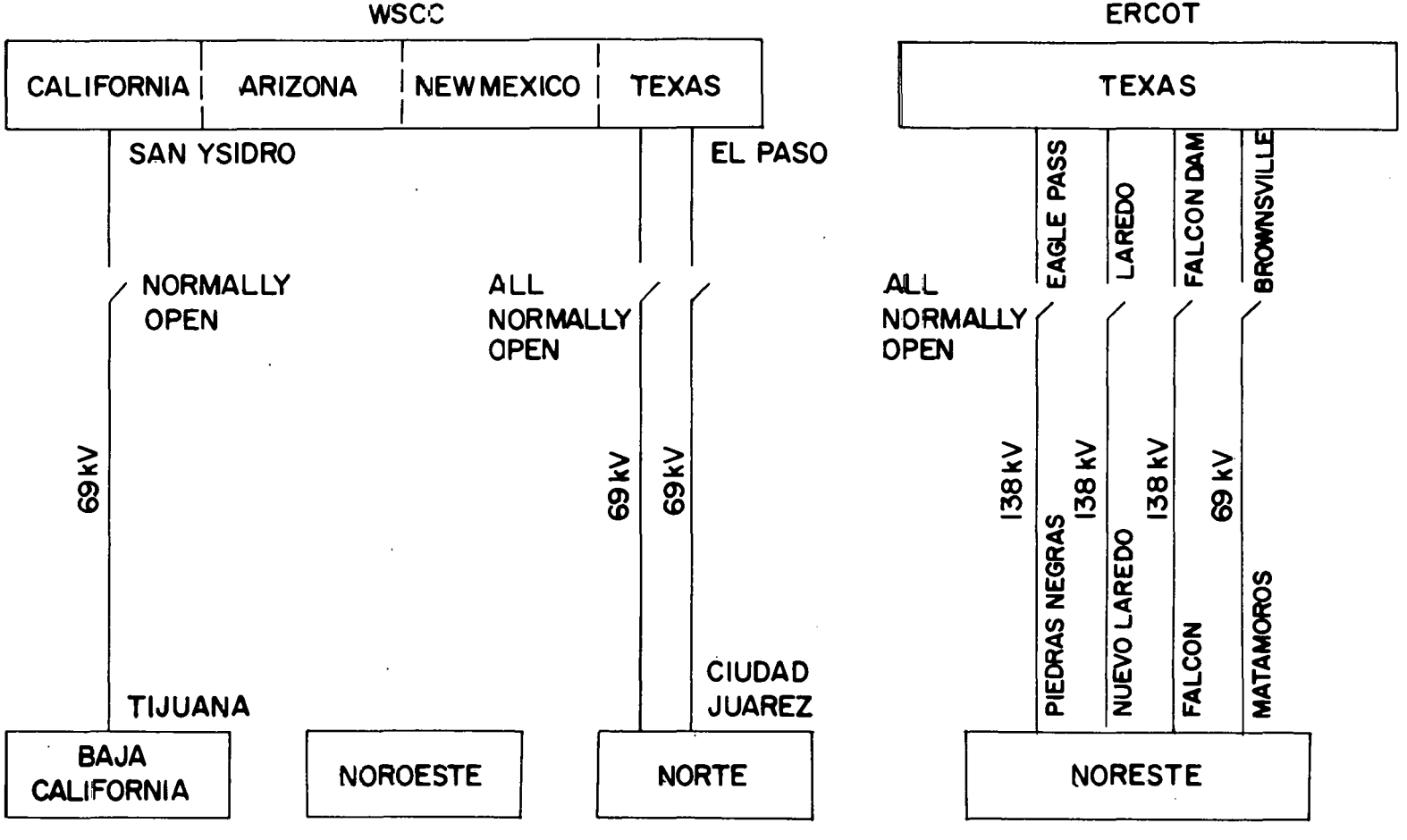
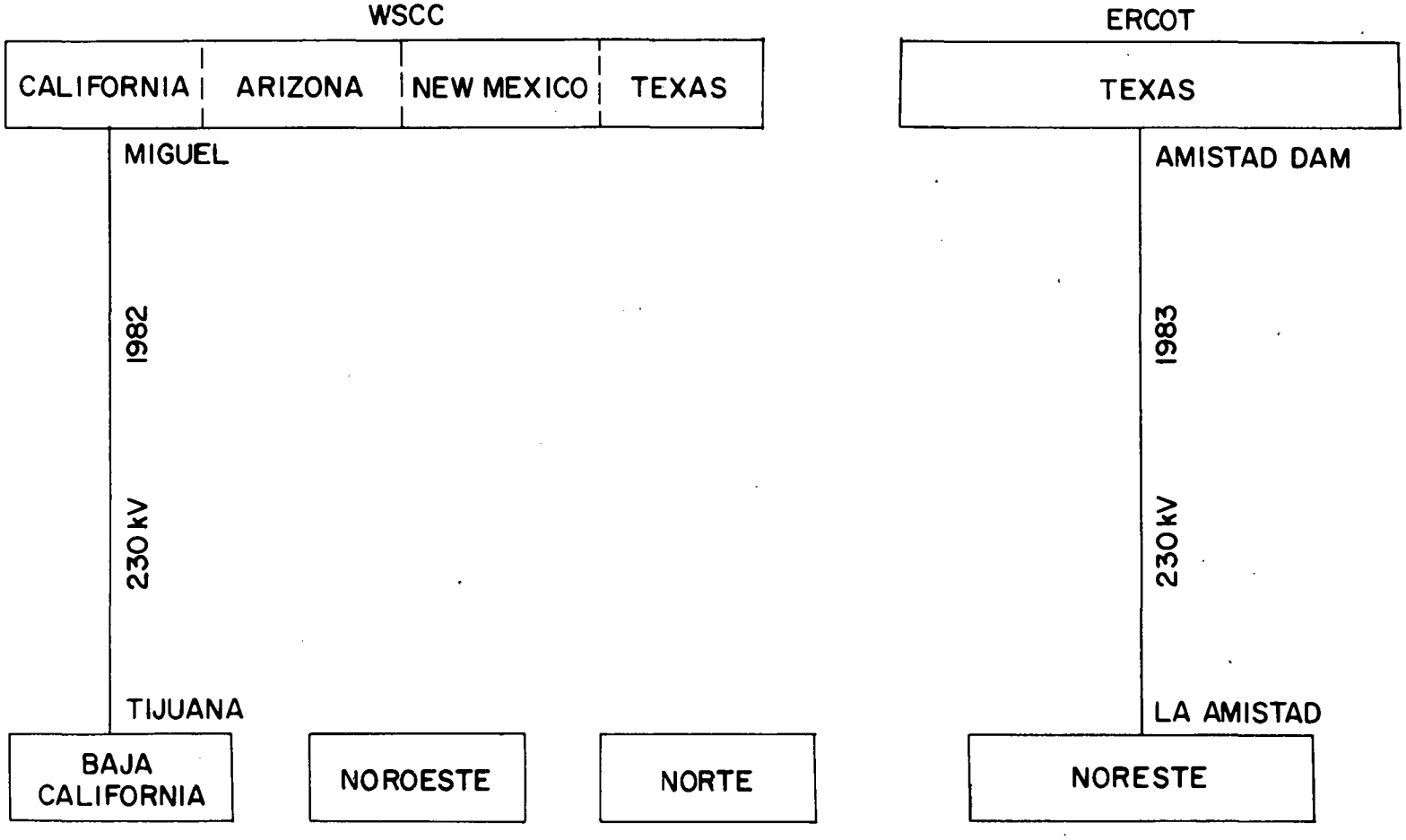


FIGURE 2.5
PLANNED NEW BULK POWER INTERCONNECTIONS



result, capacity and energy are often exchanged between the United States utilities and CFE on a block loading basis, i.e., physical portions of one system are isolated and transferred to the other. This arrangement is used only during periods of shortage or other emergency.

The three 138 kV ties from Texas have a limited transfer capability of 150 megawatt (MW) which is considerably less than the sum of the individual tie capacities, because of the need to limit transfers to the internal capacity of the CP&L system. This 150 MW limit becomes even more restrictive since actual loading on the three lines must be limited so that the 150 MW value will not be exceeded for the worst single contingency which can occur in the CFE system.

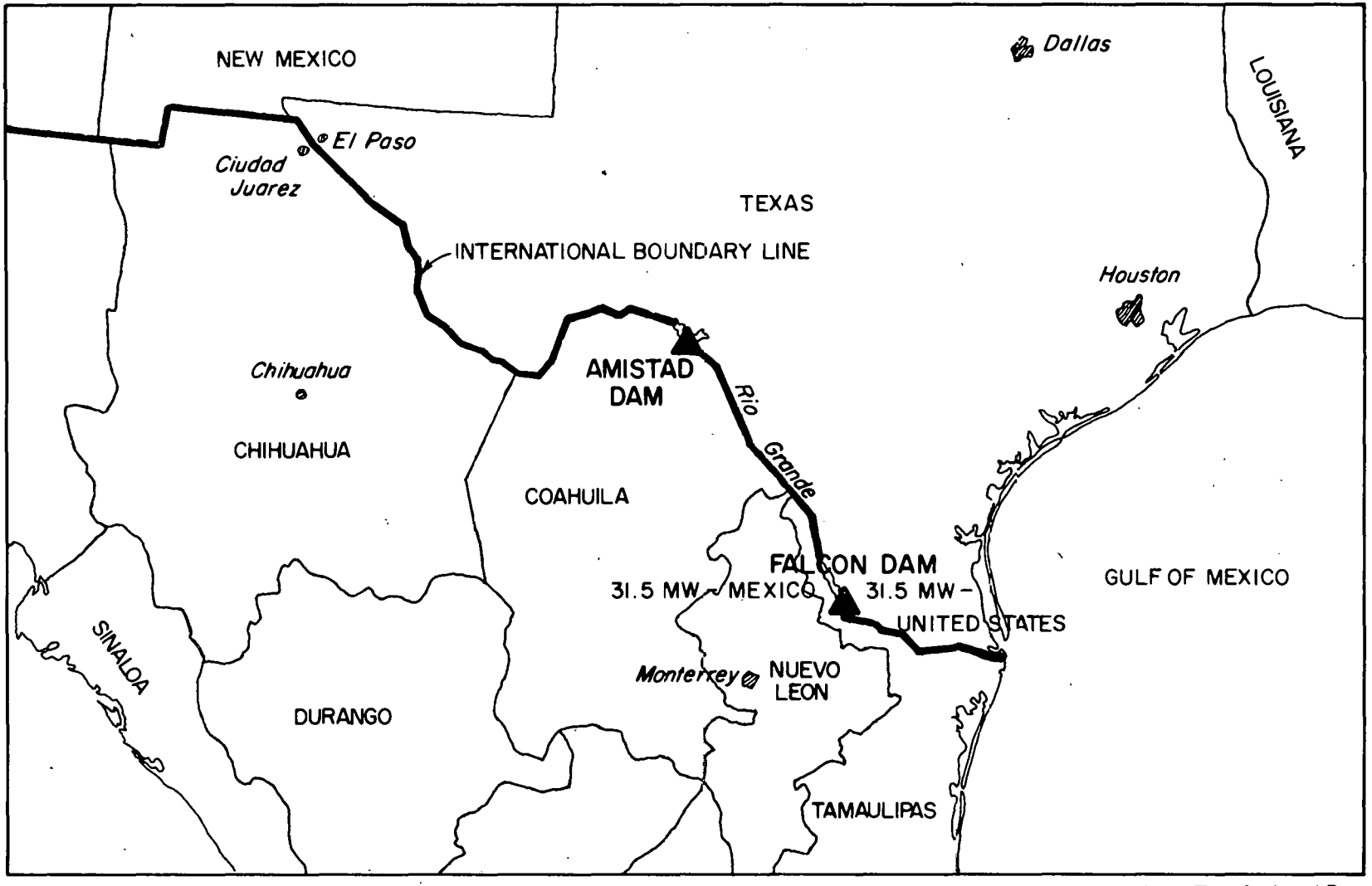
JOINT HYDRO PROJECTS

Mexico and the United States have coordinated in the development of the hydroelectric resources on the Rio Bravo (called the Rio Grande in the United States). The dams at Falcon and Amistad (See Figure 2.6) were jointly installed.

Both the Falcon and Amistad Projects are under the overall supervision of the International Boundary and Water Commission. The International Boundary Commission was created pursuant to the Treaty of March 1, 1889 and its jurisdiction has been extended by subsequent treaties. It was reconstituted as the International Boundary and Water Commission, United States and Mexico, by the Water Treaty of 1944 with expanded responsibilities and functions under the policy direction of the United States Department of State and the Mexican Secretariat of Foreign Relations.

FIGURE 2.6

JOINT UNITED STATES / MEXICO HYDROELECTRIC DEVELOPMENTS



The hydroelectric generating facilities at Falcon Dam are installed with a powerhouse on eachside of the border. The Amistad Dam is complete, and the installation of 120 MW of hydroelectric generating facilities is planned by 1983. These dams are operated by the International Boundary and Water Commission.

The Commission, consisting of United States Section and the Mexican Section, is charged with implementing the provisions of existing treaties dealing with boundary and water matters affecting the two countries including: preservation of the international boundary; distribution between the two countries of the waters; control of floods; regulation by joint storage works to enable equal utilization of these waters; improvement of quality of waters; sanitation measures; and use of waters to develop jointly hydroelectric power.

Two power plants exist at the Falcon site, one Mexican and one American. Each power plant has an installed generating capacity of 31.5 MW, for a total at the site of 63 MW. The electricity produced at Falcon is divided equally between the two countries. Total average annual production at Falcon has been 194,000 MWH, which is marketed in the United States by the Western Area Power Administration. The Mexican share is delivered to the CFE system. The Amistad Dam located on the Rio Bravo, approximately 550 km (340 miles) northwest of the Falcon Dam, was completed in 1969. Each country is entitled to one half of the potential hydroelectric energy. The installation by the United States of two generating units at the existing Amistad Dam is underway and is scheduled for completion in 1982. The energy from these units will be marketed by the Western Area Power Administration, South Texas Electric Cooperative and the Medina Electric Cooperative. The Mexican installation of two 27 MW units and associated transmission are scheduled for 1983. Total average annual production at Amistad is estimated to be 320,000 MWH, which will be divided equally.

RESOURCE AND LOAD CHARACTERISTICS

The benefits available from international electric energy exchange depend in part, on available generating sources. Figure 2.7 shows the

present and projected sources of electric generation for both nations in the border region.

The adjacent service areas in both Mexico and the United States are characterized by wide variations in population density resulting in significant differences in electric load densities, and long distances between load centers and power stations. The annual load factor, i.e. the ratio of average use to peak use, of the CFE system is higher than typical United States systems, largely because the CFE system has a higher proportion of industrial load.

Recent growth rates have been considerably higher on the CFE system than on the United States system. This growth disparity is expected to increase as shown by the forecasts in the following sections.

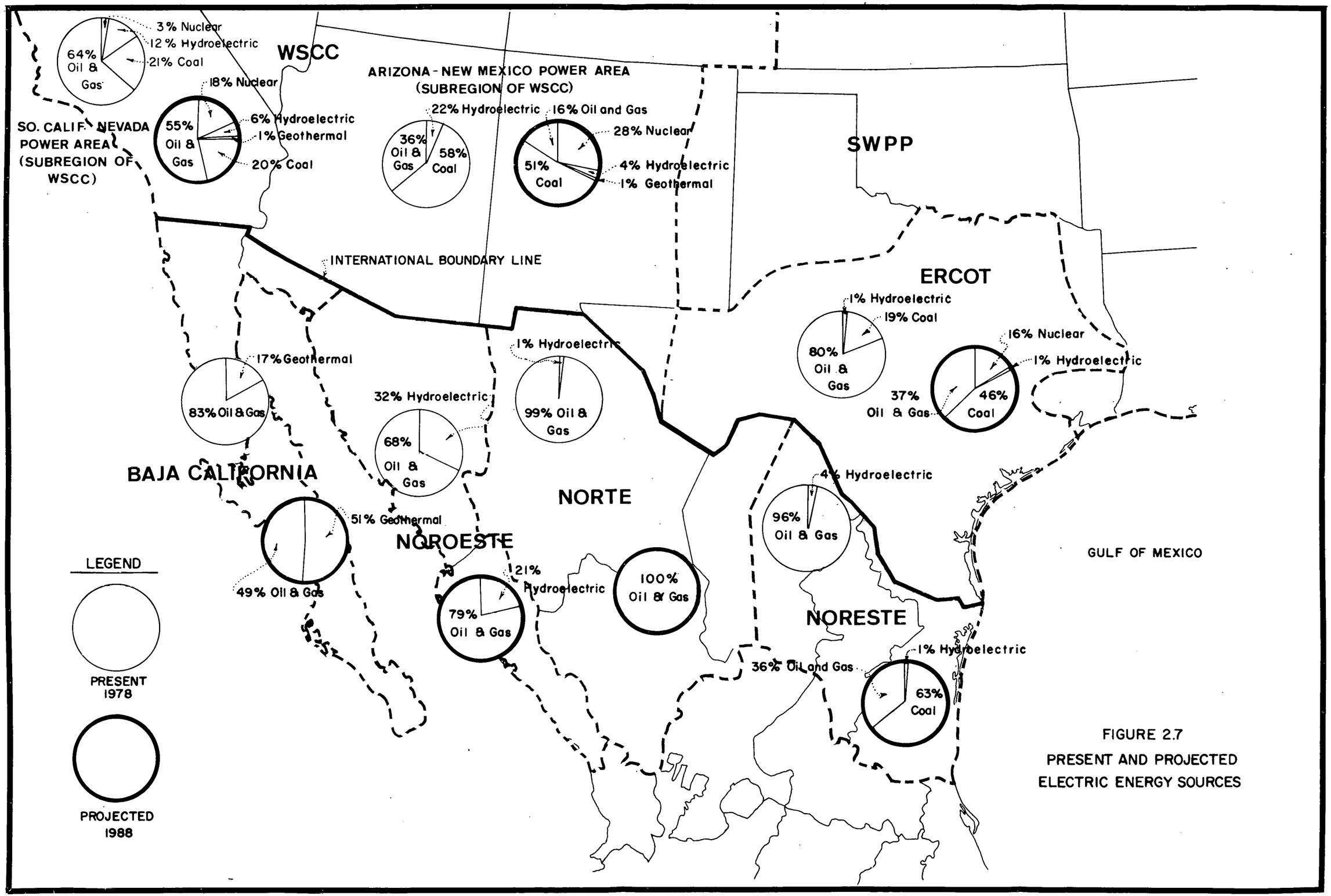


FIGURE 2.7
PRESENT AND PROJECTED
ELECTRIC ENERGY SOURCES

3. ELECTRIC POWER SUPPLY IN THE UNITED STATES

UTILITY TYPES AND OWNERSHIP

Individual companies and organizations plan, design, construct, and operate electric power systems in specific geographical areas. These organizations can be categorized by type of ownership as follows:

- Investor-owned utilities.
- Rural electric cooperatives.
- State or local government agencies.
- Federal.

The investor-owned systems generally are granted territorial franchises by state or local government regulatory agencies. The franchises, in effect, create local monopolies in that a second investor-owned company cannot be franchised in the same territory. As the classification suggests, the investors in the company, i.e., purchasers of the equity issues, are the owners. Due to the special nature of electric utility franchises, utility management must be responsive to its customers as well as its "owners."

The Rural Electrification Administration (REA) in the United States Department of Agriculture cooperative system was initiated in 1935-1936 by a Presidential Executive Order, with the REA established as a government financing agency. Rural electric cooperatives are for the most part consumer owned utilities incorporated under the laws of the states in which they operate. Most of the 1,000 rural elec-

tric cooperatives are distribution systems, but there are twenty-seven cooperatives which generate and transmit (G&T's) power to their distribution system members. Consumer cooperatives are usually non-profit corporations, owned and controlled by the people they serve.

There are 2,223 public non-federal systems in the United States including power supply entities which serve towns and cities (municipals), special utility districts, and state authorities. Municipal utilities numbering 1,743 systems are the most common form of the public non-federal power entity. There are public utility districts or authorities which serve state-specific territories, e.g. the Power Authority of the State of New York (PASNY). Other public power systems include the Los Angeles Department of Water and Power and the Salt River Project Agricultural Improvement and Power District.

There are several federal agencies directly involved in the supply of electrical power and they are as follows:

- Tennessee Valley Authority (TVA).
- Department of Energy (DOE)
  - Bonneville Power Administraton (BPA).
  - Southwestern Power Administration (SWPA).
  - Western Area Power Administration (WAPA).
  - Southeastern Power Administration (SEPA).
  - Alaska Power Administration (APA).
- Department of Interior
  - Water and Power Resources Service.
- Department of Defense
  - Corps of Engineers.
- Department of State
  - International Boundary and Water Commission.

These agencies produce and market electric power that amounts to roughly 10 to 12 percent of the nation's electrical energy supply. The TVA was established in 1933 to develop the resources of the Tennessee River Basin, with a specific charter to develop hydroelectic power. After full development of the hydroelectric power potential of the basin, TVA developed a power production system which included fossil-fueled and nuclear generating plants. TVA is currently the nation's largest electric system in terms of installed generating capacity. The TVA serves a set of preferential wholesale customers that are public owned utilities or cooperatives. BPA is the marketing agent for power from 33 federal hydroelectric projects of the Water and Power Resources Services. The Southwestern and Western Area Power Administrations market the power produced at hydroelectric plants in the southwest and western states, respectively. The International Boundary & Water Commission operates Falcon and Amistad Dam. Finally the Corps of Engineers and Department of the Interior operate many hydroelectric power plants built in widely separated areas in the Western states.

A number of factors have stimulated the development of joint as opposed to single company power plant projects. When plants could be planned, built and introduced in a six to eight year time frame, with some reasonable assurance of a competitive return and essentially no risk that the plans would be aborted through regulatory and environmental intervention, private utilities in general had little need to seek partners. As the planning horizon lengthened to ten to twelve years due to environmental and land use regulations and few sites met regulatory requirements, utilities were forced to plan bigger capacity additions requiring greater sums of capital and construction financing over extended time intervals.

Thus, the general financial impediments to utility investment induced many utilities to seek partners to reduce their own capital requirements and limit the consequence of failure should it be necessary to abort a given project. These utilities generally sought to establish joint arrangements with neighboring utilities.

REGULATORY CONTROLS

The following aspects of the electric utility industry are subject to regulation by local, state or federal authorities:

- Retail Rates (local or state control).
- Wholesale Rates for Resale (Federal Energy Regulatory Commission (FERC) controls).
- Interconnection Contracts between United States Utilities (FERC controls).
- International Interconnection Contracts (Economic Regulatory Administration within DOE controls).
- Land Use.
- Environmental Quality.
- Financing (Securities and Exchange Commission).
- Fuel Utilization.
- Generation and Transmission Facilities Siting.
- Water-Use.

The Department of Energy is charged with encouraging electric utility industry coordination in the United States. The Federal Energy Regulatory Commission (FERC) regulates the sale of electricity in interstate commerce, the interconnection of electric utilities, the appointment of corporate directors and the issuance of securities. It

also has the power to order the wheeling of energy when certain conditions are met.

The Economic Regulatory Administration (ERA) is charged with providing direction in overall energy regulatory policy development. Specific responsibility for allocating fuel supplies in times of shortages and for ordering the emergency interconnection and transfer of electricity among utilities rests with ERA. This agency also has regulatory responsibility for authorizing the construction of international electric power lines and issuing authorization for electric exports.

All states in the United States have public utility commissions which have varying authority to establish rates for the retail sale of electricity and also conduct public hearings on controversial matters and arrive at decisions. The United States Nuclear Regulatory Commission (NRC) controls the siting and installation of nuclear power plants. The State environmental protection agencies control the utility operation whenever it affects the environment in any way. In addition, there are many other local, State, and regional agencies which perform regulatory functions. In some cases, there is overlapping jurisdiction of these various authorities.

COORDINATING ORGANIZATIONS IN THE UNITED STATES

Utility systems in the United States are generally managed, planned and operated by a single corporate or governmental utility organization. In a few cases, a holding company will own a number of operating companies. Of particular relevance are the Central and South West Corporation which owns the Central Power & Light Company, Public Service Company of Oklahoma, Southwestern Electric Power Company, and West Texas Utilities Company; and the Texas Utilities Company which owns the Dallas Power & Light Co., the Texas Electric Service Co., and the Texas Power & Light Co. These holding companies have the responsibility for all operations of their subsidiaries.

In many cases, electric utilities plan and operate as a part of power pools. A contract covering duties and obligations is signed by all participants. Usually covered by the contract are procedures for coordinated planning and coordinated operation. In some cases a centralized operating center and centralized planning procedures are provided. Typical of such power pools are the Pennsylvania-New Jersey-Maryland Interconnection (PJM), and the Texas Interconnected System (TIS).

Many benefits and obligations result from power pool operations. Among the benefits are increased reliability, decreased investment, requirements, and fuel expenditures. Among the obligations are the need to accept coordination of plans and operation, and occasionally subjugating individual company views to overall pool requirements. The net result is significant benefits to consumers of all organizations involved.

Pool contracts vary considerably in content, ranging from a brief outline of coordination procedures to a detailed description of capacity obligations, reserve obligations, transmission cost sharing formulas, price formulas for exchanging capacity and energy, both under normal and emergency conditions, penalities for failure to provide regulating capacity, etc. In many cases, the pricing arrangements involved are based on split savings. For example, if energy can be produced by one utility at an incremental cost of $0.020/kWh, and another utility at $0.028/kWh, the sale will take place from the lower cost utility to the higher cost utility at a price of $0.024/kWh.

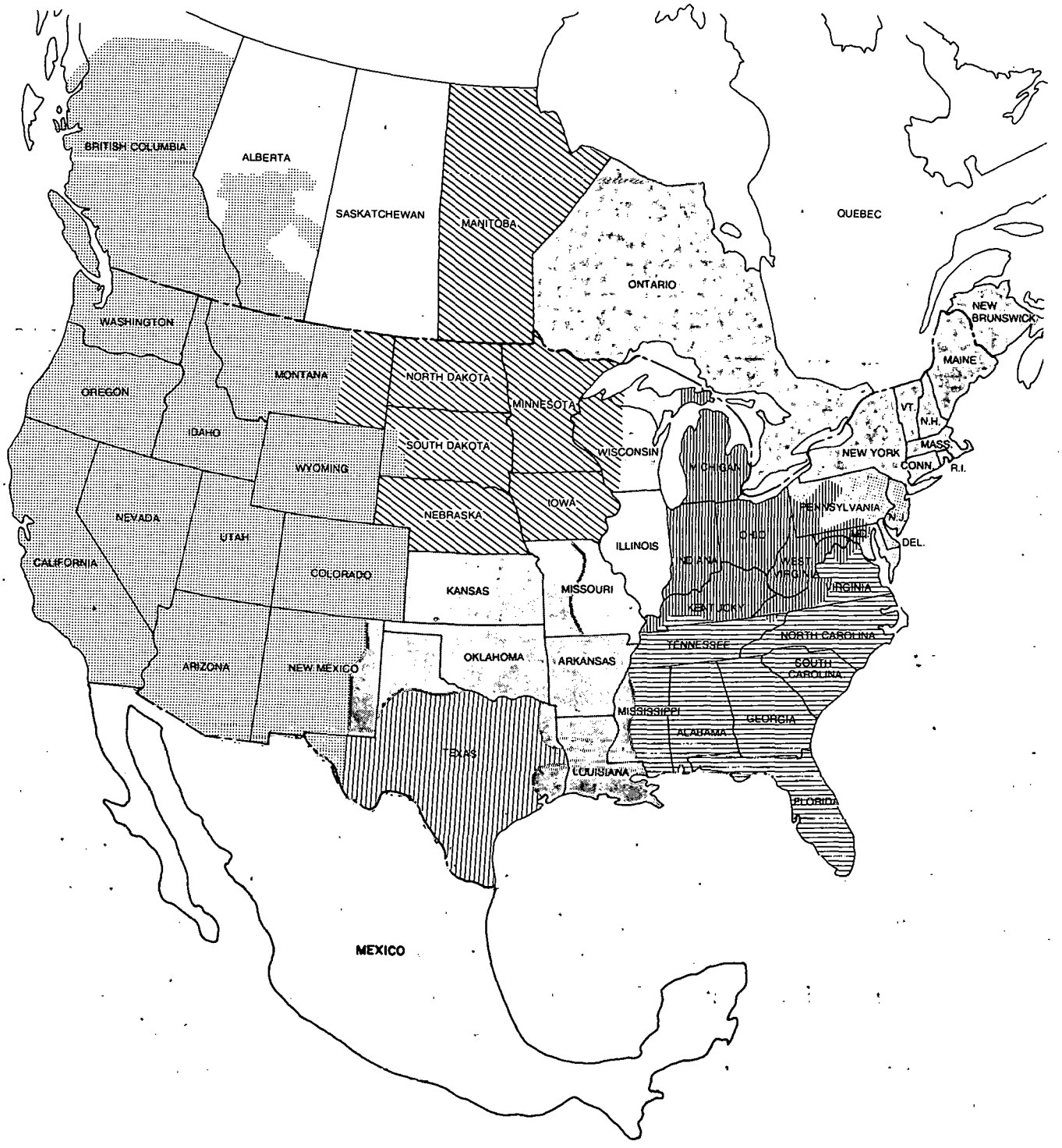
Reliability councils have been established to ensure adequate coordination in a region from both the adequacy and a reliability viewpoint. In some cases, the councils are comprised of individual organizations, in others, one or more power pools exist within a council. These councils have no planning or operating responsibilities, but rather assess plans and operating procedures to make sure they are satisfactory. The United States is covered by nine reliability councils as shown in Figure 3.1.

The National Electric Reliability Council (NERC) is composed of representatives from each of the nine regional councils. Its main function is to achieve the necessary interregional coordination. It also takes national positions when reliability and adequacy are involved. NERC periodically makes reliability reviews of each of the regions to ensure overall NERC compliance. This is an important role since deficiencies in one system can cause serious interruptions in the adjoining systems.

The reliability councils and NERC provide data banks for use in regional planning and operating studies.

FIGURE 3.1

NATIONAL ELECTRIC RELIABILITY COUNCIL



Trade associations such as the Edison Electric Institute, and the National Electrical Manufacturers Association are affiliations of power system enterprises established to exchange experiences and to enable a coordinated approach to common problems. Attendance at meetings and technical sessions is usually limited to representatives from member companies. They provide a mechanism for frank and vigorous discussion of problems, e.g., poor performance of a specific type of equipment.

There are many professional societies and periodic technical conferences in the United States. Power system engineers join and participate in these activities as individuals and not as representatives of their employers or the organizations. The main function of these organizations of individuals is to provide a forum for the discussion of new methods, new technology, and experiences. Typical among these are the Institute of Electrical and Electronics Engineers (IEEE), American Society of Mechanical Engineers (ASME), the International Conference on Large High Voltage Electric Systems (CIGRE), and the American Power Conference.

The setting of equipment standards in the United States is a cooperative effort, with NEMA, IEEE, ASME, and CIGRE among those playing important roles. The American National Standards Institute (ANSI) and the American Society for Testing Material (ASTM) also play key roles.

Significant electric system research efforts are currently underway in the United States. These are being conducted by the Electric Power Research Institute, the DOE, and many individual organizations.

THE UNITED STATES BULK POWER NETWORK

The United States power supply system is comprised of about 3,400 separate electric utilities, coordinating groups and federal agencies operating in three major networks. These networks are: the Eastern System, extending from the east coast to the Rocky Mountain states; the WSCC System, extending from the west coast to the separation with the Eastern System; and the ERCOT system in Texas. These systems are shown diagramatically in Figures 3.2 and 3.3 along with the CFE system. The interconnections between systems and areas have grown because of economic factors.

The size and type of interconnections required between geographic areas depend on the size and characteristics of the areas, particularly the maximum sizes and units of plants. Many different types and sizes of generating units exist in the United States today and are planned for future installation. Maximum size generating units and plants existing and planned are:

	Existing	Planned
Maximum Unit Size (MW)		
Eastern System	1300	1300
WSCC	1130	1270
ERCOT	775	1250
Maximum Plant Size (MW)		
Eastern System	3201	5976
WSCC	4900	5976
ERCOT	2517	2517

FIGURE 3.2
SYNCHRONOUS SYSTEMS IN NORTH AMERICA
SUMMER PEAK
(ALL DATA GIVEN IN GW)

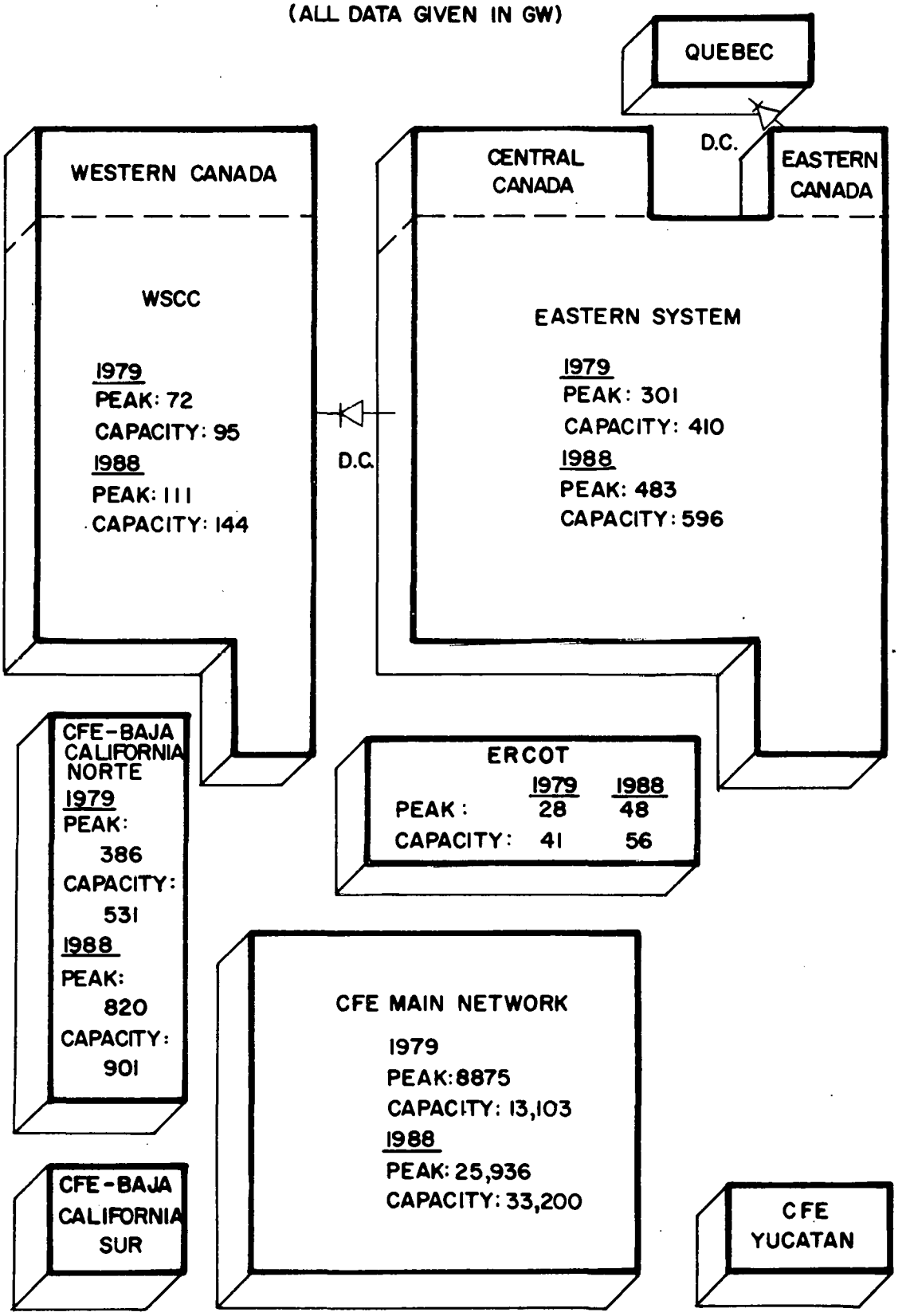
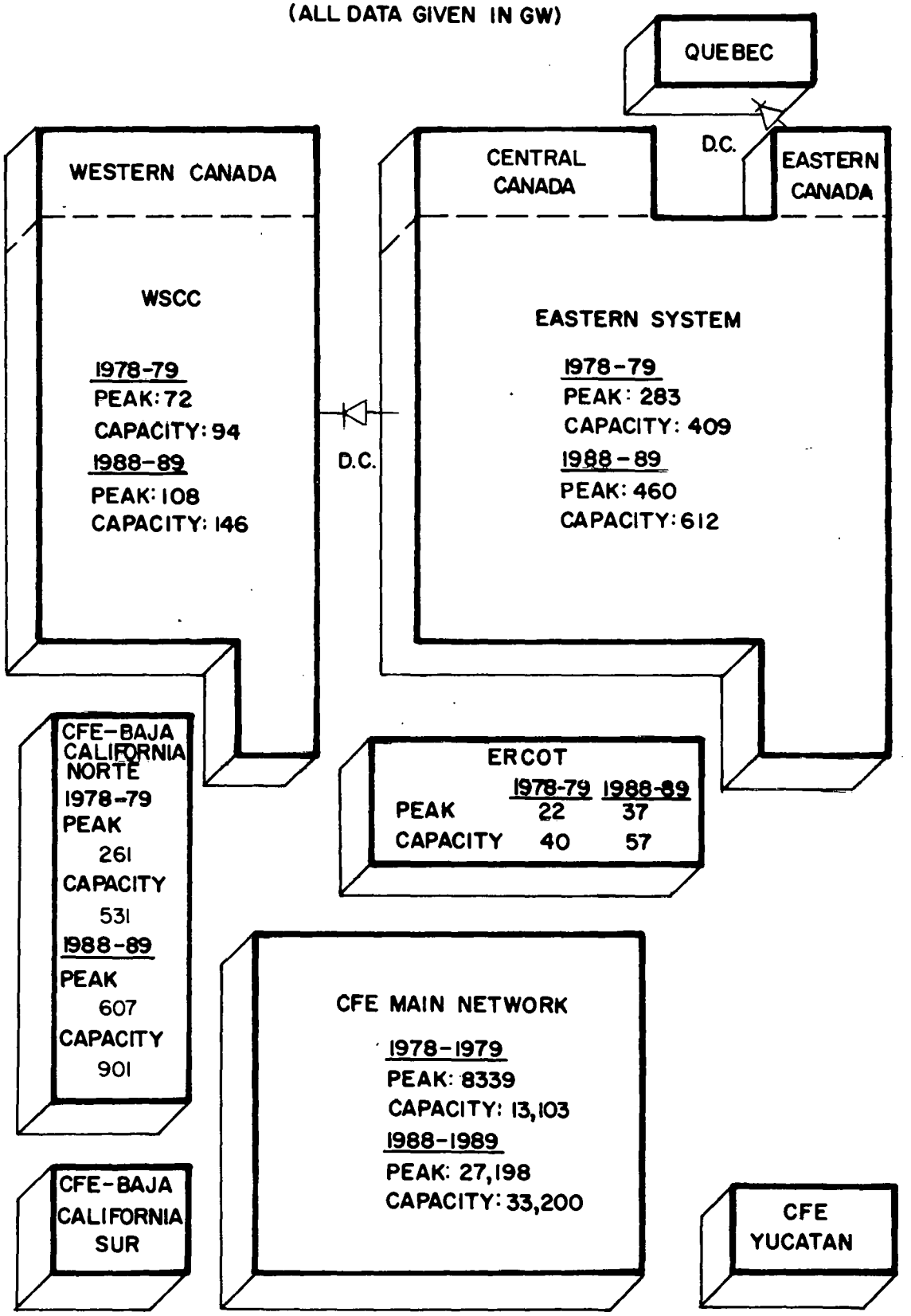


FIGURE 3.3
SYNCHRONOUS SYSTEMS IN NORTH AMERICA
WINTER PEAK
(ALL DATA GIVEN IN GW)



In 1978, national electric energy production was divided among the principal sources as follows:

	Percent of Energy Produced (1978)
Oil	13.5
Gas	14.7
Coal	47.8
Hydroelectric	12.5
Nuclear	11.4

Fuel use varies considerably, however, among the regions. Figure 2.7 shows the existing use of fuel in the regions bordering Mexico. In California and Texas, oil and gas are the predominant fuels for electric generation. In Arizona and New Mexico, coal predominates. Future plans call for a reduction in the use of oil and natural gas in the electric utility sector by one million barrels per day by 1990.

Areas of high population density are most prevalent in the eastern half of the United States, particularly on the eastern seaboard. As a consequence, most eastern utilities evolved close-knit transmission systems. Transmission distances from generation to the load center seldom exceed 100 km (60 miles). Therefore, most transmission system capability is determined by conductor thermal limits and allowable bus short circuit duties. An exception occurs in the Midwest (e.g., in the states of Indiana, Ohio, Illinois) where transmission distances may reach 350 km (200 miles). Here transmission system capability is often limited by the ability to maintain adequate voltages during emergencies.

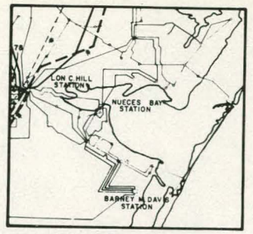
In the WSCC System, there are relatively few high density load centers and sources of generation are generally remote from the load centers.

Thus, transmission distances often exceed 160 km (100 miles) and western systems for many years were not highly interconnected. Because of the relatively long transmission distances, western transmission system capability is primarly determined by voltage or system stability limitations.

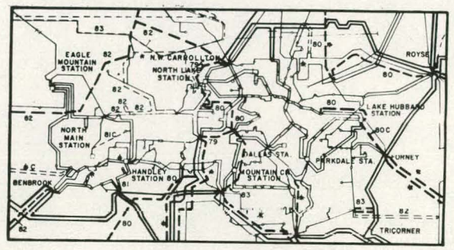
The Pacific Intertie, consisting of 1418 km (851 miles) of ± 400 kV DC line from the Columbia River in Washington to Los Angeles, operates in parallel with two 1418 km (851 miles) of 500 kV AC lines. In the past, oscillations have occurred which have caused various AC ties to open. As a result power system stabilizers were installed on nearly all generating units. These stabilizers which provide supplemental generator field control, have proved effective in solving this problem.

The ERCOT trunk transmission network consists principally of a 345 kV network which links the load centers of South Texas with those of North Texas. Most transmission lines are double circuit, with two circuits on each tower line. Generally, voltage or system stability conditions limit power transfers because of the long transmission distances. The ERCOT transmission network is shown in Figure 3.4 and a detailed description is given in Appendix C.

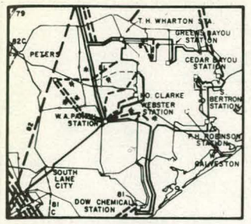
The southern portion of the WSCC transmission network is shown in Figure 3.5. The trunk transmission system is 500 kV, supplemented by some 345 kV and a significant amount of 230 kV. Line capacities are usually constrained by voltage or system stability limitations. A detailed description of the WSCC system is given in Appendix D.



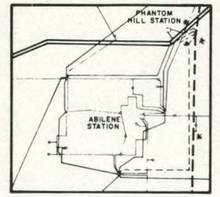
CORPUS CHRISTI AREA INSERT



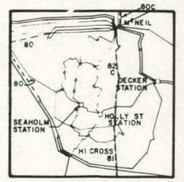
FT. WORTH – DALLAS AREA INSERT



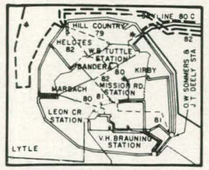
HOUSTON AREA INSERT



ABILENE AREA INSERT



AUSTIN AREA INSERT



SAN ANTONIO AREA INSERT

LEGEND

345 KV	In Service	Future
138 KV	In Service	Future
69 KV	In Service	Future
Generating Station	In Service	Future
Substation	*	C - To Be Converted
Change of Ownership		

SCALE IN MILES 0 15 30 45 60

MAJOR TRANSMISSION NETWORK OF INTERCONNECTED SYSTEMS IN TEXAS PROPOSED 1979-1988 ADDITIONS
(FOR SYSTEM PLANNING PURPOSES ONLY)

JANUARY 30, 1979

NOTE:
1. YEAR ADJACENT TO LINE INDICATES FIRST PEAK LOAD SEASON FOR WHICH LINE IS AVAILABLE.
2. ASTERISK (*) INDICATES IN-SERVICE DATES 1984-1988
3. LINE CURRENTLY NOT REPRESENTED IN TIS INTRASTATE STUDIES, BUT IS INCLUDED BY CPL IN ITS PREFERRED PLAN FOR INTERSTATE OPERATION
5. LINE CURRENTLY NOT REPRESENTED IN TIS INTRASTATE STUDIES, BUT IS INCLUDED BY WTU IN ITS PREFERRED PLAN FOR INTERSTATE OPERATION
6. LINE SHOWN IN A LATER YEAR IN TIS INTRASTATE STUDIES, BUT IS INCLUDED IN 1982 BY WTU IN ITS PREFERRED PLAN FOR INTERSTATE OPERATION

FIGURE 3.4
PRESENT AND FUTURE ERCOT TRANSMISSION NETWORK

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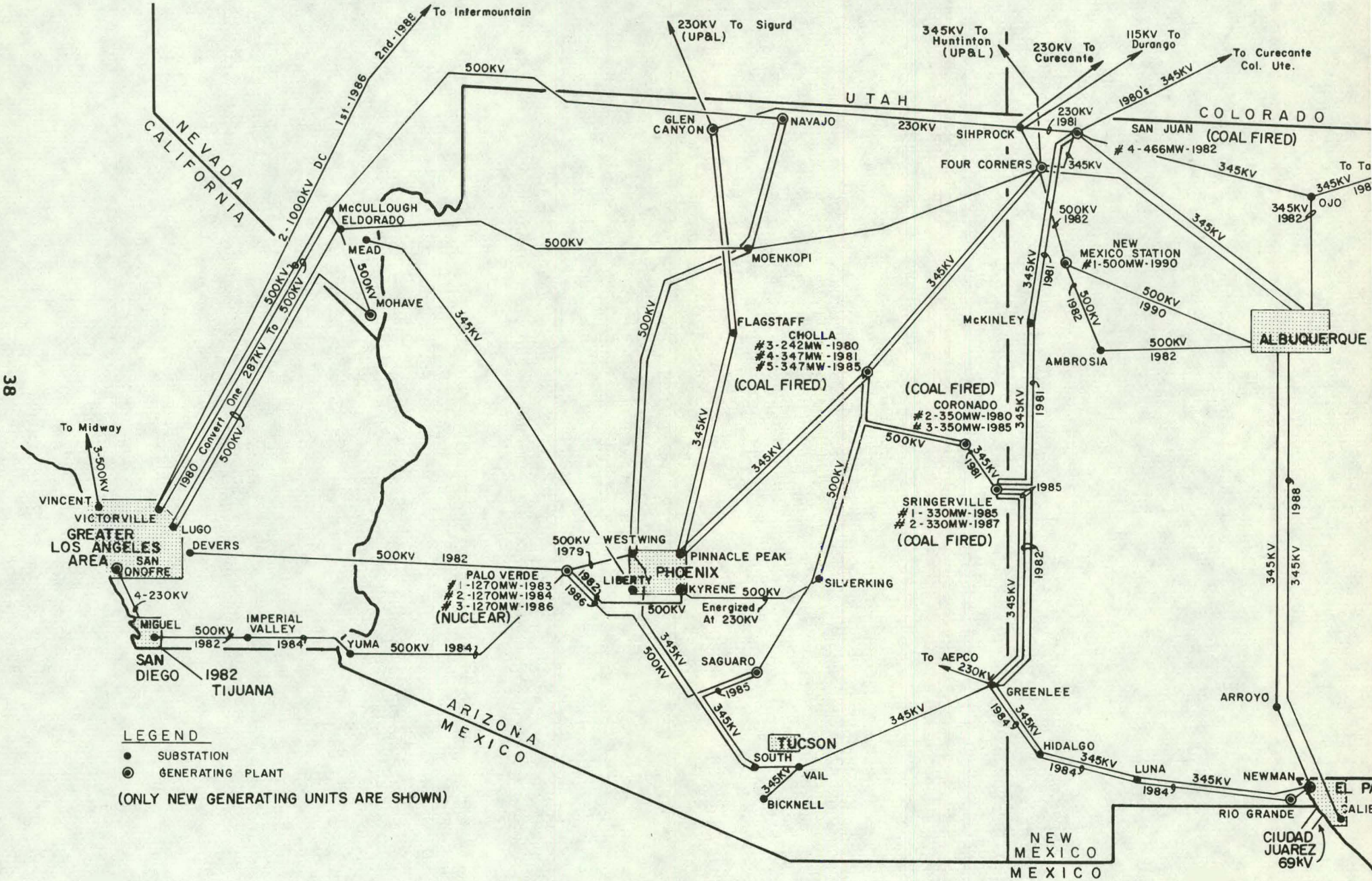
FIGURE 3.5

PRESENT AND FUTURE SOUTHERN CALIFORNIA - ARIZONA - NEW MEXICO BULK TRANSMISSION NETWORK



OPERATING PROCEDURES

Each individual electric system is responsible for the operation of its own facilities. In cases where systems are owned by a holding company, the holding company may have a centralized dispatch center and control operation of the subsidiaries.

When systems are members of a power pool, a regional control center is usually established. The responsibilities given this center vary from a maximum absolute control of operations to a minimum of routine information exchange. Overall coordination of operations is provided by the North American Power System Interconnection Committee (NAPSIC), the operating committee of NERC.

The regional reliability councils have no direct operating responsibilities. They do provide, however, basic policies and criteria to be used in operations. Among the critera covered are:

- Operating procedures to protect against potential cascading outages.
- Spinning and ready reserve definitions and obligations.
- Area control obligations.

In some systems, computers are "on-line" continually monitoring system conditions, checking for potential contingencies, and alerting system operators so they can take corrective action to eliminate potential hazards. In other systems, computers are used "off-line" to check system conditions anticipated in the future and to calculate safe operating limits.

Communications networks consisting of microwave, telephone circuits, carrier or pilot-wire facilities are utilized to obtain necessary data from other locations and to issue operational instructions.

The operating personnel are responsible for the economic operation of their systems and the prevention of interruptions of service. Their function includes deciding which generator units to operate, and at what loading, the power sales or purchases to make, and the safe loading limits for the transmission system.

In ERCOT, there are two coordination centers, one in North Texas and the other in South Texas, which coordinate the operation of eight major individual company dispatching areas. In each dispatching area, generation is scheduled to satisfy load with scheduled interchanges being quite small.

WSCC operations are based predominantly on individual company dispatch with interchanges scheduled and coordinated through company to company procedures.

Automatic control of the individual generators to maintain proper frequency and to control power flow on interconnection lines is generally provided by an area or zone basis. There are more than 110 control zones in the United States controlling the transfer of power to neighboring zones at scheduled values.

WSCC has four control areas, two of which border on Mexico: one is the California-Nevada control area; the other is the Arizona-New Mexico control area. In ERCOT, control is by individual companies resulting in eight principal control areas with four subareas within the principal control areas.

The first operating step in the event of power supply capacity shortage is usually to reduce load by reducing voltage. This is usually followed by radio and television appeals to consumers to reduce the use of electricity. If the situation becomes serious enough, their operators may manually disconnect loads. In order to provide for highly improbable situations which develop rapidly, the systems of the United States are generally are equipped with underfrequency relays which disconnect load as frequency declines to prevent complete system shutdowns. As an example, the load may be disconnected in three steps such as 10 percent at 50.4 Herz, 10 percent at 58.9 Herz, and 10 percent at 58.5 Herz.

BULK SYSTEM EXPANSION PROCEDURES

Individual companies and organizations plan and operate electric power systems in the United States in specific service areas. The basic approach has been for the planning engineers to find the best overall technical and economic solutions regardless of corporate or organizational boundary lines; then to work out arrangements for equitably allocating the resulting savings from this overall optimization to the individual organizations. After the allocation of the savings, the obligations of each of the enterprises to pay for the cost of the projects are then determined. This approach has led to a geographic optimization which has worked well and also provided full consideration for individual local and regional requirements.

Planning of the United States systems usually takes place in two steps. First, a general long-range program, usually in the order of 15 to 50 years, is developed by each of the organizations considering the important parameters that exist in their particular company or region. These recommended programs outline the best

long-range direction to follow, both as to size and type of generating units, their general location, choice of fuel and projected price trends, transmission voltages to be used, role of new technology, and expected social and economic changes. They then provide the basis for the second step: the development of specific plans.

The usual planning period in the United States for developing specific plans for which commitments are made and projects are initiated is 10 to 15 years for generation and 5 to 10 years for transmission. The reason for these long lead times is the time required for the necessary regulatory and governmental procedures and approvals, including numerous public hearings and discussions.

Plans developed by individual companies are usually coordinated through a review by appropriate committees of the power pools and reliability councils of which they are members. Plans are also submitted to the Federal Government and State and local governments for review and approval.

The first step in preparing specific plans for the future is the making of load forecasts. These load forecasts provide estimates for the system as a whole, including the estimation of peak power loads and energy requirements for the next 10 to 15 years.

Monthly peak load and energy forecasts are also usually made for the system. These loads are then allocated to the various geographic areas and substations based on detailed analysis of load growth in each distribution, subtransmission, and transmission area.

In making these load forecasts, a large number of factors must be considered. Among the most important are the effects of new technologies such as solar energy, environmental constraints, fuel availability, conservation effects, and price trends on the growth and use of electricity as supplied from the bulk power system.

After each organization has made its load forecast, these forecasts are combined with those of the other organizations in joint planning studies considering the individual load characteristics. Combined loads are then determined considering the diversity among the organizations and, sometimes, regions, i.e., the difference between the sum of the separate peaks of the areas and their simultaneous combined peak.

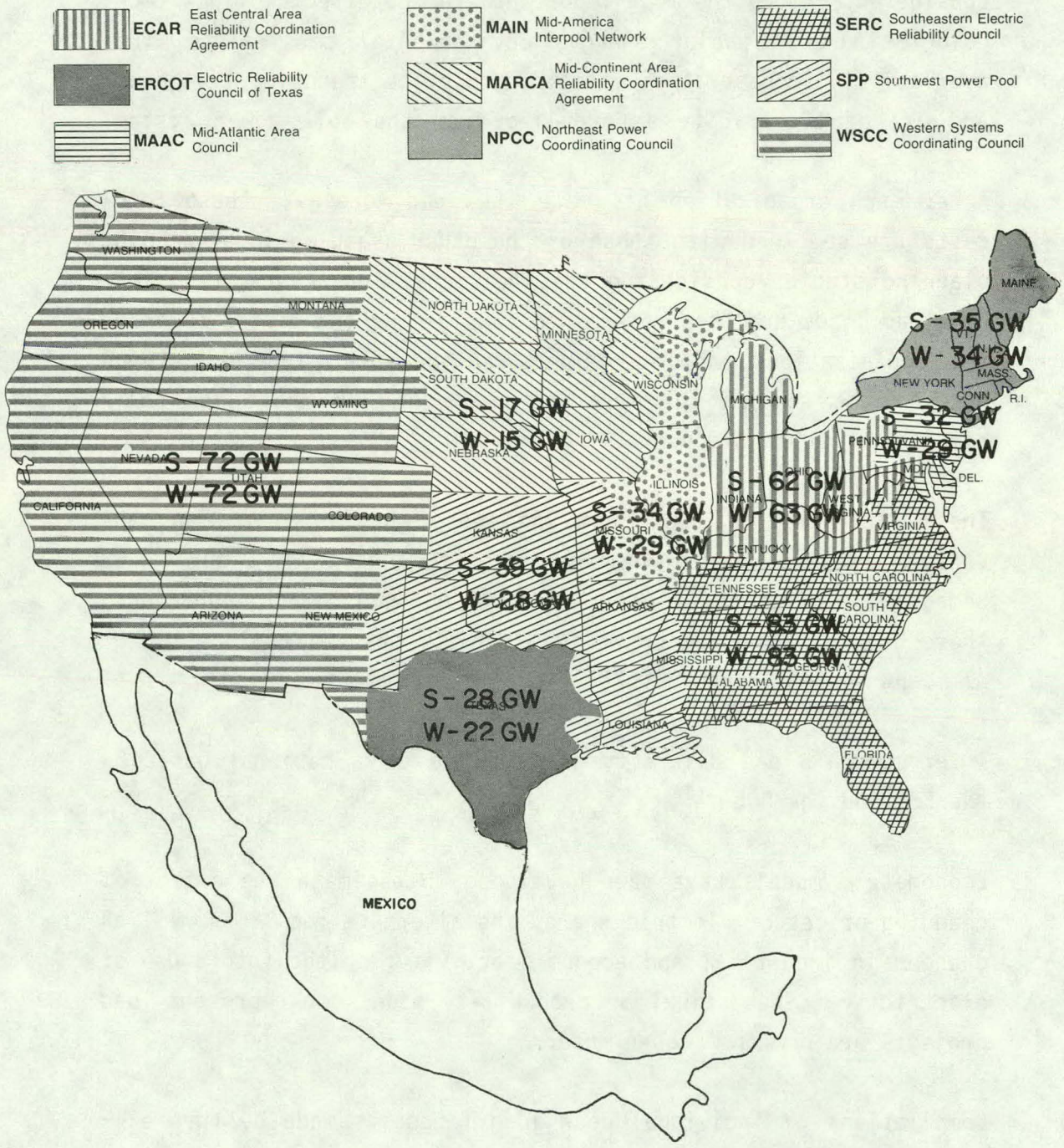
The distribution of peak load and energy requirements among the various regions of the United States is shown in Figure 3.6. Because the duration of peak loads can be from four to ten hours, there is little hourly or daily diversity between regions. Significant seasonal load diversity does exist in some cases.

Interregional load diversity is compiled on a national basis by the EEI and the DOE.

Econometric models have been developed to estimate the effect of changing prices of electric energy and alternate fuels, as well as changes in industrial and economic activity, on the future use of electricity. Statistical or probability models to represent load projects are now in frequent use.

Compilations of individual peak load forecasts made by the reliability councils and NERC indicate a United States national growth rate of 4.8 percent annually. (The Mexican forecast is 9.8 per-

FIGURE 3.6
REGIONAL PEAK LOADS (GW) - CONTIGUOUS UNITED STATES



S-SUMMER PEAK LOAD (CONTIGUOUS UNITED STATES 400 GW, ACTUAL 1979)
W-WINTER PEAK LOAD (CONTIGUOUS UNITED STATES 376 GW, ACTUAL 1978-79)

cent annual growth). Growth in the United States has been slowing down as a result of conservation efforts, increasing prices, and fuel shortages.

Load growth in ERCOT is estimated to average 5 percent annually in the future while the WSCC peak load growth estimate is 4.3 percent.

The next step in power system planning is usually to determine the total amount of capacity required. This is done by probability calculations which evaluate the possibilities of generator outages, emergency assistance available from neighboring utilities, and load forecast uncertainties. The usual reliability criteria used in planning generation is that the expected frequency of not being able to supply predicted loads should not be more than once in ten years. As a result, generation reserves of between 15 and 20 percent are usually specified.

After the amount of capacity required has been determined, optimum capacity mix studies are made. The economic evaluations consider many different types and sizes of generating units using different fuels. Both capital costs and operating costs (including fuel) are determined. Computer programs are usually used to calculate operating costs based on generator efficiencies and system load characteristics. Overall costs are evaluated on a present worth basis taking into account the time value of money. The economic evaluation is usually carried through a 30-year period. To reflect future availability and price of alternate fuels, the effect of future fuel costs on the optimum solution is also frequently determined.

After having determined the optimum mix and amount of capacity, the next step is to introduce into the planning process the real life constraints. For example: On siting, what is the seismology of the area? What are the estimated initial and future water supply conditions? What are the environmental and regulatory requirements? How will these affect the lead times utilized in making the plan? Are the needed capital funds available? What are the projected long-term supply and price conditions?

In WSCC a major generation planning constraint is the lack of sufficient acceptable generating station sites in the southern portion of the region, due mainly to environmental restrictions. In ERCOT, the future planning problems are mainly the result of the need to decrease the use of oil and gas and increase the use of alternate fuels for electric generation.

The transmission planning process is usually conducted in parallel with the generation planning process because frequently the optimum solution will depend on transmission considerations.

In the United States there are basically three main functions for the transmission system. One is to deliver energy from generating plants to the bulk power grid. The second is to supply the loads in substations in the service area of a particular company or region. The third is to interconnect the generating stations, substations, areas, organizations, and regions in a reliable grid. The transmission systems in the various parts of the country have different characteristics because of the differing load densities, and sizes, and types of generating units and stations.

There are no national uniform planning criteria for evaluating transient stability. Most systems provide for the worst type of

short-circuit at any one location, usually a fault on all three phases. Many also take into account the failure of breakers or first-line relays to operate. In these areas the limitations on circuit loading are typically those shown in Figure 3.7 which shows how transmission capacity is affected by transmission distances.

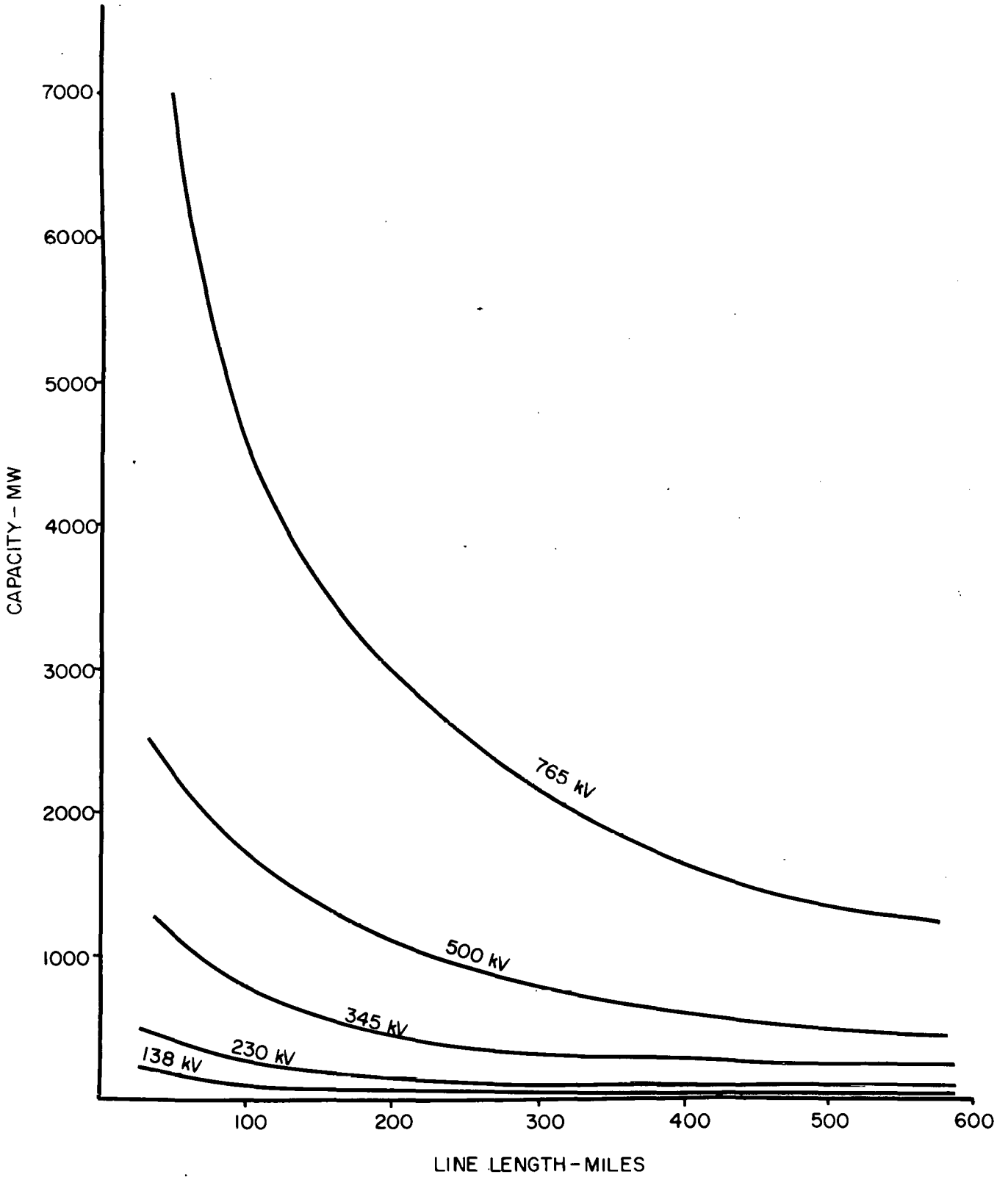
A major problem in developing new higher voltage networks and superimposing them on existing lower voltage networks is the appropriate relative loading, or paralleling, between the two networks. The general procedure in the United States is to maintain the lower voltage intersystem ties when new higher voltage ties are added. In cases where problems might exist, the lower voltage networks are either split or reinforced or, in a few cases, phase-angle regulators are being installed to control power flows.

Definitions for the measurement and assessment of interregional transmission capabilities have been developed by NERC and are in use by all regions. As yet, no national criteria have been approved to set minimum limits on these transmission capabilities.

Interconnections between utilities are installed whenever this is the optimum economic solution for meeting adequacy and reliability requirements. Interregional transmission capabilities in the United States generally are estimated to be in the order of 5 percent to 10 percent of the load in a region. Transregional capability also is provided, generally in the order of about 5 percent, through the normal design of the network. This transregional capability allows shipment of power between two noncontiguous regions through other regions.

FIGURE 3.7

TYPICAL MAXIMUM CIRCUIT LOADINGS IN GEOGRAPHIC AREAS WHERE STABILITY AND VOLTAGE CONDITIONS LIMIT



TYPES OF INTERCONNECTION ARRANGEMENTS

In the United States joint projects, interconnections, or operating arrangements are usually studied by the appropriate planning and operating staff personnel who make their recommendations to their superiors. After appropriate review and discussion, corporate or system approval is obtained.

In general, Federal, State and occasionally local government approvals are required of inter-utility contractual agreements as discussed in other sections of this report.

In the sale or purchase of capacity and energy, many different arrangements are used in inter-utility contracts in the United States. Among these are:

- Reserve Sharing: Agreements for mutual generation support so that new power plant requirements are decreased.

- Diversity Exchanges: Non-coincident peak loads which allow utilities to "share" generation and realize economic benefits.

- Purchase of Capacity:
  - Firm Capacity
  - Share of a specific unit
  - Emergency capacity.

- Surplus Energy Sales: The existence of secondary markets (including storage) to utilize energy from renewable resources that would otherwise be wasted (e.g., run-of-river hydro and, in the future, tidal and wind).

- Economy Interchange: The interchange of electricity, between two utilities, which takes place when the exchange will result in a reduction in costs to the consumers in both utilities' areas.

- Transmission Service (Wheeling): The transport of capacity and/or energy by an intervening party between a supplier and a receiver.

- Coordinated Operation Agreement: Cooperation between utilities, principally in generation facility planning, operation, and maintenance, to reduce investment requirements and plan maintenance outages such that system operations are optimized.

INTERNATIONAL TRANSMISSION LINE AND ELECTRIC POWER EXPORT AUTHORIZATION

The Economic Regulatory Administration (ERA) of the United States Department of Energy has the responsibility for authorizing the construction of international electric power lines and issuing authorization for electric exports.

A Presidential Permit is required to build electric power lines from the United States to any other country. This permit is issued by the Administrator of the ERA. Appendix B provides a summary of the United States Federal authorization procedures.

A Federal environmental impact statement will usually be prepared and made available to the public and other governmental agencies. Following the publishing of the final environmental impact statement, the Council on Environmental Quality reviews the total

process for compliance with the National Environmental Policy Act. Other federal approvals may be necessary regarding use of wetlands, flood plains, wildlife habitats, and water crossings. The final environmental decision, however, is the responsibility of ERA.

Section 202(e) of the Federal Power Act provides statutory authority for the DOE to approve the export of electricity unless the export will endanger the supply of electric power or will impede or tend to impede the coordination among electric utilities in the United States. This authority extends to regulatory control of the terms and conditions of the export. No control is provided over electricity imports except for that associated with the Presidential Permit.

Currently, ERA requires that the United States utility negotiate a satisfactory contract with the foreign utility and then make this contract available for public review.

4. MEXICAN ELECTRICAL SYSTEM

ORGANIZATIONAL AND INSTITUTIONAL STRUCTURE

The Comision Federal de Electricidad (CFE) is a decentralized organization within the Mexican Federal Government that was created to provide electrical service in Mexico. This electrical service consists of:

- Planning the national electric system.
- Generation, transmission, transformation, distribution and sale of electric energy.
- Carrying out all works, installations and undertakings associated with planning, construction, operation, and maintenance of the national electric system.

It is also the responsibility of CFE:

- To export and import electric energy.
- To promote national scientific and technological research in electrical matters.
- To promote the national development and manufacture of equipment and materials useful to the electric power system.
- To carry out the operations and actions, and enter into contracts which may be necessary for the fulfillment of its functions.

CFE operations are under the responsibility of the Secretaria de Patrimonio y Fomento Industrial (Secretary for National Property and Industrial Promotion). The operation, investment and financial programs required for CFE in the short, mid and long-term, after approval by the Secretaria de Patriomonio y Fomento Industrial must also be approved by the Secretaria de Programacion y Presupuesto, (Secretary for Planning and Budgeting), and Secretaria de Hacienda y Credito Publico (Secretary for Treasury and Finance). The general organization of CFE is shown in Figure 4.1.

NATIONAL ENERGY SITUATION

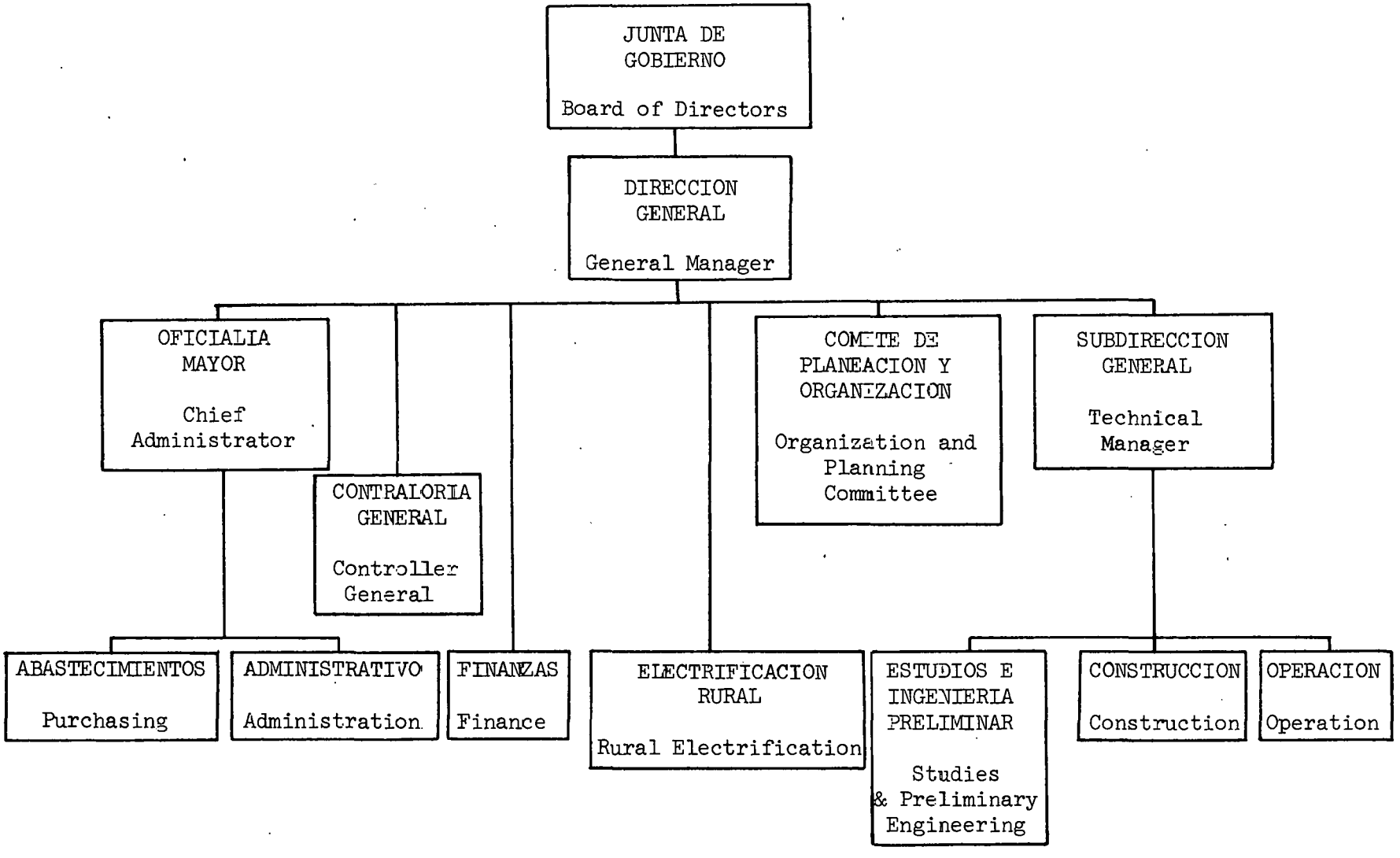
Energy is one of the fundamental bases for the development of the country. The present administration has placed energy among its policy priorities. In organizational structure the Secretaria de Patrimonio y Fomento Industrial has the role of coordinator of the energy sector. Its functions include the control and supervision of the sector, and in particular, the application of the energy policies.

The Mexican energy situation has the following main features:

- energy self-sufficiency.
- development and exploitation of energy sources by state enterprises.
- the preponderance (almost 90 percent) of oil and gas in the energy balance.

FIGURE 4.1

COMISION FEDERAL DE ELECTRICIDAD
ORGANIGRAMA ESTRUCTURAL
Organization



- high rate of growth of demand.

The national policy is aimed at conserving the advantageous features and at slowly modifying those which can be improved in order to better respond to new situations.

Energy self-sufficiency is fundamental to assure the development of the country; independence constitutes the major objective of many nations' energy policies. Fortunately, studies show that Mexico will be able to maintain this characteristic for many decades and may even export certain amounts of oil and gas. However, export ceases to be an objective related merely to energy and becomes a matter of general economic policy.

The role of the Government in the energy supply sector is to facilitate the compliance in the operation of the sector with the general interest of the country.

Even though Mexico has considerable hydrocarbon reserves, overdependence on them is not considered appropriate, therefore the country has placed diversification among the energy policy priorities. The electric sector is the most flexible candidate for diversification of its primary energy sources; the following specific measures have been taken in the last few years:

- In 1973 the first commercial geothermal plant was put into service. It has an installed capacity of 150 MW and is being enlarged to attain a capacity of 500 MW in the near future.

- A nuclear power plant is under construction in Laguna Verde, Veracruz, with an initial capacity of 1303 MW.

The first unit of 654 MW will be in operation in 1982 and the second in 1983.

- In Rio Escondido, Coahuila, a coal burning plant is under construction, comprising four 300 MW units, for a total capacity of 1,200 MW. The first unit will be in service in 1982; the other units will follow in six month intervals. (See Figure 4.2)

- Future electric power development includes the addition of new units of the types mentioned above and, in addition, hydroelectric capacity will be developed to the maximum extent possible.

The high growth rate of energy demand reflects the industrialization process required to cope with a high population growth and a concomitant increase of living standard. The Secretaria de Patrimonio y Fomento Industrial has established an Industrial Development Plan which was approved and put in effect by Presidente Lopez Portillo in early 1979. This plan has energy and particularly hydrocarbons as its main leverage, both because of revenues from exports and because of the availabilities and subsidies of fuels and electricity offered to industries that are willing to locate themselves in the priority areas earmarked for development. With this plan, Mexico expects to achieve a GNP growth rate of about 10 percent during the eighties.

Seen in the light of the previous paragraph, the expected high rate of growth of energy demand may seem justified. However, it is believed that the efficient use of energy could reduce the rate of growth of demand without hampering the increase in the standard of living. Several studies are under way to analyze improvements

in energy efficiency mainly in the industrial and transport sectors.

In addition to the points made previously about energy policy, the inclusion in the future of new sources of energy is being considered as they develop and become economically feasible. In this respect, some research and development activities in the field of renewable energy are under way.

DESCRIPTION OF THE CFE BULK SUPPLY NETWORK

The CFE national network, shown in Figure 4.2, is operated as a single synchronized system with the exception of relatively small and remote systems which are operated on an isolated basis in the Baja California and Yucatan areas. The 400 kV backbone transmission system substantially covers the whole nation. Significant additional transmission at 230 kV and 115 kV also exists. The Northeastern transmission system in Mexico, however, is considerably stronger than the Northwestern systems. Due to the great distances between load center and substations, transmission capacity is generally limited by steady-state stability. The CFE national network is divided into a number of regions for administration of generation, transmission, and distribution. The regions that are adjacent to the United States are Baja California, Noroeste, Norte, and Noreste.

The Baja California Norte region is not connected to the main national network. This area of 1,220 square kilometers (470 square miles) has a population of 1.5 million. CFE has three generating plants in the region with a total capacity of 531 MW and transmission network of 230-KV, 161-KV, and 69-KV lines. Extensive geothermal resources exist in the Baja California region and are in the process of being developed.

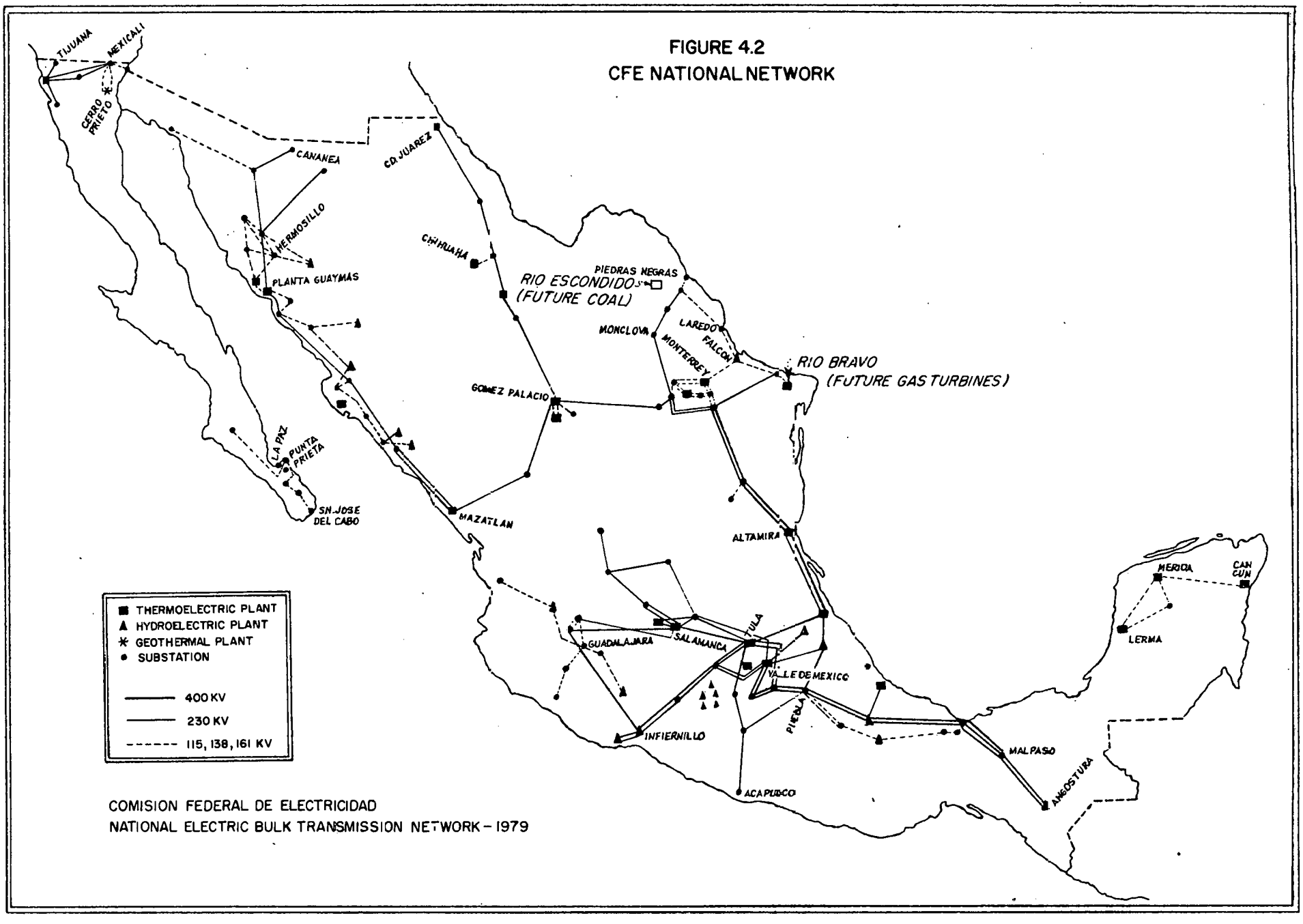


FIGURE 4.2
CFE NATIONAL NETWORK
TIJUANA
MEXICALI
CERRO PRIETO
CANANEA
CD. JUAREZ
HERMOSILLO
CHIHUAHA
PLANTA GUAYMAS
PIEDRAS NEGRAS
RIO ESCONDIDO
(FUTURE COAL)
MONCLOVA
LAREDO
FALCON
MONTERREY
RIO BRAVO
(FUTURE GAS TURBINES)
GOMEZ PALACIO
LA PAZ
PUNTA PRIETA
SN. JOSE DEL CABO
MAZATLAN
ALTAMIRA
MERIDA
CAN CUN
LERMA
GUADALAJARA
SALAMANCA
TULA
VALLE DE MEXICO
PUEBLA
INFIERNILLO
MALPASO
ACAPULCO
ANGOSTURA
THERMOELECTRIC PLANT
HYDROELECTRIC PLANT
GEOTHERMAL PLANT
SUBSTATION
400 KV
230 KV
115, 138, 161 KV
COMISION FEDERAL DE ELECTRICIDAD
NATIONAL ELECTRIC BULK TRANSMISSION NETWORK - 1979

National peak load and energy requirements for 1979, 1985, and 1990 are given in Table 4.1. The forecasted annual peak load growth is 9.8 percent. To meet this growth the addition of about 18,700 MW of generating capacity is planned by 1990, a very significant expansion since it results in more than doubling the present system capacity. Figure 4.3 shows the various CFE operating regions and their summer peak loads for the border regions.

MAXIMUM SIZES OF UNITS AND PLANTS

Maximum generator unit and generating plant sizes on the system are:

	Baja California		Noroeste		Norte	
	Existing	Planned	Existing	Planned	Existing	Planned
Maximum unit size	82	82	150	300	100	150
Maximum plant size	307	307	300	900	280	300

	Noreste		Rest of Nation	
	Existing	Planned	Existing	Planned
Maximum unit size	150	300	300	654
Maximum plant size	900	1200	1200	1500

TIE LINE AND FREQUENCY CONTROLS

At present only two generating plants in Mexico are equipped with automatic controls that vary output with frequency and/or tie line loadings. Both of these generating plants are in the geographic area adjacent to the ERCOT system. Normally, these controls are

TABLE 4.1

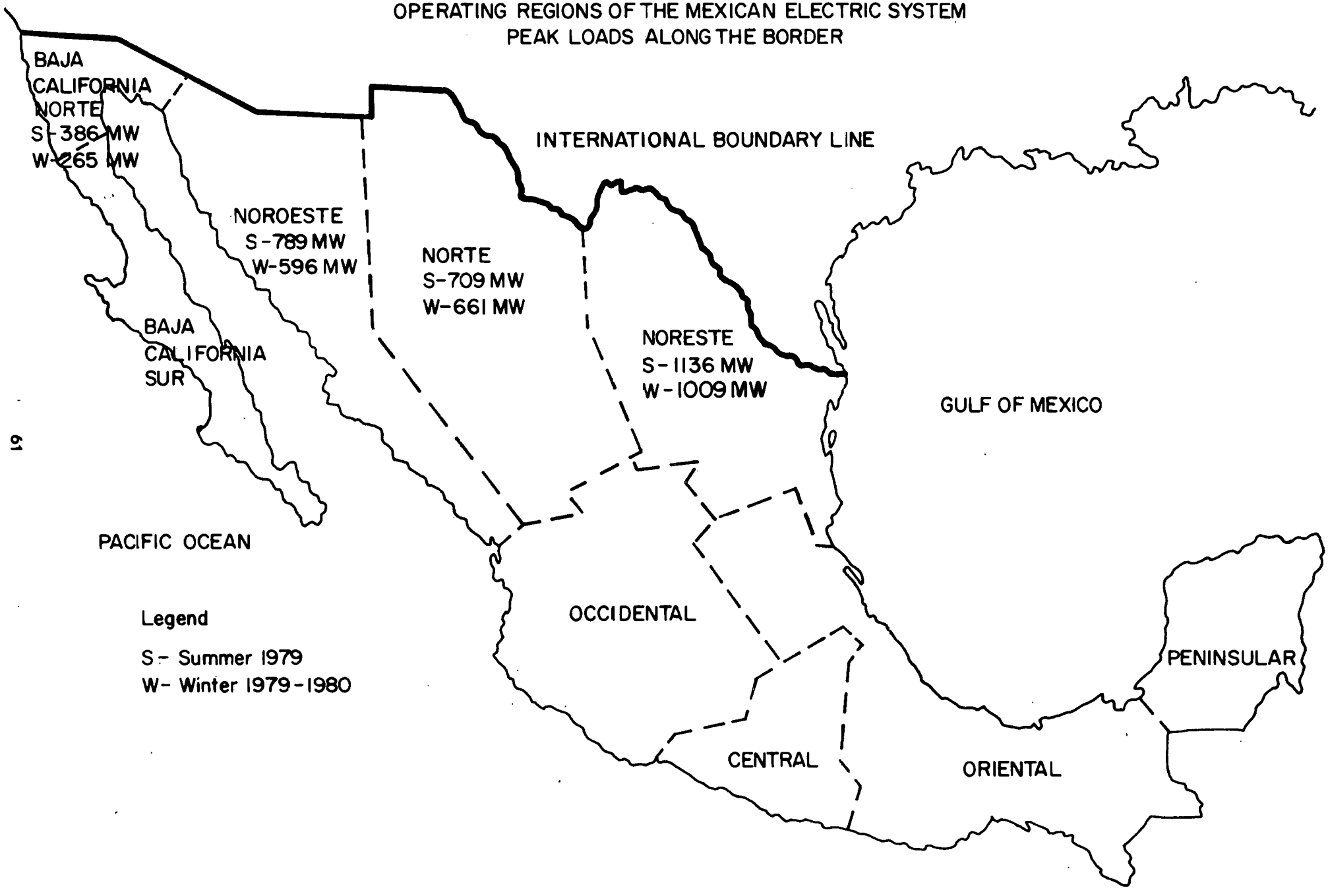
MEXICAN PEAK LOAD FORECAST (MW)

National	1979	1985	1990	Growth Rate %
Low	-	17,600	26,500	8.5
Most Likely	9,633	19,400	30,600	9.8
High	-	19,750	32,300	10.3

MEXICAN ENERGY FORECAST (GWH)

National	1979	1985	1990	Growth Rate %
Low	-	96,500	145,800	8.8
Most Likely	58,070	106,300	168,500	10.1
High	-	108,300	177,600	10.6

FIGURE 4.3
OPERATING REGIONS OF THE MEXICAN ELECTRIC SYSTEM
PEAK LOADS ALONG THE BORDER



not in operation, but are placed in operation whenever the interconnections with ERCOT are closed.

CFE has embarked on a program for equipping all its generating units with tie line and frequency controls. By 1982 this program is expected to be completed. The main CFE system will be operated in six control areas. Baja California and Yucatan are two additional control areas. Of the main integrated network, the three control areas adjacent to the United States are the Noroeste area, the Norte area, and the Noreste area. (See Figure 2.2)

PLANNING PROCEDURES

CFE is the only organization responsible for planning of the electrical system in Mexico. Resources, generation, and main transmission planning are handled by Central Office personnel.

The regional and local centers are responsible for planning subtransmission installations and distribution in coordination with the Central Office. Expansion of the system is based on the optimization of the total system. This integrated planning is founded on a structure of mathematical models. Realizing that there is a very complex problem involved, this is solved through the mathematical decomposition by means of time stages (long, medium and short terms), geographical integration (national and regional node networks) and complemented by global and marginal analysis. The planning scheme is aimed at minimizing the expected investment and operational costs, which are updated and subject to the technical and economic restrictions that usually arise in large interconnected systems with thermal and hydro plants. The mathematical models are based on techniques of optimum control, linear pro-

gramming, and simulation, paying particular attention to the treatment of the important random variables.

The load forecasting for the electrical systems of Mexico uses two main procedures, depending on whether it refers to the medium or long term. For the medium term, an autonomous model is used in which time is an independent variable, and the loads are divided by type (emphasizing the industrial loads). This has been found convenient since in the industrial field, in particular, demand forecasting must be made on the basis of development programs which include the various projects of new industries with the possibilities of their completion on given dates. Some new industrial projects have an electric power demand that could be very large in relation to the total demand of the system, which means that the program must be carried out by stages and not with a regular exponential curve as in the electrical systems of the industrialized countries.

In order to make the long term forecast, methods are used to relate electric power demand with population and the economic grow of the country.

GENERATION PLANNING

The general strategy of the generation system development is determined by a global one-node model, minimizing the present worth of investment and operating costs, plus the costs of load not supplied.

A discount rate specified by the Federal Government is used and the analysis covers a period that may last for several decades.

In general, present day costs are also used in the analyses. Linear programming is used to identify the best geographical location of thermal units, base load units, and peaking units, which must be installed in a given year, based on the available hydroelectric generation and demand at each load center.

As a result of these analyses, generation reserves of between 10 percent and 15 percent are usually installed.

TRANSMISSION PLANNING

With the locations determined for the hydroelectrical and thermal plants, several models are used for planning the required electrical network which take into account operational and reliability requirements for the system. For this reason, it is important to consider the probability of loss of every element in the network. Total costs are considered in decisions to install new transmission facilities, including costs for energy not supplied. Transmission facilities are only installed when justified on this economic basis.

UNDERFREQUENCY RELAYING

To provide for unusual emergencies during which system split-ups can occur, underfrequency load shedding relays have been provided in all regions, with shedding take place in four steps as follows:

59.0 herz. - 10 percent
58.8 herz. - 10 percent
58.6 herz. - 10 percent
58.4 herz. - 10 percent

OPERATING PROCEDURES

The National Control Center (CENACE) was created by the CFE to direct the operation of the country's electrical system. CENACE is charged with the operation of electrical installations and coordination with the management of other resources such as fuels and water.

The organizational structure of CENACE consists of a three tier hierarchy as follows:

Level	Administration by	Functional Responsibility
1	Executive Group	National Electrical System
2	Area Operation Groups	Regional Operation Areas
3	City Operation Groups	Distribution Areas

Level 1 - National Control Center

The national system is operated based on economy and security dispatch considering transmission limitations and the optimum use of water resources.

Responsibilities include overall management and coordination of the National System. Specific functions performed include:

(1) Daily, weekly, monthly, and yearly forecasts of energy required and peak demand.
(2) Studies of the bulk supply network.
(3) Generator unit schedules.
(4) System studies.
(5) Design and operation of national and regional control centers.

The performance of these specific functions requires network studies and economic analyses which detect any potential future for critical operating conditions requiring close monitoring or changes in operating arrangements.

Level 2 - Area Control Center

The Area Control Centers are responsible for the actual operation including system capacity. Specific functions performed are:

(1) Supervision of all transmission and subtransmission systems in specific areas.
(2) Maintenance of adequate voltage and reactive conditions.
(3) Operations planning.
(4) Maintenance of communication and control equipment.
(5) Evaluation of system performance.

There are eight such control centers.

Level 3 - Distribution

Local distribution centers are responsible for operation of distribution facilities in urban and rural areas.

The operating criteria used by CFE require provisions for any single contingency such as loss of any generator or any line. Such single contingencies do not include loss of a transmission tower line having two or more circuits. Spinning reserve policy calls for the provision of reserve equal to the capacity of the

largest unit. This reserve is distributed in the regions considering the security requirements of the network.

INTERNATIONAL TRANSMISSION AND ELECTRIC POWER IMPORT AND EXPORT AUTHORIZATION

In Mexico, both the import and export of electric power is under control of the Federal Government. (In the United States only the export is under Federal control). The approvals required are as follows:

(a) The Ministry of Patrimony and Industrial Development (Secretaria de Patrimonio y Fomento Industrial), pursuant to the Law of Public Service of Electric Energy and Regulations derived therefrom.

(b) The Ministry of Scheduling and Budget (Secretaria de Programacion y Presupuesto) relative to the investments representing the facilities for which CFE is responsible.

(c) The Ministry of Commerce (Secretaria de Comercio), pursuant to the Law of Public Service of Electric Energy and Regulations derived therefrom, relative to import and export of electric energy.

5. OPPORTUNITIES AND INCENTIVES

The reports from the Eastern and Western Region (Appendixes C and D) working groups indicate that there are a number of short-term and long-term electricity exchange opportunities between the United States and Mexico that merit further study. These opportunities range from the exchange of capacity and energy through to diversity in peak loads, to supplying loads in one country from the other country to help alleviate system capacity problems. These opportunities can result in mutual economic benefits and the conservation of scarce fuels.

LOAD DIVERSITY

When two electric utility systems operating in adjoining areas or in relative proximity experience their system peak load at different times, and agree to share resources, the combination of the systems can be supplied with less installed generating capacity than if the systems were operated independently. Such an arrangement results in the better use of the available generating resources in that more load is supplied by the highly efficient base load equipment. This shared generating concept brings economic benefits to both systems.

The data from the regional reports, summarized in Table 5.1 indicate that both the Eastern and Western regions in the United States have summer peaks due to the air-conditioning load in these very hot areas. Despite identical weather conditions along the Mexican border, the installation of air-conditioners is much less prevalent. This causes some diversity in peak loads, though the absolute quantity has not been determined.

TABLE 5.1

SUMMARY OF CHARACTERISTICS, NEEDS & CAPACITIES

	EASTERN REGION				WESTERN REGION					
	CFE		ERCOT		BAJA CALIFORNIA NORTE-SO. CALIFORNIA		NOROESTE-ARIZONA		NORTE-NEW MEXICO/WEST TEXAS	
LOADS	Noreste Area	Noreste Border Region*	Entire Region	C.P.L.	C.F.E.	U.S.A.	C.F.E.	U.S.A.	C.F.E.	U.S.A.
Present Peak Load MW	1,136 (1979)	414 (1979)	31,184 (1979)	2,335 (1979)	386 (1979)	18,411 (1979)	789 (1979)	5,729 (1979)	709 (1979)	1,602 (1979)
Load Characteristics										
Time of Peak	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer
Annual Load Factor %	74	55	55	64	55	57	60	56	69	65
Predominant Load Type	Industrial	Industrial	Mixture	Mixture	Residential	Mixture	Residential	Mixture	Industrial	Mixture
Rates of Growth %	13	13	5	5	7	3	10	5	6	6
Est. Future Peak MW	3,424 (1988)	1,300 (1988)	47,995 (1988)	3,682 (1988)	911 (1990)	26,307 (1990)	2,301 (1990)	9,615 (1990)	2,563 (1990)	3,163 (1990)
Energy Requirements GWH										A + B
Present	6,732 (1979)	2,000 (1979)	151,000 (1979)	13,000 (1979)	1,751 (1979)	102,317 (1978)	4,144 (1979)	A	4,529	B	37,387 (1978)
Est. 1988/1990	20,091 (1988)	5,000 (1988)	239,000 (1988)	20,000 (1988)	4,270 (1990)	141,910 (1988)	12,246 (1990)		12,600		76,377 (1988)
Capacities MW										
Generation-Present										
COAL & LIGNITE	0	0	8,005	0	0	2,526	0	2,945	0	629
NUCLEAR	0	0	0	0	0	436	0	0	0	0
OIL & GAS	794.5	112.5	32,526	2,976	381	15,676	691	3,268	689	1,173
HYDROELECTRIC	31.5	31.5	230							
GEOTHERMAL	0	0	0	-30	150	4,682	305	636	0	135
WASTE HEAT	0	0	182							
PURCHASES & SALES	0	0	0							
TOTAL	826.0 (1978)	144.0 (1978)	40,943 (1979)	2,946 (1979)	531 (1979)	23,320 (1979)	995 (1979)	6,829 (1979)	689 (1979)	1,937 (1979)
Generation-Planned 1988/1990										
COAL & LIGNITE	2,400	2,400	20,326	1,160	0	4,402	0	6,405	0	1,572
NUCLEAR	0	0	5,930	0	0	4,233	0	1,959	0	990
OIL & GAS	2,170	1,488.5	29,357	2,619	501	17,621	2,704	3,318	2,099	1,110
HYDROELECTRIC	85.5	85.5	230							
GEOTHERMAL	0	0	0	-179	565	4,370	754	614	0	301
WASTE HEAT	0	0	182							
PURCHASES & SALES	0	0	0							
TOTAL	4,656.0 (1988)	3,974.0 (1988)	56,025 (1988)	4,230 (1988)	1,066 (1990)	30,626 (1990)	3,458 (1990)	12,296 (1990)	2,099 (1990)	3,973 (1990)

*See Appendix C for definition of this area

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Further study and analyses of the capacity and fuel savings from load diversity is warranted.

FUEL DIVERSITY

Table 5.1 shows the United States systems have larger capacities and loads than the adjacent CFE areas or regions. Also, the United States systems have nuclear, coal and lignite generating capacity, while the CFE system has no generating capacity of these types, using only oil, gas, hydroelectric and geothermal units. However, coal and nuclear units are presently under construction. The diversity of fuels and energy sources available in Mexico and the United States for electric generation can be mutually advantageous. Fuel shortages can occur in the United States because of mining, transportation or labor problems, international embargoes, or new environmental constraints. In the event of emergency shortages of specific fuels in the United States, the availability of electric energy from CFE could be important. Energy shortages can occur in Mexico particularly because of variations in the availability of hydroelectric energy as a result of variations in rainfall. In years when shortages occur, the availability of electric energy from the United States could be helpful to Mexico.

POTENTIAL POWER PLANT CONSTRUCTION DELAYS

Mexican electric demand is expected to grow 9.8 percent annually, while the United States demand is expected to increase 4.8 percent annually. Future CFE plans call for the installation of major amounts of generating capacity in the border regions as shown in Table 5.1. Past experience has shown that undertakings of this magnitude can have unanticipated delays due to construction and

equipment problems. Also, future needs may exceed projections. The availability of electric generation from the United States could be very helpful to CFE if such problems materialize.

Construction delays may also occur in the United States, principally because of regulatory and environmental proceedings.

A major advantage from United States/Mexico interconnections is that the two systems will be considerably more secure in meeting the uncertainties of the future.

REGIONAL AREA SHORTAGES

Peak load, generating capacity, and reserve data for the various regions and areas are shown in Table 5.2. This tabulation shows a number of situations where cooperation may be beneficial. Specifically:

1980-1990 - The Norte area in the CFE system will be short of generating capacity or will have inadequate reserves. It is a difficult area for CFE to supply because of its geographical remoteness. CFE prefers to continue to provide as much of the area's energy requirements as possible since the CFE energy costs are lower than those in the United States.

The WSCC system appears to have adequate reserves and is geographically located to be able to provide support.

1981-1984 - The Noroeste area in the CFE system, while having adequate generating reserves, has a relatively weak transmission system. Transmission support could be provided through joint planning with Arizona.

1983-1985 - Generating reserves in the Central Power and Light Company system in ERCOT are low. CFE will have just completed a large coal fired generating plant at Rio Escondido, about 15 km (10 miles) from the border, near Eagle Pass, and may be able to provide some capacity, since its generating reserves in the northeast border region will be quite high starting in 1982. This Rio Escondido capacity may also be available to other Texas utilities.

1982-on - Some of the surplus capacity of the CFE Rio Bravo plant could be made available to the City of Brownsville, and other Texas utilities.

In general, CFE is interested in obtaining generating capacity from the United States to cover their peak period needs. Energy costs are higher in the United States and CFE prefers to provide as much energy as possible from their own system.

In general, the United States is interested in obtaining both capacity and energy. The use of any surplus CFE system energy may therefore result in savings to the United States consumers.

TABLE 5.2

CAPACITY, LOAD AND RESERVE SUMMARY (MW)

		1979**	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
ERCOT - CFE													
NORESTE	CAPACITY	826	1,003	1,302	1,956	2,556	2,556	2,856	3,456	4,056	4,656		
	PEAK LOAD	1,136	1,347	1,543	1,765	2,007	2,248	2,197	2,783	3,084	3,424	3,990	4,500
	RESERVE	-310	-344	-241	191	549	308	359	673	972	1,232		
NORESTE BORDER REGION	CAPACITY	144	320	620	1,274	1,874	1,874	2,174	2,774	3,374	3,974		
	PEAK LOAD	415	502	566	660	764	833	923	1,026	1,139	1,282		
	RESERVE	-271	-182	54	614	1,110	1,041	1,251	1,748	2,235	2,692		
ERCOT	CAPACITY	40,943	42,418	43,906	44,151	45,744	48,087	50,059	52,720	54,079	56,025		
	PEAK LOAD	31,184	32,855	34,248	36,053	37,827	39,770	41,850	43,620	45,749	47,995		
	RESERVE	9,079	9,413	10,001	8,603	8,269	9,110	8,598	9,658	8,627	8,311		
CPL (ERCOT AREA)	CAPACITY	2,946	3,446	3,414	3,355	3,303	3,554	3,496	4,355	4,012	4,230		
	PEAK LOAD	2,335	2,529	2,678	2,828	2,960	3,083	3,210	3,359	3,510	3,682		
	RESERVE	611	917	736	527	343	471	286	996	502	548		
WSCC - CFE													
SOUTHERN CALIF.	CAPACITY	23,320	23,344	23,800	24,840	25,398	26,398	26,858	27,446	28,219	29,245	29,607	30,626
	PEAK LOAD*	18,411	18,948	19,702	20,472	21,027	21,809	22,482	23,237	24,029	24,782	25,529	26,307
	RESERVE	4,909	4,396	4,098	4,368	4,371	4,589	4,376	4,209	4,190	4,463	4,078	4,319
BAJA CALIF. NORTE	CAPACITY	531	531	591	651	706	761	816	871	926	956	1,011	1,066
	PEAK LOAD*	386	478	517	554	591	633	675	719	768	820	862	911
	RESERVE	145	53	74	97	115	128	141	152	158	136	149	155
ARIZONA	CAPACITY	6,829	7,483	8,219	8,479	9,204	9,562	9,911	10,277	10,714	10,927	11,984	12,296
	PEAK LOAD*	5,729	6,151	6,491	6,948	7,298	7,617	7,997	8,331	8,614	8,933	9,257	9,615
	RESERVE	1,100	1,332	1,728	1,531	1,906	1,945	1,914	1,946	2,100	1,994	2,727	2,681
NOROESTE	CAPACITY	995	1,298	1,354	1,654	1,654	2,128	2,444	2,624	3,240	3,458	3,458	3,458
	PEAK LOAD*	789	878	1,048	1,163	1,281	1,415	1,569	1,749	1,932	2,031	2,155	2,301
	RESERVE	207	420	306	491	373	713	875	895	1,308	1,427	1,303	1,157
NEW MEXICO-WEST TEXAS	CAPACITY	1,937	2,208	2,344	2,702	2,871	3,175	3,175	3,506	3,505	3,469	3,599	3,973
	PEAK LOAD*	1,602	1,762	1,930	2,089	2,208	2,305	2,473	2,606	2,743	2,863	2,997	3,163
	RESERVE	335	446	414	613	663	870	702	900	762	606	602	810
NORTE	CAPACITY	689	761	896	1,031	1,166	1,289	1,559	1,694	1,829	2,099	2,099	2,099
	PEAK LOAD*	709	784	891	1,002	1,129	1,270	1,431	1,606	1,811	2,043	2,288	2,563
	RESERVE	-20	-23	5	29	37	19	128	88	18	56	-189	-464

* NON-COINCIDENTAL
**Summer Peak

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SPECIFIC SHORT-TERM OPPORTUNITIES

A number of opportunities for coordination in the near term (through 1982) have become apparent:

Joint Transmission for Amistad Dam

Development of both the United States and Mexican powerhouses at the Amistad Dam is currently underway. Plans for transmission outlets for the electric power produced are being developed independently. A coordinated transmission plan, with one system performing the transmission role, may result in savings.

Increased Use of Existing CPL-CFE Ties

The use of the three CPL-CFE ties from the ERCOT system is now limited (see page 18). The technical studies are currently underway by ERCOT and CFE to identify changes that will make the increased use of these ties feasible. These changes could include:

- Reinforcements or rearrangements in the internal ERCOT system.
- Improved CPL-CFE operating coordination and communications.
- Changes in relaying arrangements to isolate each system when certain disturbances occur.

Baja California-California Coordination

Currently, there is one 69 kV line connecting the CFE Baja California Norte system and the San Diego Gas and Electric Company (SDG&E) System. The facility is used to supply about 30 MW of load near the border on an isolated basis in either country. Studies between CFE and SDG&E have shown that interconnecting the two systems is technically feasible and could provide substantial benefits to both parties. The proposed interconnection is an 230 kV AC line from SDG&E's Miguel Substation to CFE's Tijuana Substation. An application for approval of this project is pending before ERA. The placement of a second 230 kV line between a new CFE substation west of Mexicali and a new SDG&E substation in the Imperial Valley is being studied.

The second transmission line would provide the capability for additional bulk energy transfers from one system to another. SDG&E, the Southern California Edison Company (SCE), and CFE have signed a letter of intent dated February 20, 1980 to allow the California utilities to purchase 220 MW of capacity and energy in the 1983-1992 period from CFE geothermal installations at Cerro Prieto. This will require that CFE accelerate the development of its geothermal installations.

Technical studies, and further contract negotiations are currently in progress.

Arizona-Noroeste Coordination

The Noroeste of the CFE system (see Figure 2.2) is supplied through a transmission system that is very long. Certain transmission line outages during the 1980-1984 period could result in reliability problems in the region near the United States border.

The installation of a transmission tie or ties between the Arizona systems and the CFE system could overcome these problems.

New Mexico/West Texas-Norte Coordination

Supply from the United States to the CFE Norte area loads would be especially beneficial. Presently, the two 69 kV transmission lines in the El Paso-Ciudad Juarez areas are used to supply loads in the Juarez area during emergency conditions. The CFE and El Paso Electric Company are pursuing a formal agreement covering mutual support during emergencies. Other transmission ties, or further reinforcement of existing ties, from the New Mexico/ West Texas area to the CFE system may be feasible.

Supply to Border Loads

A number of communities exist along the United States/Mexico border where supply from the other country would be helpful.

Offsetting Deliveries

Because of the location of electric energy resources, energy flow will be predominantly to the United States in some areas and to Mexico in others. An overall arrangement under which, in so far as possible, the energy delivered to Mexico at one point could be offset by energy deliveries to the United States at some other point could have advantages, since it might avoid difficulties in determining the charges for electricity bought and sold. Of course, such an arrangement would have to include recognition for the time of day and season in which the energy is received and returned, as well as the use of the internal transmission systems of the companies involved.

SPECIFIC LONG-TERM OPPORTUNITIES

Load diversity, fuel diversity and construction delays as discussed earlier provide long-term electricity exchange opportunities. Some more specific long-term opportunities are:

- o exchange of fuel for electric power, with one country providing the fuel and the other returning appropriate amounts of electric energy; provided the United States' dependence on imported oil it not increased. It should be noted that portions of the vast United States coal resources could be developed for export to Mexico.

- o coordination of future generation and transmission developments so as to provide increased opportunities for mutual savings.

- o expansion of past arrangements so that border communities in the United States and Mexico are supplied in the most economical manner, using both the CFE and United States systems for this purpose.

Non-border systems, as well as border systems in the United States should consider the potential benefits of electricity exchanges with Mexico.

6. OBSTACLES AND CONSTRAINTS

TECHNICAL CONSTRAINTS

A major factor in the future exchanges of electricity between the utility systems in Texas and Mexico is the ability of the two systems to be normally connected to each other with alternating current lines and thus operate in synchronism.*

The United States transmission system is operated in three distinct areas, as shown in Figures 3.2 and 3.3. The ability to connect the CFE system with the WSCC and/or ERCOT systems in the United States using alternating current lines will depend on future developments in the United States. Of particular importance are the proposed connections between the ERCOT system and the other United States systems.

The key constraints that must be recognized are:

(a) The Mexican System cannot become the means for tying together in synchronism the WSCC and the ERCOT Regions, which are presently operated independently of each other. Such an arrangement would cause power swings through the Mexican system on loss of generating capacity in ERCOT or WSCC of a magnitude that could cause instability and trip outs in the Mexican system.

*To be connected together alternating current systems must operate in synchronism which requires that all generators operate at precisely the required speed at any moment.

Also, such an arrangement could cause problems in WSCC and ERCOT systems because of changes in the power flow distribution in these systems immediately after the loss of generation from those power flows for which these systems were planned.

(b) The present ERCOT system cannot be operated in synchronism with the CFE national system because of two problems:

(1) The CFE system generators at the present time are not equipped with automatic load and frequency control.

(2) Circuit openings in the ERCOT systems that have resulted in major service disruptions in the past.

The first problem will disappear because of the CFE program to install controls on all generator units by 1982. The second problem was in part the result of inherent limitations in the ERCOT transmission system, the failure to coordinate the operations of the two systems, and difficulties arising from poor communications.

The lack of a single set of compatible planning and operating criteria between CFE and the United States systems constrains electricity exchanges. This is particularly important if each system is to avoid endangering the quality of service rendered by the other. Currently, each contractual arrangement must be sufficient to overcome these problems.

INSTITUTIONAL CONSTRAINTS

A number of institutional constraints on Mexican-United States cooperation in electrical system development and electricity exchanges are apparent. The permit and construction time required for new electric facilities is considerably longer in the United States than in Mexico. This is in large measure the result of United States governmental approval procedures. This difference in lead times will result in difficulties in scheduling future projects.

These bilateral projects are subject to greater risk since they must comply with national energy policies and changing regulations in the two countries. Interconnection projects, as well as other joint development projects, can involve large amounts of capital investments. The feasibility of such plans can be put at a serious economic disadvantage if either side considers premature abandonment.

The centralized planning and operation of the Mexican system differs from the decentralized approach in the United States. With the United States approach, each company will negotiate its own terms and conditions for interconnections, creating difficulties in negotiations between the Mexican and United States utilities.

Language differences can also present some obstacles to the planning and operation associated with electricity exchanges.

REGULATORY CONSTRAINTS

Governmental approval procedures differ in the two countries and are complex. In some cases these procedures appear to involve restraints which may impede mutually beneficial developments.

In the United States, procedures are more time consuming, because a Presidential Permit and an authorization to export electricity are required. Occasionally the routings of an international transmission line necessitates the approval of other Federal and State agencies. In many cases public hearings are required, and the approval times are extended.

Appendix B provides a summary of Federal authorization procedures.

7. PROCEDURES TO RESOLVE OBSTACLES AND MINIMIZE CONSTRAINTS

There are a number of actions that may be taken at this time which should result in increasing the electricity exchanges between the United States and Mexico to the mutual benefit of both nations. The best progress will be made if these actions are planned and coordinated jointly by the involved electric utilities, their regional reliability councils, and the appropriate Federal and State government regulatory agencies. Increased electricity exchanges will require the coordinated development of electric power system planning and operating procedures. In the planning areas the United States utilities in ERCOT and WSCC and the CFE need to work toward a compatible set of power system planning criteria that provide for:

- The amount of generation reserves to be provided to back-up firm power transactions.
- The power flow rating of transmission facilities during normal and emergency conditions.
- The types of transmission line protective relaying schemes and equipment to be employed.
- The exchange of technical power system data on a continuing basis.

The actual exchange of electric energy will require that a set of coordinated operating procedures be developed by the CFE and the ERCOT/WSCC utilities. If such procedures can be established, many of the problems of individual contract negotiation between CFE and the United States utilities can be overcome. Among these operating procedures should be the following:

- Means to determine operating and spinning reserve amounts to support firm transactions,
- Provisions for the coordination of maintenance schedules for all facilities (including relays) affecting a specific interchange.
- Means to achieve effective communications between the involved power system operators with special attention given to the difference in basic languages.
- Means to share power system data between the involved utility systems.
- Specific provisions regarding system emergencies with special attention given to the exact conditions when the interconnections will be opened.

An evolutionary approach by CFE and the ERCOT/WSCC utilities will likely be the best means of achieving these desired goals. Initial efforts should be based on the existing international interconnections with subsequent expansion to include the plans for new interconnections between the two countries. To assure progress and eliminate procrastination, a target date of one year from the publishing of the study should be set for establishing these planning and operating procedures.

Increases in the exchanges of electricity to the mutual benefit of both nations will have to recognize that certain facilities exist today and that progress will have to be phased.

In the first stage, exchanges may have to be made by isolating either the load or generation portions of one system and transferring it to the other for either operation or supply. An example of this type of arrangement exists today wherein Canada's Quebec Hydro utility provides power to New York State by isolating a generating plant from their system and connecting it to the New York

system. Similarly, a recent arrangement between CFE and the San Diego Gas and Electric System requires that a load area either in Mexico or in California be isolated from its normal supply and connected to the other system.

The second stage of development requires that a long-range plan covering the connecting together of the CFE main system and the Texas and/or Arizona/New Mexico utility systems under normal conditions be developed. The plan, of course, will have to overcome several technical constraints. Once a satisfactory plan is developed it should be evaluated on an economic basis and implemented in such a way that optimum benefits occur in both countries.

It is recognized that the technical factors are significant. Thus, the following discussion of two possibilities for normal power system interconnection is provided. Such ties could be alternating current (AC) ties, which would result in full synchronous operation of the involved systems or direct current (DC) ties, which would allow power exchanges but would not require synchronous operation. (Such a tie is the only link today between the eastern systems and WSCC in the United States.) Table 7.1 provides a comparison of the general characteristics of AC and DC transmission interconnection.

The DC approach will effectively isolate many of the problems in one system from the other system. It also has the advantage that it can be installed in smaller, more discrete steps. Installed in the proper location, as indicated by appropriate future studies, DC ties can help control the power flow on any future high capacity AC lines which may be installed. DC ties have a distinct advantage in that they can be installed without any increase in system short-circuit currents. System stability can also be enhanced.

Table 7.1

GENERAL COMPARISON OF CHARACTERISTICS

AC vs. DC TRANSMISSION

	AC	DC
Transfer of Real Power (Mw)	Yes	Yes
Transfer of Reactive Power (Mvar)	Yes	No
Transfer of Short-Circuit Currents	Yes	No
Inherent Reactive Charging Capacity	Yes	No
Reactive Losses	Low	High
Normal Control of Individual Circuit Power Loading - both magnitude and direction	Not unless angle regulators are installed at increased cost	Yes
Fast Control of Individual Circuit Loading	May be feasible in future using new devices currently under development	Yes
Control of Loading of Group or Circuits from a control area	Yes	Yes
Availability for service	Excellent	Good
Modularity	Facilities can be built mechanically for a higher voltage but operated at a lower voltage until capacity is needed	Capacity can be installed in discrete steps as desired
Flexibility for changes and rearrangements	Good - Can be tapped or rearranged if required in the future	Limited - No DC circuit breaker has yet been installed even though extensive R&D work has been done
Costs	Terminal costs low, incremental line costs are high due to wider right-of-way and the need for a third phase of conductor	Terminal costs high, incremental line costs are lower than AC due to the requirement for less right-of-way and the need for only two sets of primary conductors

The installation of synchronous AC ties between the CFE main system and the United States may be more economic than DC ties. Since the CFE Baja California system plans to interconnect with WSCC system with AC ties, future AC ties from Arizona to the CFE national system would effectively connect the CFE Baja California network to the CFE national network via the WSCC system. This could offer advantages to CFE in that its Baja California system could probably share some generation resources on both a time and seasonal diversity basis. Extensive joint technical studies to evaluate the feasibility of such a proposal is required. The installation of AC ties between the CFE main network and United States utilities in Arizona, New Mexico, or West Texas, and between CFE main networks and the south Texas utilities in ERCOT would effectively connect the United States WSCC and ERCOT networks in parallel through the CFE network. It is likely that several new bulk power interconnections as well as a significant amount of system reinforcement on both sides of the border will be necessary. A series of joint technical studies including load flow and system stability are necessary. Since the ERCOT region in the United States which currently operates isolated from the other United States networks, is evaluating possible connections to the eastern United States network, these studies with Mexico will have to cover this possibility.

Two basic options are available to electric power systems considering the use of AC ties. These are strong ties or weak ties. With a number of high capacity ties providing significant power exchange capability both the United States systems and the CFE systems in the border regions will have to be designed internally to carry the large power flows that may result under normal and emergency conditions over the interconnections. When only a few AC ties exist, the power exchange capacity is very low and the ability of the system to operate on a synchronous basis during

emergencies is usually limited. Normally these weak ties trip out whenever flows over them occur which can jeopardize the internal systems in either country.

Some short-term steps that can be taken by the individual electric utility systems in the United States and the CFE are:

1. Recognize that emergency mutual assistance and economic energy exchanges may have to be provided through a "block loading" basis with only portions of one system connected to the other during transfer periods.
2. Continue with the review of the application to construct a 230 kV tie between the CFE Baja California system and the SDG&E Company in California and complete the discussions concerning the installation of a second two 230 kV tie between CFE and SDG&E, and the purchase of CFE geothermal energy by SDG&E and the Southern California Edison Company.
3. Initiate joint studies by ERCOT and CFE of the transmission necessary to deliver the output of the Amistad Dam. In particular, ascertain if savings can be made through a coordinated transmission plan rather than two independent plans that will likely result in increased construction costs.
4. Develop joint plans for the supply of loads near the United States/New Mexico border so that electric energy resources are utilized in the most efficient manner.
5. Complete discussions between CFE and El Paso Electric Company to formalize the emergency assistance agreement covering the existing El Paso-Ciudad Juarez 69 kV ties.
6. Complete a CFE and ERCOT/CPL study to evaluate the increased use of the three existing 138-kV interconnections.

7. CFE and the Arizona utilities should study the feasibility of reinforcing the existing low voltage interconnections such that increased emergency assistance is available on a mutual basis.
8. ERCOT and WSCC should review their needs and capabilities on a council wide basis to determine the potential for short-term electricity exchanges with the CFE.

A joint power systems operations committee with representation from CFE, WSCC and ERCOT should be established as soon as feasible to investigate:

1. The exchange of the necessary data and the establishment of operating limits for power transfer if the presently open ties are closed.
2. Improvements in operator communications procedures to insure prompt bilingual response to inquiries for information and requests for operating actions.
3. Agreement on emergency operating procedures, including voltage reductions, manual load shedding, and conditions under which any closed interconnections may be opened.
4. Review of relaying equipment and protective schemes to insure that troubles in one system do not cause failures and outages in the other systems.
5. Review the need for supplemental generator governor controls on CFE generators such that they can be operated in synchronism with the United States.

Participation by CFE representatives in the activities of ERCOT and WSCC should be initiated as soon as feasible. The participation of the CFE in the activities of the above organizations, taking a role parallel to that of the Canadian utilities in WSCC and other regional reliability councils, should lead to significantly

increased professional contacts among key system officials with the goal of improved understanding, coordination and cooperation.

A joint power system planning committee, with representation from CFE, WSCC, and ERCOT, should be established. Initial assignments should include:

1. Establishment of the data bases necessary for joint study of planning and operating problems.
2. Performance of a coordinated study of the benefits and problems of AC interconnections between the CFE Main network and the WSCC and/or ERCOT networks.
3. Evaluation of the load diversity potential between the CFE border regions and the neighboring United States utilities to determine potential capacity exchanges.
4. Investigation of the way to coordinate future bulk power system transmission voltages.
5. Determination of the potential benefits of long-range capacity and energy exchanges, including:
   a) the exchange of Baja California geothermal energy for Arizona coal energy, including potential transmission savings.
   b) the savings that may be possible from sharing generating reserves.
   c) the exchange of fuel for electric energy.

There are a number of actions which may have mutual benefits which can be best approached on an individual system basis, including:

1. ERCOT utilities and CFE should study the advantages and system arrangements required for the sale of some of the output of CFE's Rio Escondido coal-fired plant in the initial years of operation. (See Figure 4.2)

2. CFE and the ERCOT utilities should study the system arrangements and advantages of the sale of some of the output of CFE's new Rio Bravo gas-fired plant in the initial years of its operation. (See Figure 4.2)

There are a number of actions that should be considered by both governments to facilitate future beneficial interconnections and exchanges.

The Federal regulatory agencies in the United States should investigate appropriate steps to accelerate the present approval procedures in order to decrease the lead times for installation of electrical facilities while still assuring that appropriate statutory requirements are fulfilled. Possibly the state regulatory agencies and the ERA should investigate the use of consolidated review procedures.

Actions should be taken to clarify government policies in both countries relating to electricity exchanges. Particular emphasis must be given to the conditions governing firm electricity exports and imports.

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TELEPHONE (202) 466-2036
CABLE "CASAZZA"

May 13, 1980

Mr. J. M. Brown, Jr.
Chief, System Reliability
& Emergency Response Branch
Economic Regulatory Administration
U. S. Department of Energy
2000 M Street, N. W.
Room 4110
Washington, D. C. 20461

Dear Jim:

Re: Contract No. DE-A01-791A-10038

Attached is the camera ready copy of the "United States/Mexico Electricity Exchanges, May 1980" report prepared by our office for the Department of Energy under the above noted contract number.

This completes our work for this job. If you have any questions, please call us.

Thank you for your cooperation.

Sincerely,

Jack

John A. Casazza

JAC/rg

encl.

cc: Ms. Kay McKeough w/o attachment
Robert S. Kirk w/o attachment
Sandra Fagans w/o attachment

APPENDIX A

List of Participants

United States Federal Representatives

Department of Energy

Jerry L. Pfeffer	Office of Utility Systems
James M. Brown, Jr.	Power Supply & Reliability Division
Leslie J. Goldman	Office of International Affairs
Peter Borre'	Office of International Affairs
Kay McKeough	Office of International Affairs

Department of State

Eleanor Savage	U.S. Embassy-Mexico City

Southwest Border Regional Commission

Sharon Gillespie	Southwest Border Region Commission

United States Electric Utility Representatives

Electric Reliability Council of Texas Region

D. Eugene Simmons	Houston Lighting & Power Co.
Merle Borcheldt	Central Power & Light Co.
Clifford Mast	Central Power & Light Co.
Jess Poston	Public Service Board of San Antonio
Arthur Von Rosenberg	Public Service Board of San Antonio
Harold Tynan	Electric Reliability Council of Texas

Western Systems Coordinating Council Region

Russell Hulse	Arizona Public Service Co.
Stanley Sierra	Arizona Public Service Co.
Harry Wilson	El Paso Electric Co.
Ronald Watkins	San Diego Gas & Electric Co.
Dennis Eyre	Western System Coordination Council

State Government [1]

Hon. Bud Timms	Arizona Corporation Commission
Hon. John Bryson	California Public Utilties Commission
Hon Richard Montoya	New Mexico Public Service Commisson
Tom Sweatman	Texas Public Utilities Commission
Rick Griffith	Western Interstate Energy Board
Carl Jimenez	Southern States Energy Board

[1] Participation by these persons was limited to document review and comments.

Significant support in the preparation of this report was received from John A. Casazza, a principal in the firm of Ransom and Casazza, Inc. This firm was retained by the United States Department of Energy to assist with this project.

Representatives of the United States of Mexico

Directorate of Energy

Juan Eibenschutz	Secretariat of Patrimony & Industrial Development
Bruni De Vecchi	

Federal Commission of Electricity

National Staff

Alberto Escofet	CFE-Mexico City, Main Office
Joaquin Carrion	CFE-Mexico City, Main Office
Jesus Sada-Gamiz	CFE-Mexico City, Main Office
Fernando Sosapavon	CFE-Mexico City, Main Office
Carlos Gutierrez	CFE-Mexico City, Main Office
Jose M. Galvan	CFE-Mexico City, Main Office

Regional Staff

Ernesto Rodriguez	CFE-Mexicali Office
Genaro Paez	CFE-Monterrey Office
Roberto Dessommes	CFE-Monterrey Office
Jose Luis Apodaca	CFE-Monterrey Office
Guillermo Ortega	CFE-Mexicali Office
J. S. Portugal	CFE-Hermosillo Office
R. Woo	CFE-Juarez Office

APPENDIX B
U.S. FEDERAL AUTHORIZATION PROCEDURES

UNITED STATES ELECTRICAL POWER EXPORT AUTHORIZATION PROCEDURES

The United States Federal government has regulatory authority over the exports of electric energy, and must formally authorize the construction of international electric power lines. The authority currently rests with the Secretary of Energy who has delegated that authority to the Administrator of the Economic Regulatory Administration (ERA). Two separate authorizations are issued by the ERA:

- Permits authorizing the construction of electrical transmission facilities at the international border (Presidential Permit);
- Authorization to export electrical energy across the international border.

Executive Order 10485, issued September 3, 1953, established the requirement for Presidential Permits. Construction of every line crossing the international border, regardless of size, must be authorized by a Permit. When an applicant applies for a Presidential Permit, a review of the environmental impacts of the line is conducted. The scope of the environmental review would entail the entire project associated with the transmission line. If it is determined that the proposed project could have a significant impact on the environment, an Environmental Impact Statement must be prepared. The public is given opportunities to comment on environmental impacts and the permit application. If public concerns warrant, hearings are held.

In addition to Federal environmental requirements, State governments have route selection and environmental requirements that must be satisfied. After the Environmental Impact Statement is completed, the Administrator of the ERA will weigh the environmental, technical, and economic considerations of the application and make a decision to issue a Permit or to reject the application. After reaching a decision, a record outlining the reasons for making the decision is prepared to go along with the Permit or the application rejection. If he decides to issue the Permit, he will then request concurrence from the Secretary of Defense and the Secretary of State. If differences between the Departments cannot be resolved, the matter is referred to the President who will make the final decision.

Authorizations to export electrical energy are required of non-public utilities in accordance with Section 202(e) of the Federal Power Act. Public utilities (Federal, State, or Municipal) are not within the jurisdiction of Part II of the Federal Power Act and do not require an authorization.

Applications for an authorization must set forth specific information and include required exhibits. Applications must include:

- Proposed rates
- Characteristics of electrical energy to be exported (i.e., amount, maximum rate (KW), voltage, etc.)
- Statement of reasons why the proposed transmission would not impair the sufficiency of electric power supply within the United States

Required exhibits include:

- Copy of rate contracts under which the energy is to be transmitted
- Statement of financial relationship between applicant and any other involved person or corporation.

The ERA may require additional information relevant to the application. Normally, Environmental Impact Statements are not required.

As with Presidential Permits, public notices are published and hearings may be held.

After considering all the available information, the Administration will deny, grant, or grant with conditions, the authorization.

There is no set term for the authorizations, and they may be modified by the ERA Administrator as he finds necessary.

Utilities authorized to export electric energy are to file information copies of subsequent rate schedules, supplements, etc., pertaining to the exports. In addition, they must report to the Administrator the actual annual imports and exports of electrical energy, related costs and revenues, and the maximum rate (KW) of exported energy.

INTERCONNECTION AND COORDINATION OF FACILITIES;
EMERGENCIES: TRANSMISSION TO FOREIGN COUNTRIES

(AS AMENDED AUGUST 7, 1953)

FEDERAL POWER ACT
PART II
SECTION 202

(e) After six months from the date on which this Part takes effect, no person shall transmit any electric energy from the United States to a foreign country without first having secured an order of the Commission authorizing it to do so. The Commission shall issue such order upon application unless, after opportunity for hearing, it finds that the proposed transmission would impair the sufficiency of electric supply within the United States or would impede or tend to impede the coordination in the public interest of facilities subject to the jurisdiction of the Commission. The Commission may by its order grant such application in whole or in part, with such modifications and upon such terms and conditions as the Commission may find necessary or appropriate, and may from time to time, after opportunity for hearing and for good cause shown, make such supplemental orders in the premise as it may find necessary or appropriate. [49 Stat. 849; 16 U.S.C. 824a(e)]

(f) The ownership or operation of facilities for the transmission or sale at wholesale of electric energy which is (a) generated within a State and transmitted from that State across an international boundary into a State and not thereafter transmitted into any other State, or (b) generated in a foreign country and transmitted across an international boundary into a State and not thereafter transmitted into any other State, shall not make a person a public utility subject to regulation as such under other provisions of this part. The State within which any such facilities are located may regulate any such transaction insofar as such State regulation does not conflict with the exercise of the Commission's powers under or relating to subsection 202(e). [67 Stat. 461; 16 U.S.C. 824a(f)]

EXECUTIVE ORDER 10485

PROVIDING FOR THE PERFORMANCE OF CERTAIN FUNCTIONS HERETOFORE PERFORMED BY THE PRESIDENT WITH RESPECT TO ELECTRIC POWER AND NATURAL GAS FACILITIES LOCATED ON THE BORDERS OF THE UNITED STATES

WHEREAS section 202(e) of the Federal Power Act, as amended, 49 Stat. 847 (16 U.S.C. 824a(e)), requires any person desiring to transmit any electric energy from the United States to a foreign country to obtain an order of the Federal Power Commission authorizing it to do so; and

WHEREAS section 3 of the Natural Gas Act, 52 Stat. 822 (15 U.S.C. 717b), requires any person desiring to export any natural gas from the United States to a foreign country or to import any natural gas from a foreign country to the United States to obtain an order from the Federal Power Commission authorizing it to do so; and

WHEREAS the proper conduct of the foreign relations of the United States requires that executive permission be obtained for the construction and maintenance at the borders of the United States of facilities for the exportation or importation of electric energy and natural gas; and

WHEREAS it is desirable to provide a systematic method in connection with the issuance and signing of permits for such purposes:

NOW, THEREFORE, by virtue of the authority vested in me as President of the United States and Commander in Chief of the armed forces of the United States, it is hereby ordered as follows:

Section 1.

(a) The Federal Power Commission is hereby designated and empowered to perform the following-described functions:

(1) To receive all applications for permits for the construction, operation, maintenance, or connection, at the borders of the United States, of facilities for the transmission of electric energy between the United States and a foreign country.

(2) To receive all applications for permits for the construction, operation, maintenance, or connection, at the borders of the United States, of facilities for the exportation or importation of natural gas to or from a foreign country.

(3) Upon finding the issuance of the permit to be consistent with the public interest, and, after obtaining the favorable recommendations

of the Secretary of State and the Secretary of Defense thereon, to issue to the applicant, as appropriate, a permit for such construction, operation, maintenance, or connection. The Commission shall have the power to attach to the issuance of the permit and to the exercise of the rights grants thereunder such conditions as the public interest may in its judgment require.

(b) In any case wherein the Federal Power Commission, the Secretary of State, and the Secretary of Defense cannot agree as to whether or not a permit should be issued, the Commission shall submit to the President for approval or disapproval the application for a permit with the respective views of the Commission, the Secretary of State and the Secretary of Defense.

Section 2. The Chairman or Acting Chairman of the Federal Power Commission is hereby designated and empowered to sign any permits issued by the Federal Power Commission pursuant to section 1(a)(3) hereof.

Section 3. The Federal Power Commission is authorized to issue such rules and regulations, and to prescribe such procedures, as it may from time to time deem necessary or desirable for the exercise of the authority delegated to it by this order.

Section 4. All Presidential Permits heretofore issued pursuant to Executive Order No. 8202 of July 13, 1939, and in force at the time of the issuance of this order, and all permits issued hereunder, shall remain in full force and effect until modified or revoked by the President or by the Federal Power Commission.

Section 5. Executive Order No. 8202 of July 13, 1939, is hereby revoked.

The White House
September 3, 1953

Dwight D. Eisenhower

PRESIDENTIAL DOCUMENTS

TITLE 3 -- THE PRESIDENT

Executive Order 12038 February 3, 1978

Relating to Certain Functions Transferred to the Secretary of Energy by the Department of Energy Organization Act

By virtue of the authority vested in me as President of the United States of America, in order to reflect the responsibilities of the Secretary of Energy for the performance of certain functions previously vested in other officers of the United States by direction of the President and subsequently transferred to the Secretary of Energy pursuant to the Department of Energy Organization Act (91 Stat. 565; 42 U.S.C. 7101 et seq.), it is hereby ordered as follows:

Section 1. Functions of the Federal Energy Administration. In accordance with the transfer of all functions vested by law in the Federal Energy Administration, or the Administrator thereof, to the Secretary of Energy pursuant to Section 301(a) of the Department of Energy Organization Act, hereinafter referred to as the Act, the Executive Orders and Proclamations referred to in this Section, which conferred authority or responsibility upon the Administrator of the Federal Energy Administration, are amended as follows:

(a) Executive Order No. 11647, as amended, relating to Federal Regional Councils, is further amended by deleting "The Federal Energy Administration" in Section 1(a)(10) and substituting "The Department of Energy," and by deleting "The Deputy Administrator of the Federal Energy Administration" in Section 3(a)(10) and substituting "The Deputy Secretary of Energy."

(b) Executive Order No. 11790 of June 25, 1974, relating to the Federal Energy Administration Act of 1974, is amended by deleting "Administrator of the Federal Energy Administration" and "Administrator" wherever they appear in Sections 1 through 6 and substituting "Secretary of Energy" and "Secretary," respectively, and by deleting Section 7 through 10.

(c) Executive Order No. 11912, as amended, relating to energy policy and conservation, and Proclamation No. 3279, as amended, relating to imports of petroleum and petroleum products, are further amended by deleting "Administrator of the Federal Energy Administration," "Federal Energy Administration," and "Administrator" (when used in reference to the Federal Energy Administration) wherever those terms appear and by substituting "Secretary of Energy," "Department of Energy," and "Secretary," respectively, and by deleting "and the Administrator of Energy Research and Development" in Section 1(b) of Executive Order No. 11912, as amended.

Section 2. Functions of the Federal Power Commission. In accordance with the transfer of functions vested in the Federal Power Commission to the Secretary of Energy pursuant to Section 301(b) of the Act, the Executive Orders referred to in this Section, which conferred authority or responsibility upon the Federal Power Commission, or Chairman thereof, are amended or modified as follows:

(a) Executive Order No. 10485 of September 3, 1953, relating to certain facilities at the borders of the United States is amended by deleting Section 2 thereof, and by deleting "Federal Power Commission" and "Commission" wherever those terms appear in Sections 1, 3 and 4 of such Order and substituting for each "Secretary of Energy."

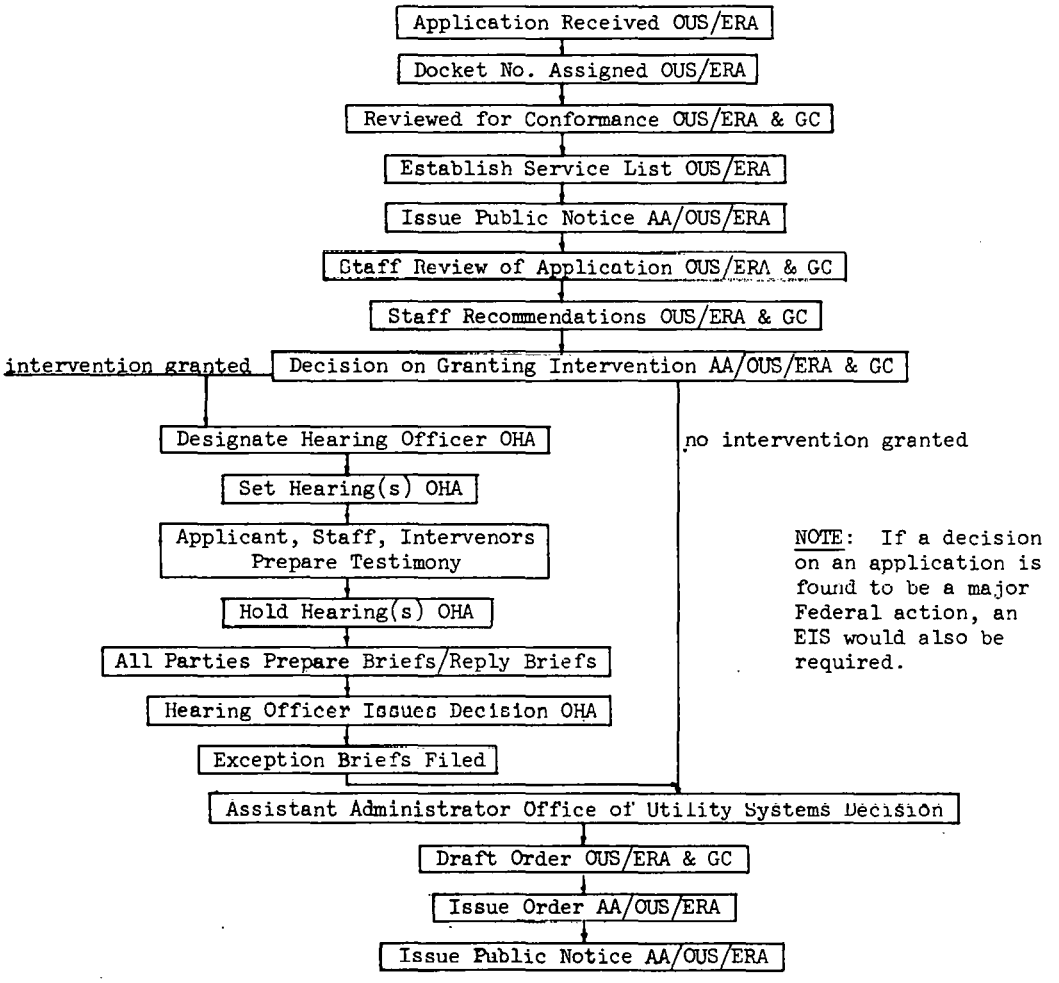
(b) Executive Order No. 11969 of February 2, 1977, relating to the administration of the Emergency Natural Gas Act of 1977, is hereby amended by deleting the second sentence in Section 1, by deleting "the Secretary of the Interior, the Administrator of the Federal Energy Administration, other members of the Federal Power Commission and" in Section 2, and by deleting "Chairman of the Federal Power Commission" and "Chairman" wherever those terms appear and substituting therefor "Secretary of Energy" and "Secretary," respectively.

(c) Paragraph (2) of Section 3 of Executive Order No. 11331, as amended, relating to the Pacific Northwest River Basins Commission, is hereby amended by deleting "from each of the following Federal departments and agencies" and substituting therefor "to be appointed by the head of each of the following Executive agencies," by deleting "Federal Power Commission" and substituting therefor "Department of Energy," and by deleting "such member to be appointed by the head of each department or independent agency he represents."

The White House
February 3, 1978

Jimmy Carter

APPLICATION HANDLING UNDER SECTION 202e OF FEDERAL POWER ACT



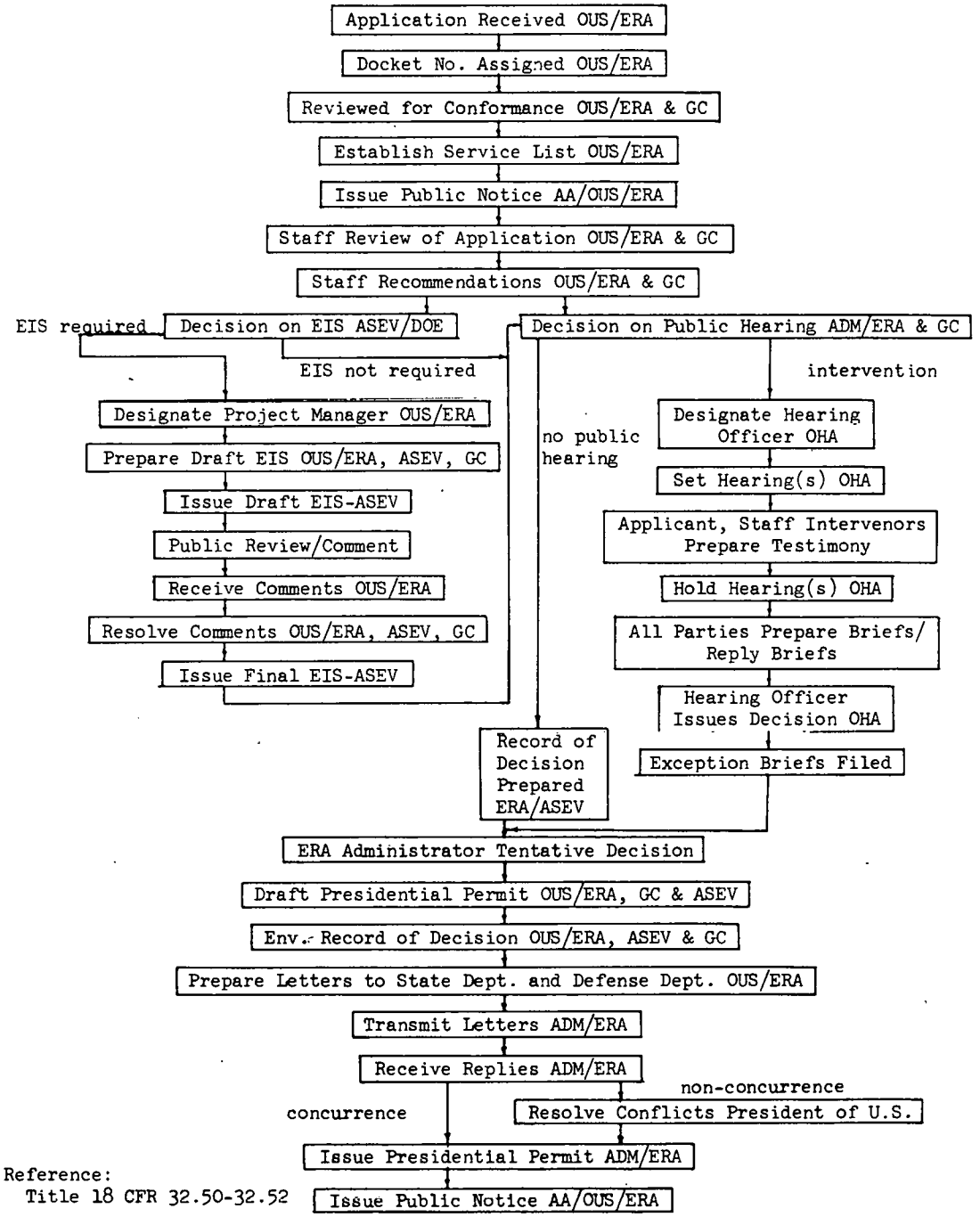
NOTE: If a decision on an application is found to be a major Federal action, an EIS would also be required.

Reference: Title 18 CFR 32.30-32.38

(Section 202e Federal Power Act: "... shall not transmit any electric energy from the United States to a foreign country without first having secured an order of the Commission ... The Commission shall issue such order upon application unless, after opportunity for hearing, it finds that the proposed transmission would impair the sufficiency of electric supply within the United States ...")

OUS - Office of Utility Systems
ERA - Economic Regulatory Administration
GC - General Counsel
AA - Assistant Administrator
OHA - Office of Hearing and Appeals

HANDLING OF APPLICATION FOR PERMIT UNDER EXECUTIVE ORDER OF THE PRESIDENT NO. 10485



Reference:
Title 18 CFR 32.50-32.52

(Executive Order No. 10485, Sept. 3, 1953, covers Application for Construction, Operation, Maintenance, or Connection at International Boundary, of Facilities for Transmission of Electric Energy.)

OUS - Office of Utility Systems
ERA - Economic Regulatory Administration
GC - General Counsel
AA - Assistant Administrator
OHA - Office of Hearing and Appeals
ASEV- Assistant Section for EV
ADM/ERA - Administration/ERA

Executive Order 12114 of January 4, 1979

Environmental Effects Abroad of Major Federal Actions

By virtue of the authority vested in me by the Constitution and the laws of the United States and as President of the United States in order to further environmental objectives consistent with the foreign policy and national security policy of the United States, it is ordered as follows:

Section 1.

1-1. Purpose and Scope. The purpose of this Executive Order is to enable responsible officials of Federal agencies having ultimate responsibility for authorizing and approving actions encompassed by this Order to be informed of pertinent environmental considerations and to take such considerations into account with other pertinent considerations of national policy in making decisions regarding such actions. While based on independent authority, this Order furthers the purpose of the National Environmental Policy Act and the Marine Protection Research and Sanctuaries Act and the Deepwater Port Act consistent with the foreign policy and the national security policy of the United States, and represents the United States government's exclusive and complete determination of the procedural and other actions to be taken by Federal agencies to further the purpose of the National Environmental Policy Act with respect to the environment outside the United States, its territories and possessions.

Sec. 2

2-1. Agency Procedures. Every Federal agency taking major Federal actions encompassed hereby and not exempted herefrom having significant effects on the environment outside the geographical borders of the United States and its territories and possessions shall within eight months after the effective date of this Order have in effect procedures to implement this Order. Agencies shall consult with the Department of State and the Council on Environmental Quality concerning such procedures prior to placing them in effect.

2-2. Information Exchange. To assist in effectuating the foregoing purpose, the Department of State and the Council on Environmental Quality in collaboration with other interested Federal agencies and other nations shall conduct a program for exchange on a continuing basis of information concerning the environment. The objectives of this program

shall be to provide information for use by decisionmakers to heighten awareness of and interest in environmental concerns and, as appropriate, to facilitate environmental cooperation with foreign nations.

2-3. Actions Included. Agencies in their procedures under Section 2-1 shall establish procedures by which their officers having ultimate responsibility for authorizing and approving actions in one of the following categories encompassed by this Order, take into consideration in making decisions concerning such actions, a document described in Section 2-4(a):

(a) major Federal actions significantly affecting the environment of the global commons outside the jurisdiction of any nation (e.g., the oceans or Antarctica);

(b) major Federal actions significantly affecting the environment of a foreign nation not participating with the United States and not otherwise involved in the action;

(c) major Federal actions significantly affecting the environment of a foreign nation which provide to that nation:

(1) a product, or physical product producing a principal product or an emission or effluent, which is prohibited or strictly regulated by Federal law in the United States because its toxic effects on the environment create a serious public health risk: or

(2) a physical project which in the United States is prohibited or strictly regulated by Federal law to protect the environment against radioactive substances.

(d) major Federal actions outside the United States, its territories and possessions which significantly affect natural or ecological resources of global importance designated for protection under this subsection by the President, or in the case of such a resource protected by international agreeement binding on the United States, by the Secretary of State. Recommendations to the President under this subsection shall be accompanied by the views of the Council on Environmental Quality and the Secretary of State.

2-4. Applicable Procedures. (a) There are the following types of documents to be used in connection with actions described in Section 2-3:

(i) environmental impact statements (including generic, program and specific statements);

(ii) bilateral or multilateral environmental studies, relevant or related to the proposed action, by the United States and one more foreign nations, or by an international

body or organization in which the United States is a member or participant; or

(iii) concise reviews of the environmental issues involved, including environmental assessments,summary environmental analyses or other appropriate documents.

(b) Agencies shall in their procedures provide for the preparation of documents described in Section 2-4(a), with respect to actions described in Section 2-3, as follows:

(i) for effects described in Section 2-3(a), an environmental impact statement described in Section 2-4(a)(i);

(ii) for effects described Section 2-3(b), a document described in Section 2-4(a)(ii) or (iii), as determined by the agency;

(iii) for effects described in Section 2-3(c), a document described in Section 2-4(a)(ii) or (iii) as determined by the agency.

(iv) for effects described in Section 2-3(d), a document described in Section 2-4(a)(i), (ii) or (iii), as determined by the agency.

Such procedures may provide that an agency need not prepare a new document when a document described in Section 2-4(a) already exists.

(c) Nothing in this Order shall serve to invalidate any existing regulations of any agency which have been adopted pursuant to court order or pursuant to judicial settlement of any case or to prevent any agency from providing in its procedures for measures in addition to those provided for herein to further the purpose of the National Environmental Policy Act and other environmental laws, including the Marine Protection Research and Sanctuaries Act and the Deepwater Port Act, consistent with the foreign and national security policies of the United States.

(d) Except as provided in Section 2-5(b), agencies taking action encompassed by this Order shall, as soon as feasible, inform other Federal agencies with relevant expertise of the availability of environmental documents prepared under this Order.

Agencies in their procedures under Section 2-1 shall make appropriate provision for determining when an affected nation shall be informed in accordance with Section 3-2 of this Order of the availability of environmental documents prepared pursuant to those procedures.

In order to avoid duplication of resources, agencies in their procedures shall provide for appropriate utilization of the resources of other Federal agencies with relevant environmental jurisdiction or expertise.

2-5. Exemptions and Considerations. (a) Notwithstanding Section 2-3, the following actions are exempt from this Order:

(i) actions not having a significant effect on the environment outside the United States as determined by the agency;

(ii) actions taken by the President;

(iii) actions taken by or pursuant to the direction of the President or Cabinet officer when the national security or interest is involved or when the action occurs in the course of an armed conflict;

(iv) intelligence activities and arms transfers;

(v) export licenses or permits or export approvals, and actions relating to nuclear activities except actions providing to a foreign nation a nuclear production or utilization facility as defined in the Atomic Energy Act of 1954, as amended, or a nuclear waste management facility;

(vi) votes and other actions in international conferences and organizations;

(vii) disaster and emergency relief action.

(b) Agency procedures under Section 2-1 implementing Section 2-4 may provide for appropriate modifications in the contents, timing and availability of documents to other affected Federal agencies and affected nations, where necessary to:

(i) enable the agency to decide and act promptly as and when required;

(ii) avoid adverse impacts on foreign relations or infringement in fact or appearance of other nations' sovereign responsibilities, or

(iii) ensure appropriate reflection of:

(1) diplomatic factors;

(2) international commercial, competitive and export promotion factors;

(3) needs for governmental or commercial confidentiality;

(4) national security considerations;

(5) difficulties of obtaining information and agency ability to analyze meaningfully environmental effects of a proposed action; and

(6) the degree to which the agency is involved in or able to affect a decision to be made.

(c) Agency procedure under Section 2-1 may provide for categorical exclusions and for such exemptions in addition to those specified in subsection (a) of this Section as may be necessary to meet emergency circumstances, situations involving exceptional foreign policy and national security sensitivities and other such special circumstances. In utilizing such additional exemptions agencies shall, as soon as feasible, consult with the Department of State and the Council on Environmental Quality.

(d) The provisions of Section 2-5 do not apply to actions described in Section 2-3(a) unless permitted by law.

Sec. 3.

3-1. Rights of Action. This Order is solely for the purpose of establishing internal procedures for Federal agencies to consider the significant effects of their actions on the environment outside the United States, its territories and possessions, and nothing in this Order shall be construed to create a cause of action.

3-2. Foreign Relations. The Department of State shall coordinate all communications by agencies with foreign governments concerning environmental agreements and other arrangements in implementation of this Order.

3-3. Multi-Agency Actions. Where more than one Federal agency is involved in an action or program, a lead agency, as determined by the agencies involved, shall have the responsibility for implementation of this Order.

3-4. Certain Terms. For purposes of this Order, "environment" means the natural and physical environment and excludes social, economic and other environments; and an action significantly affects the environment if it does significant harm to the environment even though on balance the agency believes the action to be beneficial to the environment. The term "export approvals" in Section 2-5(a)(v) does not mean or include direct loans to finance exports.

3-5. Multiple Impacts. If a major federal action having effects on the environment of the United States or the global commons requires preparation of an environmental impact statement, and

if the action also has effects on the environment of a foreign nation, an environmental impact statement need not be prepared with respect to the effects on the environment of the foreign nation.

Jimmy Carter

The White House
January 4, 1979