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INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
INTERNATIONAL DEVELOPMENT ASSOCIATION

AN APPRAISAL OF
THE DEVELOPMENT PROGRAM
OF MEXICO
VOLUME IV
ANNEX III - ELECTRIC POWER

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Department of Operations
Western Hemisphere

CURRENCY EQUIVALENTS

U.S. \$1	=	12.49 pesos
1 peso (Mex\$)	=	U.S. \$.08
1 million pesos	=	U.S. \$80,000

ANNEX III
ELECTRIC POWER

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ANNEX III

ELECTRIC POWER SECTOR

DESCRIPTION

1. Electric power facilities in Mexico are today almost entirely owned by the government, which entered the power field in 1937 by creating the Comision Federal de Electricidad (CFE) for the purpose of constructing, developing and operating power facilities throughout the country.

2. CFE started its activity by installing and operating small diesel units in rural areas where power shortages were holding back the development of the zone. However, by 1944 it had constructed its first large hydro-electric plant at Ixtapantongo, with an initial capacity of 56 MW, to supply power in bulk to Mexican Light and Power Company (Mexlight) serving the city of Mexico and surroundings.

3. In 1949 the government made CFE an autonomous agency with its own management and financial responsibility, at the same time the World Bank began to participate in financing the Mexican power program. This period marks the beginning of the rapid growth of CFE and the start of a coordinated development of the power sector.

4. During the decade 1950 to 1960 CFE installed more than one million kilowatts of generating capacity (see Table 1) at over 30 locations which included every major region of the country. Three World Bank loans, totalling about US\$87 million were given to assist in the financing of this vast program.

5. In addition to its retained earnings and the loans from the World Bank, CFE obtained the entire proceeds from the Power Consumption Tax of 10 percent on all retail billings in the country, decreed by government in 1939. Also, substantial appropriations were made from the national budget and given to CFE.

6. The government acquired the Nueva Cia. Electrica Chapala in 1940 and in 1960 purchased the large private power companies, so that it now owns the entire power facilities in the country except for some small private companies and captive plants in private industry.

7. The tabulation below shows the major entities in the power sector at the end of 1962 and the generating capacity operated by each.

<u>a. Controlled by Government:</u>	<u>Gen. Capacity</u>
i. CFE	1,660 MW
ii. CFE Subsidiaries and Affiliates	
Industrial Electrica Mexicana S.A. (IEMSA)	341 MW
Nueva Cia. Electrica Chapala S.A.	127 MW
Electricidad y Gas de Monterrey	88 MW
Eight Small Subsidiaries	17 MW
Total	573 MW
iii. <u>Mexlight</u>	<u>667 MW</u>
Total Controlled by Government	2,900 MW
<u>b. Small Private Companies</u>	
Total	52 MW
<u>c. Captive Plants in Private Industry and the Government-owned Petroleum Industry (PEMEX)</u>	<u>700 MW</u>
Grand Total	3,652 MW

8. The power sector, at present, may be viewed as comprising eleven major systems covering various parts of the country, as shown on Map I. Outside these systems service to isolated towns and zones is provided by small private companies.

9. In the major systems power is generated in the plants of one or more of the power entities, whose transmission lines interconnect the various facilities within the system.

10. At most locations CFE provides power in bulk to the local company to make up its energy requirements beyond that generated in its own plants. At some locations CFE also handles retail sales, which at the end of 1962 amounted to about 31 percent of its total kilowatt hour sales and produced about 46.5 percent of its gross revenues for the year. Table 2 gives a summary of the forecast for retail and bulk power sales from 1963 to 1970 for CFE. This projection made in 1961 is equivalent to an average rate of increase in CFE's total sales of about 14% and was based upon a sector-wide rate of growth of 8%. Actual growth in 1962 was slower than forecast but resumption of the 8% nationwide rate is reasonable in the light of the country's economic prospects.

POWER PROGRAM 1963-1965

11. Since 1961 CFE has been the only entity to construct new generating facilities and it is the Government's intention to continue this policy, so that, in the future all the retail companies in the major systems will purchase their requirements for power, above that generated in their own plants, in bulk from CFE. The trend will therefore be for the other companies to gradually generate less power from their own plants as these become obsolete or less efficient in comparison with new CFE plants.

12. During the year 1962, by agreement with the other entities, CFE developed a program to control the planning for expansion and the operation of all major power plants in the eleven major systems except the captive plants in industry. This important step in the coordination of the power sector is essential for the orderly planning of future system additions, particularly as more areas become interconnected and opportunities present themselves for the more efficient and effective use of all generating units. Proper coordination and control of operations of the various units will allow each to be assigned its optimum position in the generating schedule for the particular system and help to lower production costs.

Generating Plants

13. The generating plant capacity now in service and that under construction generally makes power available to meet present and estimated future demand for the next four or five years more than adequately. In several of the major systems there is a substantial surplus of capacity which could have been added more slowly. This surplus capacity will be absorbed as load increases but, in the meantime, it represents an unproductive investment which could have been avoided if the coordinated planning now envisaged could have been instituted earlier.

14. In 1962 the World Bank made a loan of US\$130 million to help CFE complete the construction program it started earlier. Table 3 gives a list of plants, associated substations and transmission lines which were under construction in 1963 for the various systems. Table 4 gives details of the available capacity and estimated demand by systems from 1963-70, as projected in late 1963. The program has since been changed to provide for frequency unification and larger generating units at Malpasos.

15. It will be seen from these tables that in 1962 CFE had about 1.4 million kilowatts of generating plant under construction at 19 different locations throughout the country. All these new facilities are scheduled to come into service before 1966 and construction is well advanced beyond the stage where it could be stopped or delayed to economical advantage. Hence the decision was taken to complete these works even though, in several cases, they will not be immediately necessary to supply the demand for power.

16. Although CFE has a competent staff of its own, it has very wisely called upon the assistance of consultants and specialists from all over the world for advice and independent opinion. These experts have often been requested to review design work, supervise construction, give counsel on special matters of construction design and geological studies, review progress in construction and operations and planning for future expansion, and make special studies as required.

17. The technical aspects of the various plants now under construction were carefully studied by CFE with the aid of these consultants, and in all cases the plants themselves are well designed and are being constructed to accepted modern standards at reasonable cost.

Frequency Unification

18. While the power program is meeting energy demands in all parts of the country it is important to note that 72 percent of all the energy used is consumed in the central part of the country with Mexico City as its hub.

19. This central area is served by four of the major systems: (a) Michoacan-Chapala-Guanajuato System (b) Central System (c) Puebla-Veracruz System and (d) Minatitlan System, which are in the process of continuous extension as a natural consequence of the load growth.

20. The energy demands in this area and particularly in Mexico City have reached such proportions that large power sources of over half a million kilowatts capacity each are being built or planned to supply it. These sources can only be located where natural conditions are suitable or adequate for the construction of hydro or thermal plants of this size. Transmission lines have then to be built to connect these plants to the load centers. Hence, the trend is progressively towards the inter-connection of all systems and the final integration of the whole power complex.

21. Integration is the next logical step of development and CFE has already made some plans towards it. However, a very serious problem is encountered because the system frequency of the Mexlight (Central) System is 50 cycles, whereas the other power systems in the country operate at 60 cycles.

22. The significance of the difference of frequency in the Mexlight system and the relative importance of this system in relation to the total power picture is illustrated by its size. The Mexlight system in 1963 sold more than 4,000 million kwh, equal to about 40 percent of the total energy sales for the country. The company generated about 70 percent of its demand in its own plants and purchased the balance in bulk from CFE. However, since all future increase in generating capacity is to be provided by CFE and as the estimated annual growth in

demand of the system is about 6-8 percent, it is obvious that continued operation of Mexlight and CFE at different frequencies would make it increasingly difficult to create a fully integrated national power system so that all generating facilities would be utilized in the most efficient manner.

23. In addition to the operating complications caused by the frequency difference, there are important economic disadvantages. The large amount of power from the Infiernillo plant (600 MW) which generates at a frequency of 50 cycles, can only be used in the Central System where it is not all needed immediately and where, even with the shut-down of over 120 MW of existing thermal capacity, there will exist very substantial capacity surpluses into 1968. In an integrated system with unified frequency, this power might also be used in the present Puebla-Veracruz or Michoacan-Guanajuato Systems.

24. In 1961 and 1962 Electricite de France and SOFRELEC had made a study for Nacional Financiera S.A. of long-term planning for the Mexican electricity industry. The study recommended the interconnection of the systems in the central part of Mexico and a standardization of frequencies. In 1963 CFE engaged the Bechtel International Corporation to study the unification of frequencies for Mexico. The Bechtel Report of September 1963 on comparative costs for the unification clearly shows that the most economic solution would be to change the 50 cycle Central System to 60 cycle operation.

The Malpaso Project

25. Early in 1963 the Bank was requested by CFE to permit inclusion of the Malpaso Hydroelectric Station in the expansion program. The initial proposal by CFE was to substitute Malpaso as a more economical alternative to other previously planned plant additions in the Puebla - Veracruz Minatitlan System.

26. In 1961 the Secretaria de Recursos Hidraulicos had started construction of the Malpaso dam with government funds as part of a flood control and irrigation scheme on the Grijalva River to serve the Chontalpa region, located on the gulf coast between Minatitlan and Merida. The work on the dam is now well advanced and completion is expected in 1965. The creation of this dam provides a source of potential hydroelectric power.

27. CFE assumed that the cost of the dam would be met by the government and that the power project would only be charged with the actual cost of the plant and immediately associated civil works. On this basis, the studies of the various alternative plant designs showed the possibility of constructing a plant at the dam site with an ultimate maximum capacity of about 700 MW.

28. In August 1963 a Bank mission made an appraisal of the power aspects of the Malpaso project based on an installation of 450 MW. The unit cost of the power facilities, excluding the dam but including transmission lines to serve the Puebla-Veracruz system, was estimated to be equivalent to US\$160 per kw. The mission agreed with CFE that Malpaso represented the most economical installation to serve the Puebla-Veracruz System even though the plant would be capable of generating more energy than presently required in this system.

29. With frequency conversion and interconnection of the Puebla-Veracruz, Central, and Michoacan-Guanajuato Systems, Malpaso could be built at the start to an optimum capacity of about 700 MW and its full output used to replace existing thermal generation at substantial savings in fuel costs.

Distribution System Expansion

30. From its start CFE has been mainly concerned with providing power plant capacity; at first to small areas later to augment the capacity of the larger systems, and finally moving into its present position where it is the only builder of new plants and has started controlling the operations of all plants serving the public in the major systems.

31. Until 1960, when the government purchased the major private companies and obtained control of almost the entire power sector, retail sales and distribution of electric energy were in the hands of private companies; Attachment 1 gives further detail about these companies. Two of these, Mexlight and Impulsora, delivered over 85 percent of all the energy sold to retail consumers in the country. Thus almost all distribution systems were in private hands and each entity planned its own system expansion and improvement in accordance with its needs and the financial resources available.

32. Under the conditions which now prevail the retailing companies acquired by the government have been relieved of the problem of providing new generating facilities but face a growing problem of transmission and distribution system expansion and improvement to deliver the ever larger quantities of energy demanded by the consumers.

33. During the past several years because of inadequate electric rates, the distributing companies were not always able to maintain their systems in satisfactory condition nor were they able to carry out all the expansion needed. This deficiency is now showing itself in higher than normal system losses at various locations.

34. In 1962, shortly before the last World Bank loan was made, the retail electric rates were raised throughout the country and the bulk power rates at which CFE sold to the retailing companies was revised.

However, while this rate increase helped the distributing companies it does not appear to have solved their problems completely for a number of reasons which are discussed later in this report.

35. The problem is particularly acute for Mexlight, the largest of the distributing companies, which now estimates it will have to invest a total of about Ps. 780 million during the years 1964 and 1965 to expand and improve its system to meet load growth and connect new customers.

36. The program proposed by this company consists of (a) the completion of a 220 kv transmission ring around Mexico City with associated step-down substations to feed the existing 85 kv system (b) additions and improvements to the present 85 kv circuits and substations (c) additions and capacity increases to existing distribution substations and networks (d) miscellaneous buildings and other requirements to serve new customers.

37. This program would increase the capacity of the 220 kv transmission lines and substations by about 900 MVA and provide facilities to carry this power through the 85 kv system and distribution networks to the ultimate customer. Since Mexlight expects to experience an increase in peak demand from the present 1,050 KVA to 1,700 KVA in 1970 and plans to receive this increased power from the CFE Infiernillo plant (600 MW) and other future CFE plants, the suggested expansion of the transmission and distribution system appears reasonable.

38. At the present, estimated losses on the Mexlight system are 18 percent which is some 3 to 4 percent higher than might be expected. In terms of revenues this excess in losses represents about Ps. 40 million annually, which might be saved by investing in system improvements. Thus, while it is not usual to attribute reduction of losses to any specific item of system betterment, the justification for this investment is given added support when system losses are higher than normally might be expected.

39. There is no doubt that the distribution expansion and betterments program is needed. However, due to the sharp increase in the amount of the proposed annual investment over that actually invested during the past two years and in view of the complex nature of the proposed program it is felt that a more detailed examination and analysis would be required before full indorsement could be given.

40. There appears to be considerable justification for a detailed review of Mexlight's program by an independent consultant who should take into consideration, in particular, the size of the program. It is felt, after a limited review of the program, that the amount of the annual investment might be reduced by as much as 25 percent by being more selective in assigning priorities to the items of construction. Thus the work could be carried out during a four or five year period instead of the proposed three years.

41. In the case of IEMSA the problem is much smaller and the estimate is for a total investment of Ps. 535 million during the years 1964 and 1965.

42. The IEMSA group of companies is divided into six divisions serving small towns and rural areas throughout the country. Therefore, its distribution system improvements program consists of many minor betterments and small transmission line and substation improvements. There is no available data upon which to assess system losses but it is known that these are high at a number of locations.

43. It would appear that IEMSA's suggested program is not unreasonable in view of the anticipated load increase during the years under consideration but in this case too, it is felt that the annual investment might be reduced by a more critical review of the proposed program.

44. In any expanding power system there is always some flexibility in the rate at which new investments must be made to meet the growth in demand and at the same time maintain an acceptable standard of service. After the basic elements which determine the need for a specific item of system improvement or expansion have been examined and the proposed investment has been accepted as justifiable, there comes the decision on the optimum moment for starting construction.

45. The decision on timing is largely a matter of judgment by management after carefully weighing the local conditions prevailing at the time and the company's ability to make the investment.

46. In view of the large investment program required by the power sector and the peak in this investment during the next three or four years, the burden of financing may be eased by delaying some investments for a year or two simply by assigning priorities to the various items of construction on the basis of "necessity" rather than "desirability".

POWER PROGRAM REVIEW AS OF JANUARY 1964

47. The power program proposed in January 1964 by the several entities in the sector would require a considerable investment during 1963-65 amounting to about Ps. 6,700 million. Table 5 summarizes these proposed investments.

48. The major portion of this investment, about Ps. 4,900 million, is to be made by CFE in the construction of new plants and the frequency unification, while the other power entities consisting of Mexlight, IEMSA, Chapala and the small companies, will make investments amounting to a total of about Ps. 1,800 million in transmission, distribution, substation and other facilities to serve the customers in their areas.

49. As a result of its own studies and the reports of outside consultants, CFE has modified its program to include the Malpaso Plant with 4 - 180 MW units, the change of frequency of the Central system from 50 cycles to 60 cycles, and the interconnection of the three large systems across the central part of Mexico. Preliminary plans have been prepared for the gradual changeover of the 50 cycle generating stations as the corresponding changes are made in the consumers' appliances and equipment. The surplus capacity at Infiernillo will permit flexible operation at both frequencies while the changeover is accomplished. The Central system will be interconnected with the Puebla-Veracruz System by January 1966 and with the Michoacan System by January 1967. Malpaso's first unit is scheduled to come into operation in June 1967 and by the end of 1968 the frequency unification will be substantially completed. At that time the coincident maximum demand is estimated to be about 2,400 MW and the firm capacity of the system, allowing 15 percent for outages, will be approximately 3,000 MW.

50. Although the total amount of generating capacity by 1968 for the combined three systems will be considerably greater than required, over 700 MW of this capacity is thermal which will only operate on stand-by or peaking status. The available hydro energy, based on an average hydrological year, is about 11,500 GWH which would almost meet the total generation requirements of the system thereby effecting large fuel savings. On balance, and especially considering the advantages of an early frequency unification, the overall program appears reasonable, although a delay in execution of parts of the program is desirable.

51. The inclusion of Malpaso in the program together with the frequency unification permits CFE to delete the proposed Salamanca thermal station and would delay for some years the proposed La Villita hydro development downstream of Infiernillo. The Comision has also decided to delay the Ciudad Juarez plant until about 1971 by continuing to purchase power from the El Paso Electric Company.

52. Table 7 presents an analysis of the sources and application of funds for the power sector as a whole assuming that the program as proposed by the Mexican power entities is adopted. It will be seen that there would be a large financing gap of about Ps. 1,460 million for the next two years.

53. The mission believes that one basic step to reduce the gap should be to rephrase the investment program. Based upon previous years' estimates as compared to actual construction progress, it is reasonable to assume that CFE's program would slip some 10 percent. In view of the large block of capacity which will be available for the central part of the country after Malpaso is built and after the frequency unification is made, no justification for the La Villita development can be established; hence it should be postponed. With regard to the frequency changeover, it is doubtful whether the proposed expenditure of Ps. 109 million could all be made this year so the mission would reduce this amount to Ps. 60 million. Finally, the mission recommends that the estimated distribution

expenditures of both Mexlight and IEMSA be reduced by some 25 percent for 1964 and 1965. Table 6 shows the effect that these suggested changes would have on the investment program for the years 1964 and 1965, amounting to a reduction of about Ps. 570 million which is equivalent to 13 percent of the total investment proposed for the period. Even if the reduced program shown in Table 6 is adopted, the financing gap would still be about Ps. 900 million.

RETURN ON INVESTMENT

54. The financial condition of the major power entities is illustrated by the information given in Table 9, which gives "rate of return" calculations for CFE, Mexlight and IEMSA separately and cumulatively. The analysis shows that the return on the power sector investment would decline from 4.9 percent in 1963 to 4.6 percent in 1965 with an average of 4.7 percent for the three-year period 1963-65. If the 10 percent power consumption tax is considered as part of the earnings of the sector, the three-year average return would be 6.6 percent. These returns are not considered satisfactory and are far below the 8 to 9 percent level which might be considered the minimum acceptable estimate of the cost of capital in Mexico.

55. This analysis is based on the figures obtained from the various entities at the beginning of 1964 in Mexico and on certain specific assumptions which are explained in Attachment 2. The return is calculated as net income from operations expressed as a percentage of average net fixed assets in operation.

56. It is to be noted that these "rates of return" do not correspond directly to the "return" as defined in the Mexican rate legislation for regulatory purposes. Also, the different entities differ in their depreciation accounting, and the investment is given at the original cost in Mexican pesos, in accordance with Mexican law which does not provide for any revaluation of fixed assets. Thus while these "rate of return" figures are illustrative of the financial condition of the major entities in the power sector and of the sector as a whole they may be subject to some adjustment which, most probably, would make the real rates of return lower than those shown in Table 9.

57. Part of the problem of the low return for the sector may be attributed to over-investment by CFE in the past in generating plants. If this investment had been made more slowly, particularly in the major systems where considerable excess capacity will exist for the next few years, the present burden of fixed charges for the sector would be much less.

58. On the other hand, Mexlight, IEMSA and the other retailing companies must now invest in distributing facilities to meet the growing loads and demands by their customers. These investments have, in some instances, been neglected in the past. However, these companies are not earning the necessary funds to contribute sufficiently towards their own investment program nor do they have a rate of return which makes them attractive to outside lenders. There is obviously a need for assistance in the form of increased revenues or, as a last resort, direct government subsidies.

FINANCIAL ASPECTS

59. If the contributions to the power sector by the Government are not to increase, the only method of bridging the remaining financing gap is: (1) by raising the earnings of the power sector through increased retail rates or higher electricity consumption taxes; or (2) by additional borrowings. The mission has assumed that in order to increase the cash available for the sector, a doubling of the 10 percent power tax could be in effect by the fourth quarter of 1964. If the proposed 20 percent tax is considered as income, the overall return on investment of the sector for 1965 would be 8.0 percent.

60. A financing plan, shown in Table 8, has been prepared on this basis for the remaining two years of the program assuming that the alternative construction program of Table 6 would be carried out. In addition to the increase in the power tax, a new long-term loan has been assumed which would cover the foreign exchange component of the program which is not yet financed. It has also been assumed that the short-term debt of both CFE and Mexlight would be refinanced by three to five year loans. NAFIN has already initiated the refinancing operation for CFE. For 1964 the plan would still be insufficient by some Ps. 176 million. In 1965, it was assumed that CFE would pay its own debt service on the suppliers' credits signed by NAFIN and that Ps. 175 million of new supplier credits would be obtained for the generating equipment at Tijuana, Los Mochis and La Laguna. The deficit for 1965 would amount to about Ps. 145 million.

61. From the above financing plan it is clear that even the combined effect of a sizable tax increase (or an equivalent rate increase) together with a loan covering only the foreign exchange component would not be sufficient to meet the requirements of the sector. Either increased government contributions or long-term loans covering some local expenditures (or both) would still be necessary.

FUTURE DEVELOPMENT OF POWER SECTOR

62. It is obvious from the discussion about the Power and Investment Programs for the power sector that these matters cannot be dealt with by examining them exclusively from the point of view of any one of the entities in the sector but the problems must be viewed and solved on a sector wide basis.

63. As time goes on the major systems of the power sector will become more interconnected, as is rapidly taking place in the central part of the country. Thus, requirements for generating capacity, substations and transmission lines are no longer the sole concern of the company or entity supplying the load but affects CFE as the entity responsible for supplying power in bulk. It also concerns the neighboring companies which, by coordinating their requirements with one another will most probably effect considerable savings in investment by avoiding future duplication of facilities.

64. The orderly planning of a system's expansion presents readily seen advantages through standardization of designs to save construction costs and to take advantage of quantity purchasing of equipment. It has already been mentioned that increased power demands are causing CFE to build larger power plants. Thus, the timing and location of new plants and the operating schedules for all plants, become major factors affecting the cost of the energy generated.

65. There are many matters, such as frequency unification, revisions of bulk and retail rates, and financial planning which concern the sector as a whole and in which the interests of more than one of the power entities is involved. In some cases these interests may conflict one with the other; hence coordinated action is required.

66. At present the power sector can be grouped under CFE and its subsidiaries and affiliates on the one hand, and Mexlight on the other. However, although each has its own management and operates as a separate entity, the financial position of CFE and Mexlight are inter-related through bulk sales and the bulk power rate. Furthermore, the financial soundness of the power sector depends upon the soundness of the individual entities within the sector; therefore, a constant review of the financial needs of the various entities is essential and a procedure should be instituted whereby adjustments of bulk and retail rates can be made quickly when required and carried out in an orderly manner.

67. Prior to the nationalization of the power sector, the government's major concern was to maintain CFE in a position to invest in needed plant construction. The distribution of energy was mostly in the hands of the private companies which had to manage their own finances. This situation has now changed so that a new approach and policy by government towards the several entities forming the power sector is urgently needed. As an illustration of the need for uniform treatment

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of the entities, Mexlight still has to pay income tax on whatever profits it makes and both Mexlight and IEMSA have to pay customs duties on imports whereas CFE is exempt from both.

68. These problems and requirements show the need for the establishment of some authority or procedure whereby the activities of the several entities of the power sector can be coordinated and planned to the mutual benefit and to the best advantage of the sector and its power customers.

69. As part of the long-term planning study in 1961, Electricite de France and SOFRELEC considered the organization and operation of the power sector. This study recommended that a single organization be set up to absorb the existing power entities. A draft statute has recently been prepared for submission to the Legislature which would provide for the creation of a new body to be called "Electricidad de Mexico" with responsibility for the development of the power program and the coordination of operations.

HISTORICAL DEVELOPMENT OF POWER SECTOR

1. Electric power was first developed in Mexico by private companies, many of which began their operations to provide power for their own use in mines or factories and later extended service to the surrounding territory. The major entities are commented upon below.

- a. In 1902 The Mexican Light and Power Company (Mexlight), a private Canadian registered company, began operations in Mexico City and its surroundings by acquiring a number of small companies and gradually developed these to form the largest private electric utility in the country with 585 Mw of generating plant capacity and annual sales of 3,184 million kwh in 1962. Map II shows the Mexlight system as it was in 1962.

In 1960 the government bought 91 percent of the common shares and 73 percent of the preferred shares of this company, thus becoming the majority shareholder. The company remained under the original Canadian charter with head offices in Toronto, Canada. At the shareholders' meeting in Toronto, three weeks later, the former officers and directors of the company resigned and were replaced by Mexican officers and directors, representing the various branches of the federal government, Nacional Financiera S.A. and Comision Federal de Electricidad (CFE).

Mexlight continues to exist and operate as a separate company although it is now under government ownership and control. It cooperates with CFE on the operation of its generating plants and purchases about 30 percent of its power requirements from CFE in bulk. These purchases of bulk power will increase each year as the load served by the company grows and since it will not be permitted to add to its own plant capacity in future.

Immediately after the purchase of Mexlight by the government an amendment was made to the 27th Article of the National Constitution, reading as follows: "The Generation, transmission, transformation distribution and supply of electric energy for the purpose of rendering a public service corresponds exclusively to the Nation. No concessions will be granted in this area to private parties and the Nation will develop the assets and national resources which are acquired for said purposes." (This quotation has been taken from the Mexlight Annual Report of 1960.)

This constitutional amendment was made to assure the total nationalization of the power sector and to prevent the appearance of new private companies in future.

Mexlight in common with all the other companies receives no contributions from government towards its construction program nor does it obtain any benefit from the electricity tax which it collects from its customers and passes on directly to CFE. It

also has to pay CFE for all bulk power purchases. In other words, it must take responsibility for raising the funds for its own investments for system expansion, which it has obtained from internal cash generation and external borrowings.

The World Bank made loans to Mexlight in 1952 for US\$26 million and in 1958 for US\$11 million to enable it to increase its plant capacity and make other system improvements and extensions. In recent years Mexlight was forced to finance its expansion increasingly with supplier credits and short-term bank loans which in turn added considerably to its financial plight.

There is a change taking place in the character of Mexlight and the other previously private companies which affect their operations. These companies started as self sufficient power entities with their own generating, transmission and distribution facilities and sold the power they generated to their own customers. With the advent of CFE as the major generator of power selling to the other companies in bulk, these entities have become retailers of power. The character of their operating costs will change as generating costs decrease and purchased power and labor costs assume larger proportions. The following statistics taken from the annual reports of Mexlight serve to illustrate this point:

Percentage of gross revenues paid out for:

	1959		1962
Salaries and social benefits	35	percent	40
Fuel	3	"	9
Purchased bulk power	14	"	21
Other expenses	8	"	6
Depreciation and amortization	9	"	5
Taxes	14	"	4
Interest	8	"	7
Dividends	6	"	1
Reinvested earnings	3	"	7
	100	"	100

The actual amounts paid for the various items shown above will change as adjustments and corrections are made by the retailing companies to adapt to their new operating conditions. However, these factors should be considered when the power rates are reviewed so that an equitable distribution of costs is obtained between bulk suppliers of energy and the retailers.

- b. In 1928 La Impulsora de Empresas Electrica (Impulsora) a subsidiary of American Foreign Power Company, a private United States company started its activities by acquiring small isolated companies throughout the country. This group of companies, some of which were slowly interconnected by transmission lines, developed to form the second largest private utility group. It served most of the following systems shown on Map I:

(a) Torreon-Chihuahua (b) Guanajuato (c) Puebla-Veracruz (d) Merida and (e) the town of Tampico. In 1959 Impulsora had an installed generating plant capacity of 340 MW and annual sales of 1,605 million kwh.

In 1960 Nacional Financiera S.A., on behalf of the government purchased the assets of Impulsora from American and Foreign Power Company and later transferred them to a CFE subsidiary, Industrial Electrica Mexicana S.A. (IEMSA).

IEMSA has a considerably smaller requirement than Mexlight for investment in system improvements and expansion but faces the same operating and financial problems. The only difference is that IEMSA is a subsidiary of CFE and may be able to obtain limited financial assistance from the parent entity.

c. Other Companies

The remainder of the country is served by a number of smaller private isolated companies supplying power to the town or area in which they are located. The two larger of these are:

(a) Nueva Cia Electrica Chapala S.A. which the government acquired in 1940.

(b) Cia de Tranvias, Luz y Fuerza de Monterrey which was owned by International Power Company of Canada Ltd., Montreal, Canada, and which was purchased by the government in 1962.

Most of the smaller companies have now become subsidiaries of CFE or are slowly being acquired by it.

BASES AND ASSUMPTIONS FOR RATE OF RETURN CALCULATIONS IN
TABLE 5

The rate of return calculations were only made for the three large government-owned companies CFE, Mexlight and IEMSA because they represent a major portion of the power sector and their financial situation would be representative of the sector's status.

The denominator for the return calculations is the annual average of fixed assets in operation, excluding work in progress, net of the accumulated reserve for depreciation, retirements and replacements.

The bases for the computations were the 1962 year-end figures, to which were added the construction expenditures given in the respective programs; capitalized interest was considered to the extent that information on it was available. The historic figures are given at original cost as required by the Mexican electricity legislation; this tends to understate investments made prior to previous peso devaluations.

The accumulated reserves for depreciation were also taken from the 1962 statements without regard to their actual adequacy. It should be noted that CFE provided in the past only for a retirement and replacement reserve (instead of proper depreciation), pursuant to the provisions of the Mexican rate legislation; the accumulated reserve is therefore much below an adequate amount.

Revenues and operating costs were taken, with minor adjustments for consistency, from the reports submitted by the power entities in January 1964.

TABLE 1

Mexico

COMISION FEDERAL DE ELECTRICIDAD
GENERATING PLANT CAPACITY

Millions
of KW

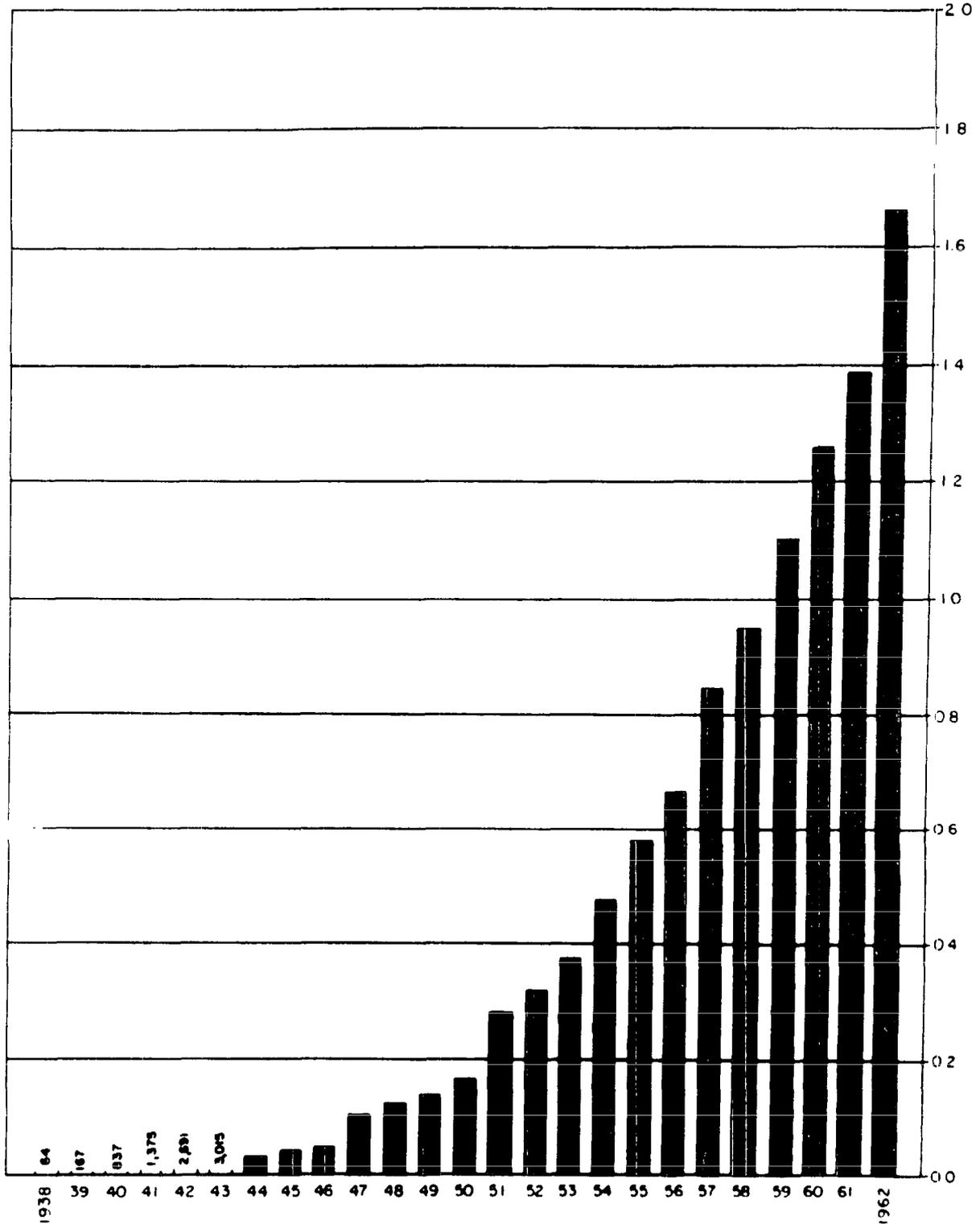


TABLE 3
COMISION FEDERAL DE ELECTRICIDAD
POWER PROGRAM 1963-66

Generating Plants Under Construction

<u>System</u>	<u>Plant</u>	<u>Type</u>	<u>Capacity</u> MW	<u>Scheduled</u> <u>Operating</u> <u>Date</u>
<u>Central</u>	Valle de Mexico	Steam	1 x 150 = 150	February 1963
	San Bartolo	Hydro	1 x 20 = 20	January 1964
	Infiernillo	Hydro	4 x 150 = 600	July 1964
<u>Puebla-Veracruz</u>	Poza Rica	Steam	3 x 39 = 117	January 1963
<u>Michoacan-Chapala</u> <u>Guajuato</u>	Santa Rosa	Hydro	2 x 30 = 60	January 1964
	Salamanca (I) ^{1/}	Thermal	1 x 75 = 75	January 1966
<u>Torreón-Chihuahua</u>	Delicias	Steam	3 x 33 = 99	December 1963
<u>Sonora-Sinaloa</u>	Sanalona	Hydro	2 x 7 = 14	May 1963
	27 de Septiembre	Hydro	1 x 20 = 20	October 1963
	El Novillo	Hydro	2 x 45 = 90	June 1964
<u>Falcon-Monterrey-</u> <u>Rio Bravo-Nava</u>	Monterrey	Steam	3 x 75 = 225	May 1963
	Rio Bravo	Steam	2 x 37.5 = 75	January 1964
	Nava	Steam	1 x 37.5 = 37.5	June 1964
<u>Colotlipa-Acapulco</u>	La Venta	Hydro	5 x 6 = 30	October 1963
<u>Merida</u>	Nachi-Cocom (Extension)	Steam	1 x 16.5 = 16.5	July 1965
<u>Tijuana-Mexicali</u>	Tijuana	Steam	4 x 75 = 300	June 1963
<u>Minatitlan</u>	Chilapan	Hydro	2 x 9 = 18	June 1964
	Minatitlan	Gas Turbine)	2 x 17.5 = 35	January 1965
			Total 1,482 MW	/cont'd....

^{1/} Later information indicated that this project had not been initiated and will be deleted.

Table 3: Substations and Transmission Lines Under Construction (Cont'd)

	Transformer and Transmission Line Voltage (KV)	Total Trans- former Capa- city (KVA)	Transmission Lines Length (Km)
<u>Substations</u>	380/220/13.2	780,000	-
	220/85	650,000	-
	161/69/13.8	267,000	-
	150/69/13.2	15,000	-
	138/13.8	115,000	-
	115/69	487,300	-
	69/6.6	151,300	-
	34.5/13.8	30,000	-
<u>Transmission Lines</u>	380	-	660
	220	-	815
	161	-	775
	150	-	80
	138	-	354
	115	-	1,686
	69	-	1,018
	34.5	-	245

TABLE 4

COMISION FEDERAL DE ELECTRICIDAD

SUMMARY OF INSTALLED GENERATING CAPACITY AND FORECAST DEMANDS

BY SYSTEMS 1963-1970

System	Item	1963	1964	1965	1966	1967	1968	1969	1970	
Central	Installed Capacity MW	1,304	1,602	1,709	1,660	1,709	1,709	1,999	1,999	
	Firm Capacity MW	1,154	1,453	1,559	1,510	1,559	1,559	1,849	1,849	
	Estimated Demand MW	1,003	1,074	1,177	1,270	1,371	1,481	1,600	1,731	
	Excess Firm Capacity MW	151	379	382	240	188	78	249	118	
Puebla-Veracruz- Mal Paso- Minatitlan	Installed Capacity MW	388.9	388.9	490.9	542.9	832.7	832.7	780.1	930.1	
	Firm Capacity MW	350.4	350.4	438.9	490.9	682.1	682.1	630.1	780.1	
	Estimated Demand MW	285	320	423	461	567	593	625	658	
	Excess Firm Capacity MW	65.4	30.4	15.9	29.9	115.1	89.1	5.1	122.1	
Michoacan-Chapala-	Installed Capacity MW	309	378	378	378	448	448	518	518	
	Firm Capacity MW	274	343	343	348	378	378	448	448	
	Estimated Demand MW	261	300	325	343	370	393	419	448	
	Excess Firm Capacity MW	13	43	18	5	8	-15	29	-	
Torreon-Chihuahua	Installed Capacity MW	226	256	256	256	286	286	286	286	
	Firm Capacity MW	155	196	196	196	226	226	226	226	
	Estimated Demand MW	1,155	160	165	169	174	178	182	187	
	Excess Firm Capacity MW	-	36	31	27	52	48	34	39	
Sonora-Sinaloa	Installed Capacity MW	220	265	265	265	265	265	305	305	
	Firm Capacity MW	175	220	220	220	220	220	260	260	
	Estimated Demand MW	120	135	150	165	180	200	225	250	
	Excess Firm Capacity MW	55	84	70	55	40	20	35	10	
Falcon-Monterrey- Rio Bravo-Nava	Installed Capacity MW	365	461	461	461	461	461	461	461	
	Firm Capacity MW	290	386	386	386	386	386	386	386	
	Estimated Demand MW	140	205	225	255	285	315	350	386	
	Excess Firm Capacity MW	150	181	161	131	101	71	36	-	
Colotlipa-Acapulco	Installed Capacity MW	35	53	53	53	53	53	75	75	
	Firm Capacity MW	27.5	45.5	45.5	45.5	45.5	45.5	53	53	
	Estimated Demand MW	21.5	25.5	31	36	40	44	50	55	
	Excess Firm Capacity MW	6.0	20.0	14.5	9.5	5.5	1.5	3	-2	
Yucatan	Installed Capacity MW	31	31	44.5	44.5	61	61	61	61	
	Firm Capacity MW	25.1	25.1	28	28	44.5	44.5	44.5	44.5	
	Estimated Demand MW	25.0	27.5	30	32.5	35	39	42	45	
	Excess Firm Capacity MW	0.1	-1.6	-2	-4.5	9.5	5.5	2.5	-0.5	
Tijuana	Installed Capacity MW	150	225	225	300	300	300	300	375	
	Firm Capacity MW	80	150	150	225	225	225	225	300	
	Estimated Demand MW	120	140	150	160	177	192	210	230	
	Excess Firm Capacity MW	-40	10	-	65	48	33	15	70	
Minatitlan	Installed Capacity MW	29	62							
	Firm Capacity MW	23	61							
	Estimated Demand MW	20	50	System interconnected with Puebla-Veracruz						
	Excess Firm Capacity MW	3	11							

TABLE 5

POWER SECTOR

1963-1965 Investment Program^{1/}

(in millions of pesos)

<u>Entity</u>	<u>Item</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>Total 1963-65</u>
CFE	(1) Plants and other facilities under construction	1,827.0	1,494.6	1,136.4	4,458.0
	(2) Frequency change	-	108.8	162.5	271.3
	(3) Contingencies ^{2/}	-	80.0	130.0	210.0
	Total	<u>1,827.0</u>	<u>1,683.4</u>	<u>1,428.9</u>	<u>4,939.3</u>
IEMSA	Total	120.6	337.3	197.7	655.6
Chapala	Total	28.3	22.8	22.0	73.1
	Sub-total	<u>1,975.9</u>	<u>2,043.5</u>	<u>1,648.6</u>	<u>5,668.0</u>
Mexlight ^{2/}	Total	<u>286.0</u>	<u>393.0</u>	<u>386.2</u>	<u>1,065.2</u>
	Grand Total	<u>2,261.9</u>	<u>2,436.5</u>	<u>2,034.8</u>	<u>6,733.2</u>

^{1/} This presentation is based on revised information received from the respective entities in January 1964 through CFE. The 1963 figures are in part actual and in part estimated.

^{2/} Contingencies for CFE were computed at 5 percent in 1964 and 10 percent thereafter. The Mexlight figures include a 10 percent overall contingency and provide for increases in labor cost.

TABLE 6

POWER SECTOR

1963-1965 Alternate Investment Program^{1/}

(in millions of pesos)

<u>Entity</u>	<u>Item</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>Total 1963-65</u>
CFE	(1) Plants and other facilities under construction	1,827.0	1,350.0	950.0	4,127.0
	(2) Frequency change	-	60.0	180.0	240.0
	(3) Contingencies	-	65.0	90.0	155.0
	Total	1,827.0	1,475.0	1,220.0	4,522.0
IEMSA	Total	120.6	320.0	180.0	620.6
Chapala	Total	28.3	22.8	22.0	73.1
	Sub-total	1,975.9	1,817.8	1,422.0	5,215.7
Mexlight	Total	286.0	330.0	330.0	946.0
	Grand Total	<u>2,261.9</u>	<u>2,147.8</u>	<u>1,752.0</u>	<u>6,161.7</u>
	Annual Savings compared to <u>Table 5</u>		288.7	282.8	571.5

^{1/} Based on an assumed slippage in CFE's program of 10%; slower progress on the frequency change; the deletion of La Villita; and a reduction in the investment program of IEMSA and Mexlight. (See para. 53).

TABLE 7
POWER SECTOR

Sources and Applications of Funds 1963-1965 1/

	<u>1963</u> 2/	<u>1964</u>	<u>1965</u>	<u>Total</u> <u>1963-65</u>
	(in millions of pesos)			
<u>Sources of Funds</u>				
Internal cash generation	738.9	920.2	1,135.8	2,794.9
Power Consumption Tax	220.0	238.0	258.0	716.0
Government appropriations	382.3	254.0	242.1	878.4
Long-term borrowings 3/	1,537.5	2,000.4	565.0	4,102.9
Miscellaneous sources	<u>307.4</u>	<u>102.9</u>	<u>158.0</u>	<u>568.3</u>
Total Sources of Funds	3,186.1	3,515.5	2,358.9	9,060.5
<u>Applications of Funds</u>				
Construction expenditures	2,261.9	2,436.5	2,034.8	6,733.2
Debt service	668.1	828.3	992.2	2,488.6
Miscellaneous applications	<u>256.1</u>	<u>984.4</u>	<u>55.2</u>	<u>1,295.7</u>
Total Applications of Funds	3,186.1	4,249.2	3,082.2	10,517.5
Financing gap	-	(733.7)	(723.3)	(1,457.0)

1/ As submitted by the Mexican power entities in January 1964

2/ Partially estimated

3/ Includes Mex\$600 million medium-term refinancing of CFE's short-term debt and continuing advances by NAFIN to CFE for debt service payments under existing suppliers' credits.

TABLE 8

POWER SECTORSources and Applications of Funds 1964 & 1965 ^{1/}

	<u>1964</u>	<u>1965</u>	<u>Total</u>
	(in millions of pesos)		1964-65
<u>Sources of Funds</u>			
Internal cash generation	920.2	1,135.3	2,056.0
Power Consumption Tax ^{2/}	313.0	516.0	829.0
Government appropriations	254.0	242.1	496.1
Long term borrowings:			
IBRD Loan 316 ^{1E}	495.4	138.0	633.4
Refinancing of CFE's short-term debt ^{3/}	600.0	-	600.0
Refinancing of Mexlight's short term debt ^{3/}	400.0	-	400.0
Draw down of other long term debt (supplier's credits)	319.3	175.0 ^{4/}	494.3
Advances by NAFIN for debt service of CFE's (supplier's credits)	397.7	-	397.7
Miscellaneous	102.9	158.0	260.9
Additional long term borrowings covering foreign component not yet financed	-	350.0	350.0
Total Sources of Funds	<u>3,602.5</u>	<u>2,764.9</u>	<u>6,567.4</u>
<u>Application of Funds</u>			
Construction expenditures	2,147.8	1,752.0	3,899.8
Debt service on medium and long term debt	846.5	1,092.7	1,939.2
Interest on new long term borrowings	-	9.5	9.5
Repayment of short term debt (including interest)	922.2	-	922.2
Miscellaneous applications	<u>62.2</u>	<u>55.2</u>	<u>117.4</u>
Total Application of Funds	3,978.7	2,909.4	6,888.1
Annual surplus or (deficit) of funds	(176.2)	(144.5)	(320.7)
Cumulative surplus or (deficit) of funds	(176.2)	(320.7)	

^{1/} Assuming Alternate Investment program shown in Table 6.^{2/} 10% of retail billings in 1963 raised to 20% in last quarter of 1964.^{3/} Assumed terms 3 to 5 years @ 7%^{4/} New Sybetra/Siemens credits.

TABLE 9

POWER SECTORReturn Calculations 1963-1965

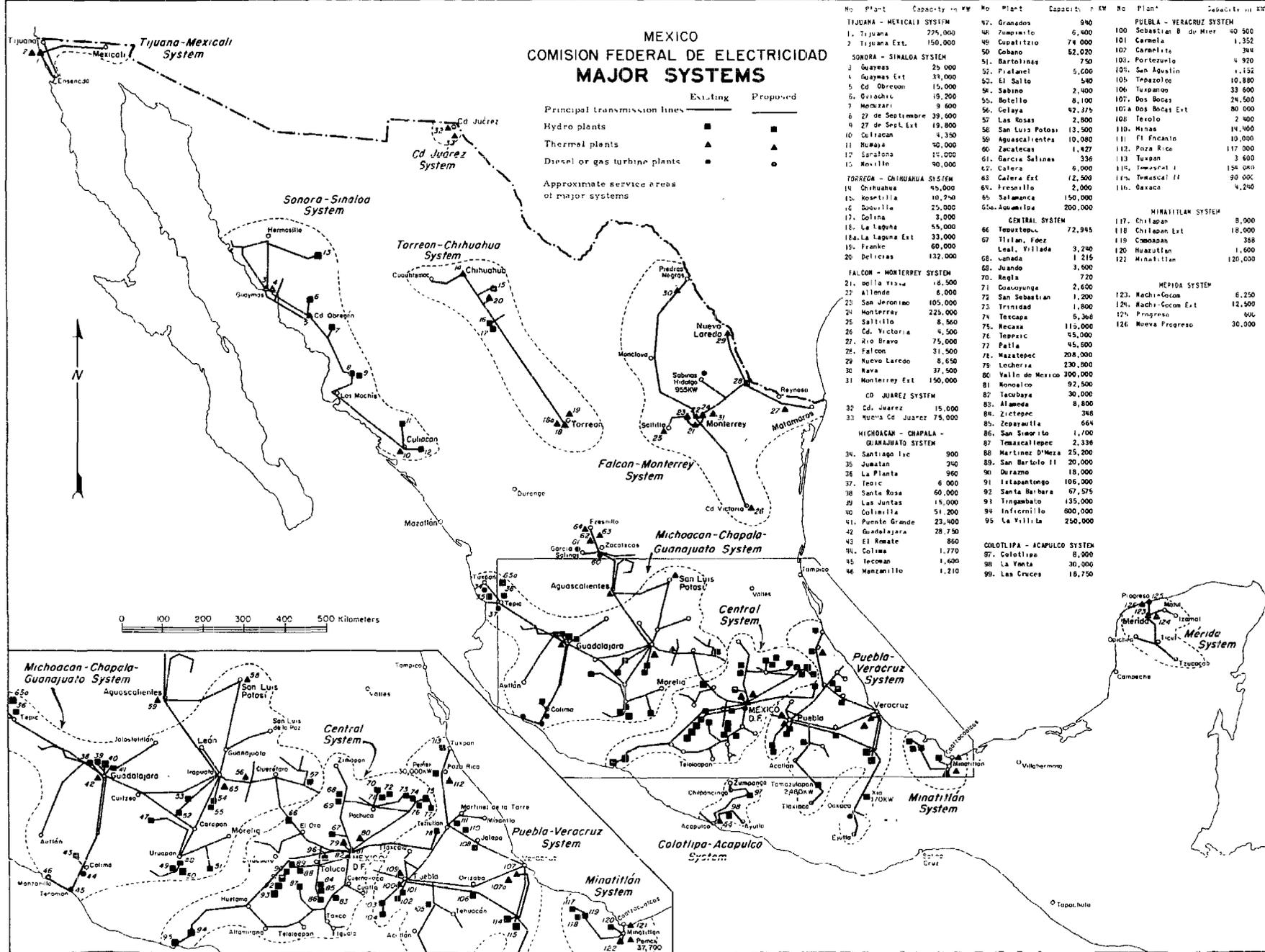
	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>Total</u> <u>1963-65</u>
	(in millions of pesos)			
<u>Average net fixed assets in operation:</u>				
CFE	5,704	8,015	10,594	
Mexlight	2,464	2,750	3,080	
IEMSA	1,405	1,590	1,806	
Total average net fixed assets	<u>9,573</u>	<u>12,355</u>	<u>15,480</u>	
<u>Operating results:</u>				
CFE: Operating revenues	985	1,263	1,512	
Operating cost	589	697	776	
Depreciation	134	206	246	
Net income from operation	<u>262</u>	<u>360</u>	<u>490</u>	1,112
Mexlight: Operating revenues) net = 1,176	1,176	1,281	
Operating cost) 186	984	1,067	
Depreciation	58	61	68	
Net income from operation	<u>128</u>	<u>131</u>	<u>146</u>	405
IEMSA: Operating revenues	534	578	617	
Operating cost	422	472	487	
Depreciation	34	37	46	
Net income from operation	<u>78</u>	<u>69</u>	<u>84</u>	231
Cumulative net income of CFE, Mexlight and IEMSA	468	560	720	1,748
<u>Return on average net fixed assets</u>				<u>Average</u> <u>1963-65</u>
CFE	4.6%	4.5%	4.6%	
Mexlight	5.2%	4.8%	4.7%	
IEMSA	5.5%	4.3%	4.6%	
Power Sector (cumulative)	4.9%	4.5%	4.6%	4.7%
Proceeds of 10% Power Consumption Tax	220	238	258	
Return including proceeds of tax	7.2%	6.4%	6.3%	6.6%

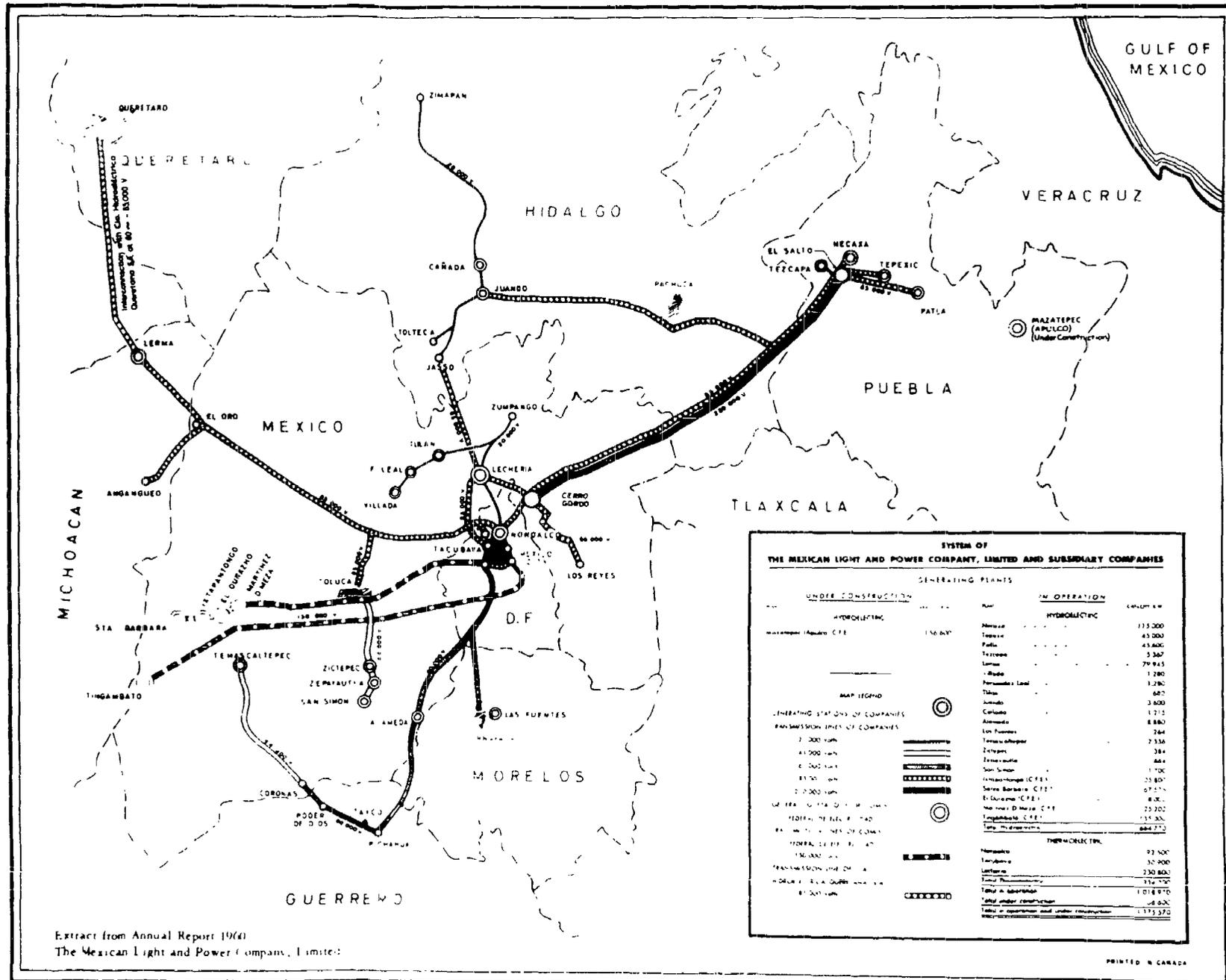
MEXICO
COMISION FEDERAL DE ELECTRICIDAD
MAJOR SYSTEMS

	Existing	Proposed
Principal transmission lines	■	■
Hydro plants	▲	▲
Thermal plants	▲	■
Diesel or gas turbine plants	●	●

Approximate service areas of major systems

No.	Plant	Capacity in KW	No.	Plant	Capacity in KW	No.	Plant	Capacity in KW
TIJUANA - MEXICALI SYSTEM								
1	Tijuana	225,000	97	Granados	940	PUEBLA - VERACRUZ SYSTEM		
2	Tijuana Ext.	150,000	48	Zumpango	6,400	100	Sebastian B. de Mier	40,500
SONORA - SINALOA SYSTEM								
3	Guaymas	25,000	49	Cupatitzio	74,000	101	Carmela	1,352
4	Guaymas Ext.	31,000	50	Cobano	52,020	102	Carmelita	344
5	Cd Obregon	15,000	51	Bartolinas	750	103	Portezuelo	4,920
6	Oviachit	19,200	52	Piramel	5,000	104	San Agustín	1,152
7	Mochizari	9,600	53	El Salto	540	105	Tetzotzo	10,800
8	27 de Septiembre	39,600	54	Sabinero	2,400	106	Tuxpan	33,600
9	27 de Sept. Ext.	19,800	55	Botello	8,100	107	Dos Bocas	24,500
10	Culiacan	4,350	56	Gelaya	42,375	108	Teotilo	2,400
11	Muyaya	40,000	57	Las Rosas	2,800	109	Minas	14,000
12	Saratona	15,000	58	San Luis Potosí	13,500	110	Fr. Fructosin	10,000
13	Mexillo	90,000	59	Agua Calientes	10,000	111	Fr. Fructosin	117,200
TORREON - CHIHUAHUA SYSTEM								
14	Chihuahua	45,000	60	Zacatecas	1,427	112	Pozos Ricos	3,600
15	Coscuatilla	10,240	61	García Salinas	336	113	Tuxpan	154,000
16	Dobuilla	25,000	62	Galera	6,000	114	Temascal I	90,000
17	Colonia	3,000	63	Galera Ext.	12,500	115	Temascal II	4,240
18	La Laguna	55,000	64	Fresnillo	2,000	MIHATITLAN SYSTEM		
19	La Laguna Ext.	33,000	65	Salamanca	150,000	117	Chilpan	8,000
20	Franko	60,000	66	Aguascalientes	200,000	118	Chilpan Ext.	18,000
21	Delicias	132,000	67	Temascal	72,945	119	Cosmas	358
FALCON - MONTERREY SYSTEM								
22	allende	6,000	68	Leon	3,240	120	Muzatlan	1,600
23	San Jeronimo	105,000	69	Canada	1,215	121	Muzatlan	120,000
24	Monterrey	225,000	70	Juando	3,900	MEPIDA SYSTEM		
25	Saltillo	8,560	71	Angia	720	123	Nachi-Cocom	6,250
26	Cd. Victoria	4,500	72	Guanajuato	2,600	124	Nachi-Cocom Ext.	12,500
27	Rio Bravo	75,000	73	San Sebastian	1,200	125	Progreso	600
28	Falcon	31,500	74	Trinidad	1,800	126	Nueva Progreso	30,000
29	Nuevo Laredo	8,650	75	Texcoco	5,368	COLOTLIPA - ACAPULCO SYSTEM		
30	Raya	37,500	76	Tepeacac	115,000	87	Colotlipa	8,000
31	Monterrey Ext.	150,000	77	Paila	45,000	88	La Yunta	30,000
CD JUAREZ SYSTEM								
32	Cd. Juarez	15,000	78	Waxtepec	208,000	89	Las Cruces	18,750
33	Nueva Cd. Juarez	75,000	79	Lecheria	130,800	Mérida System		
MICHIGAN - CHAPALA - GUANAJUATO SYSTEM								
34	Santiago Ixc	900	80	Valle de Mexico	300,000	127	Progreso I	125
35	Jumatan	240	81	Moncali	97,500	128	Progreso II	125
36	La Planta	960	82	Tacubaya	30,000	129	Progreso III	125
37	Tepec	6,000	83	Alameda	8,800	130	Progreso IV	125
38	Santa Rosa	60,000	84	Zitotepic	368	131	Progreso V	125
39	Las Juntas	14,000	85	Zapotitlan	664	132	Progreso VI	125
40	Colimilla	51,200	86	San Simón	1,700	133	Progreso VII	125
41	Puerto Grande	23,400	87	Temascaltepec	2,336	134	Progreso VIII	125
42	Guadalajara	28,750	88	Martinez D'Arce	25,200	135	Progreso IX	125
43	El Romate	860	89	San Bartolo II	20,000	136	Progreso X	125
44	Colima	1,770	90	Durango	18,000	137	Progreso XI	125
45	Manzanillo	1,210	91	Irapuato	106,300	138	Progreso XII	125
46			92	Santa Barbara	57,575	139	Progreso XIII	125
			93	Tingambato	135,000	140	Progreso XIV	125
			94	Infernillo	600,000	141	Progreso XV	125
			95	La Villita	250,000	142	Progreso XVI	125





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MAP II