

The Electrification of Mexico

by

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TABLE OF CONTENTS

Chapter		Page
I	ABSTRACT	1
	Purpose of Study	2
II	THE EARLY DEVELOPMENT STAGE: 1879-1932	4
	Problems of the Early Development	5
	Indications of Change	6
III	THE POST REVOLUTION STAGE OF DEVELOP- MENT: 1933-1959	8
	Federalization	8
	A Tangible Plan for Expansion	10
IV	THE MODERN ERA: 1960-1971	12
	Nationalization	13
	Problems of Nationalization	14
	Problems With Labor	14
	Post Nationalization Act of 1967	16
	Recent Investment	17
	New Confidence	18
	Investment Trend	18
	Per Capita Growth in Generation	20
V	THE EXISTING INFRASTRUCTURE	24
	Generation Capacity	24
	Thermal-Hydroelectric Relationship	26
	Plant Size Realities	29
	Location of Installations	30
VI	THE PROBLEM OF ELECTRIFICATION IN RURAL MEXICO	40
	The C. F. E. "Packages"	44
	The Future	44

Chapter	Page
VII PROGNOSTICATIONS AND SOME SYNTHESIZING COMMENTS	46
FOOTNOTES	48
ADDITIONAL REFERENCES	52
APPENDIX	53

GRAPHS

	Page
GRAPH I : Annual Investment in the Federal Electricity Commission	19
GRAPH II : Growth in Per Capita Generation of Electricity in 100's of Kwhrs. With Corresponding U.S. Data	21
GRAPH III: Growth in Installed Electric Generation Capacity	25
GRAPH IV: Generation-Public- Private	27
GRAPH V : Thermal Electric Capacity and Generation in Percentage of Total	28
GRAPH VI: Yearly C.F.E. Transmission Line Installations	38

MAPS

MAP I :	Mexico: Generation Capacity by State Groups	Page 31
MAP II :	Mexico: Electric Installations With Capacity Over 100,000 Kw.	36
MAP III:	Mexico: General Areas Serviced With Electricity .	42
MAP IV:	Mexico: Rural Electrification by States	43

TABLES

TABLE I :	Investments in the Federal Electricity Commission, 1960-1970.	22
TABLE II :	Total Installed Capacity by Plant Size: Mexico - 1968.	30
TABLE III:	Generation Capacity-Population Data- Number of Installations, by States-1968.	32
TABLE IV:	Transmission Line Installations of the Federal Electricity Commission, 1960-70.	39

THE ELECTRIFICATION OF MEXICO

CHAPTER I

ABSTRACT: This study is an analysis of development in the electric energy industry of Mexico. Evidence analyzed reveals inconsistent programs for development and resulting chronic inadequate supply of electric energy. Nevertheless, urban Mexico is shown to be ninety-five percent electrified, but rural Mexico is shown to be generally less than fifty percent electrified. In the decade of the 1960's per capita generation increased from 313 to 612 Kwh. During the past five years, moreover, most of the early problems which plagued the industry have been resolved and current plans indicate promise for further increased electrification of Mexico within the next decade.

Mexico has experienced significant but variable development in its electric energy industry. Characterized at first by sporadic growth, the electric energy industry after its nationalization in 1960, began a period of rapid expansion. Thus, Mexico's total electric energy generation has doubled since 1964.¹ This recent expansion gains particular significance when one considers the importance of electric energy as a factor essential to industrialization and economic progress.

Purpose of Study

This research paper is an analysis of the electric energy industry in Mexico since its inception in 1879. The research is based entirely on library sources plus documents secured from the Federal Electricity Commission of Mexico. Only minimal documentary evidence is available in English, consequently the Oregon State University library has limited resources. The Director General of the Mexican electricity commission however, was generous in providing materials, especially annual reports, which provided basic data. After perusing library sources, many reports and references, the resulting evidence and data was condensed to a concise account of the development of the electric energy industry.

The analysis examines government and private commitments and endeavors to relate them to the politico-socio-economic situation of Mexico. Although the recent realities of the electric energy industry are most pertinent to this research, the present cannot be fully comprehended without a review of the past and its political environment. Thus, three development stages are recognized.

1. The early development stage from 1879 to 1932.
2. The post revolution stage from 1933 to 1959 highlighted by the federalization of the electric industry and the birth of the Federal Electricity Commission.

3. The modern stage from 1960 to the present corresponding with nationalization of the electric industry and rapid expansion.

CHAPTER II

THE EARLY DEVELOPMENT STAGE: 1879-1932

The electrification of Mexico began in 1879 with the installation of a two Kw. capacity plant in a textile factory in Leon.² There followed installations of small plants in several other cities and in mining areas. The plants in mining areas not only stimulated the mining industry, but also sold electric energy to the public in surrounding areas. Thus a peculiar system of mixed electric service came into being--the servicio eléctrico mixto. Some remnants of this early system still exist.

The national government of Mexico very early was committed to supporting development of the electric energy industry. In 1881 the government decreed that electric lighting would be used by all municipal services in Mexico City. And in the same year a foreign owned company, Siemens and Halske³, installed forty street lights on a few major avenues and a trolley car was electrified along a stretch of nearly a mile and half of track. By 1890 it was said that Mexico City was the "best lighted city on the continent".⁴ Between 1892 and 1911 more than one-hundred electric companies entered the mushrooming Mexican market. By the turn of the century 177 plants,

totalling 20,000 Kw. of capacity were operating, only three of which were hydroelectric.⁵ This rapid growth in the number of small privately owned plants, although placing Mexico in the forefront of the youthful electric industry of the world, caused three serious problems.

Problems of the Early Development

The evidence of written reports and documents suggest that the unregulated expansion of Mexico's youthful electric industry resulted in three serious problems.

1. excessive competition and lack of central organization
2. inadequate research with resulting obsolescence
3. inadequate financial backing to support consistent growth

Excessive competition and fragmentation in the electric energy industry inhibited consistent expansion. The many small companies were simply not able to function effectively on their own, nor were they able to combat fragmentation with a co-operative effort. As one company would fail another would replace it. The records suggest that it was almost impossible to stimulate a central organization as each company was primarily concerned with its own well-being and not for the well-being of Mexico.

The apparent attitude of self interest resulted in lack of research needed to continue viability of the industry. Foreign investors apparently responded to an opportunity to make money, and research was not part of the plans for rapid financial gain. Moreover, many of the small companies were unable to support both research and new installations due to insufficient investment; hence research programs suffered.

Perhaps the most significant problem reported by the documents was that of insufficient investment in the electric energy industry. Due to a high mortality rate, it was difficult to encourage adequate investment. To combat inadequate investment the companies supplied electricity to the areas which were considered the most lucrative for the owners. Logically, the most lucrative areas were located in large cities, and rural development continued to lag behind urban-residential and industrial areas.

Indications of Change

Soon after the end of the Mexican Revolution, as early as 1920, there were indications of major changes to come in the electric energy industry. By 1926, most of the small companies had consolidated into two private groups, one of foreign ownership and one domestic. The foreign group was dominated by Mexican Light and Power Company, a Belgian group known as Mexlight. The resulting increase in

co-operation and capital helped to increase electrical output from 120,000 Kw. in 1920; to 350,000 Kw. in 1926; and 510,000 Kw. by 1930, however, the Mexican electric industry was still almost entirely controlled by foreign investments.⁷

With the ideals of the Mexican Revolution in the minds of many people, especially the notion that Mexican resources should be owned and controlled by Mexicans, many government officials and businessmen, during the 1930's, began planning legislation to gain national control of the electric industry.⁸

CHAPTER III

THE POST REVOLUTION STAGE OF DEVELOPMENT: 1933-1959

The second stage of development in the electric energy industry was characterized by increased government involvement and concern for the Mexican populous. It was during this important formative period that the Mexican government definitively realized the need for the expansion of the electric energy industry through the formation of a new government organization. The Federal Electricity Commission, once established, was to become the most important impetus in subsequent expansion.

Federalization

The efforts to re-structure the electric energy industry during the 1930's resulted in a concrete plan for the federalization of the industry. Efforts were first culminated in a 1933 constitutional amendment and in the same year in the creation of a new government agency, the Federal Electricity Commission. The societal basis for organizing a federal electric agency is very clear in the Constitution of Mexico. The Constitution states:

The right to generate, transform, distribute and supply electrical power to be used as a public service corresponds exclusively to the Nation. No concessions shall be granted in this activity to private parties and the Nation shall develop and avail itself of the material and natural resources required for such purposes.⁹

With the necessary constitutional support and the blessing of the Mexican people, the Congress of the Union, in 1933, authorized the organization of the Federal Electricity Commission--Comisión Federal de Electricidad (C.F.E.). President Abelardo L. Rodríguez stated that the C.F.E. would be charged with:

- . Organizing and directing a national system for the generation, transmission and distribution of electric energy, based on technical and economic principles, for the purpose of obtaining at the minimum possible cost the most service in benefiting the general interests.¹⁰

In short, the Federal Electricity Commission was established as an autonomous public organization with independent capital and legal status, to plan and construct the national electrification system of Mexico. It was not until 1937, however, that President Lázaro Cárdenas completed the law organizing and defining the Federal Electricity Commission, along the guidelines established by Abelardo L. Rodríguez. The first budget for the C.F.E., during 1937, was only 50,000 pesos, a most insignificant amount by present standards.¹¹

The creation of the C.F.E. did not immediately revolutionize the growth of the electric industry. In fact, from 1939 to 1944 there

was little increase in electric output. This period of little expansion was related to the Second World War and also to the fact that Mexico was experiencing political and social problems with resulting instability discouraging investment. In summary, the C. F. E. was charged with solving the problems associated with the expansion of the electric industry, however, it was not at first given the necessary support with which to solve the problems. Thus, during the late 1940's both government and public interest groups were still searching a viable plan for the expansion of the electric energy industry.

A Tangible Plan For Expansion

Analysis of the literature suggests it was not until the ending of the 1940's that any notions of a viable plan for expanding the electric industry began to evolve. Knowledgeable political and industry leaders realized that the existing fragmentation of the industry was untenable if adequate expansion of service and generation was to be accomplished. As a result, January 11, 1949 an additional law was authorized by the Congress to aid the C. F. E. in its struggle for the integration and development of the electric industry. The objectives of the 1949 law were:

- to study and plan a system for the electrification of the Nation; to carry out works related to the generation of electric energy; acquire certain private installations; participate in the planning of electric plants by private organizations and

industries; and in general, oversee and direct operations to see that the aforementioned objectives are reached.¹²

With the implementation of this new law, the C. F. E. finally had the legal authority to bring electric energy to the Mexican people. But, problems, technical, political and economic still had to be overcome.

CHAPTER IV

THE MODERN ERA: 1960-1971

During the 1950's conflicting concepts concerning the appropriate organization of the electric industry evolved into two distinct political opinions. One philosophy, supported by the Federal Electricity Commission, maintained that the electric industry should be organized according to the intent of the 1937 law which implied complete control of the public electric industry by the C. F. E. The advocates of this philosophy contended that only through enforced nationalization would it be possible to provide adequate and consistent development. Adequate development was conceived to include a program for rural electrification, where private enterprise was uneconomic, organized research and sufficient investment to support needed expansion. The opposing philosophy with private enterprise support contended that control of the electric industry should remain diversified. The advocates of diversification feared that too much power and control would be given to one organization--the C. F. E.

Nationalization

President Adolfo López Mateos, on September 27, 1960, ended a debate over the two opposing philosophies by a decree to nationalize the electric industry including the announcement that the Mexican government would purchase all foreign owned installations. The two largest companies, Mexican Light and Power (Mexlight) and American and Foreign Power Company were purchased for \$52,000,000 and \$65,000,000, respectively.¹³ In addition the government assumed a medium and a long term debt of the Mexlight. With the nationalization of the two big companies and a number of small ones the Mexican government came into control of 98 percent of the installed capacity for public service. López Mateos justified his actions by reference to the following objectives:

1. to promote the industrialization of the country
2. to give to the state control of important natural resources
3. to elevate the standard of living in Mexico¹⁴

The nationalization of the electric industry was widely approved by the Mexican people who remembered the Revolutionary doctrine that Mexican resources should be developed by Mexicans for Mexicans.

Problems of Nationalization

The plan for nationalization was fine in theory, but in practice there continued to be many problems. It seems the Mexican government was attempting to pacify both factions, one advocating strong central control and one favoring diversified control. One finds evidence of this in the fact that the government purchased the foreign-owned plants but placed them under the control of a separate government administration apart from the C. F. E. The Federal Electricity Commission considered this government action to be detrimental.¹⁵ The literature does in fact make clear that the creation of the additional and new government agency for administration of electric industry further complicated problems of the industry. In particular, the new agency was noted to have complicated an already complex labor situation.

Problems with Labor

In conjunction with the unresolved problem of control in the electric energy industry there was a resulting problem with labor. In addition to the Federal Electricity Commission, and the Compañía de Luz y Fuerza del Centro, certain other private-domestic enterprises controlled a portion of the electric industry and hence a corresponding portion of the labor force employed in the processes

associated with the generation and transmission of this electric energy. The labor relationships involved three labor unions, each with separate working agreements and each directly involved in the operation of the electric industry. Because of the diversified control and interests in the electric energy industry, it was becoming increasingly difficult for the C. F. E. to co-ordinate programs--its inherent duty. This situation prompted Guillermo Domínguez, Director General of the C. F. E. to assert, "The electric industry must be completely reorganized."¹⁶

By 1964 three organizations employed workers from three different unions. In central Mexico the Compañía de Luz y Fuerza del Centro employed workers from the Mexican Electrical Union; the Electric Industry and 18 other groups employed members of the Union of Electrical Workers of the Mexican Republic; and the Federal Electricity Commission employed members of the National Electrical Union, its original union.¹⁷ But the activities of these three unions were not to go unchecked.

The Secretary of Industry and Commerce and the National Wage Commission were charged with the task of creating a plan by which these separate entities would develop a plan simultaneously for the electrification of Mexico--a plan which would stop these organizations and unions from stifling the expansion of the industry. Moreover, the Mexican government had not yet solved the problems of inadequate

investment and insufficient research. In summary, the involvement of the Secretary of Industry and Commerce and the National Wage Commission only hastened an inevitable definitive action--the complete nationalization of the industry.

Post Nationalization Act of 1967

During the mid 1960's it became evident that the fragmented nationalization of the electric energy industry had been unsuccessful in combating two basic problems. First, adequate funding still had not been provided. When the C.F.E. was conceived, it was to be a financially independent, self-supporting organization, yet because of the still uncontrolled competition between the two main components of the public electric energy industry, financial adequacy was not a reality. Secondly, the mandate to provide rural electrification had not been accomplished.

President Díaz Ordaz, realizing the need for further effort, issued the following statement:

We need to integrate the electric industry. To accomplish this we must work hard. But, only through the complete integration of the electric industry can we have production commensurate with our needs.¹⁸

Finally, February 14, 1967, Díaz Ordaz ordered the definitive integration of the electric industry by placing under the control of the C.F.E., the plants the Mexican government had purchased in

1960. Only one company, the Compañía de Luz y Fuerza del Centro, remained under its own administration. This company primarily supplies electric energy to Mexico City, but roughly 70 percent of the electric energy sold by this company is purchased from the C. F. E. This action not only definitively nationalized the electric industry, but marks the beginning of a period of phenomenal investment and growth.

Recent Investment

The importance to economic development of investment to the electric energy industry has been stressed, thus it is pertinent to review trends of investment. It should be remembered that the early days of the industry were characterized by many small independent companies, with resulting lack of adequate investment. Apparently the resistance to investment was due principally to a lack of confidence in the existing industry and a similar lack of confidence remained in the industry until the mid 1960's. The result being that the government and the public including private capitalists believed in the fundamental need for electricity, but not in providing the financial support necessary for development. The spirit is reflected in the following statement:

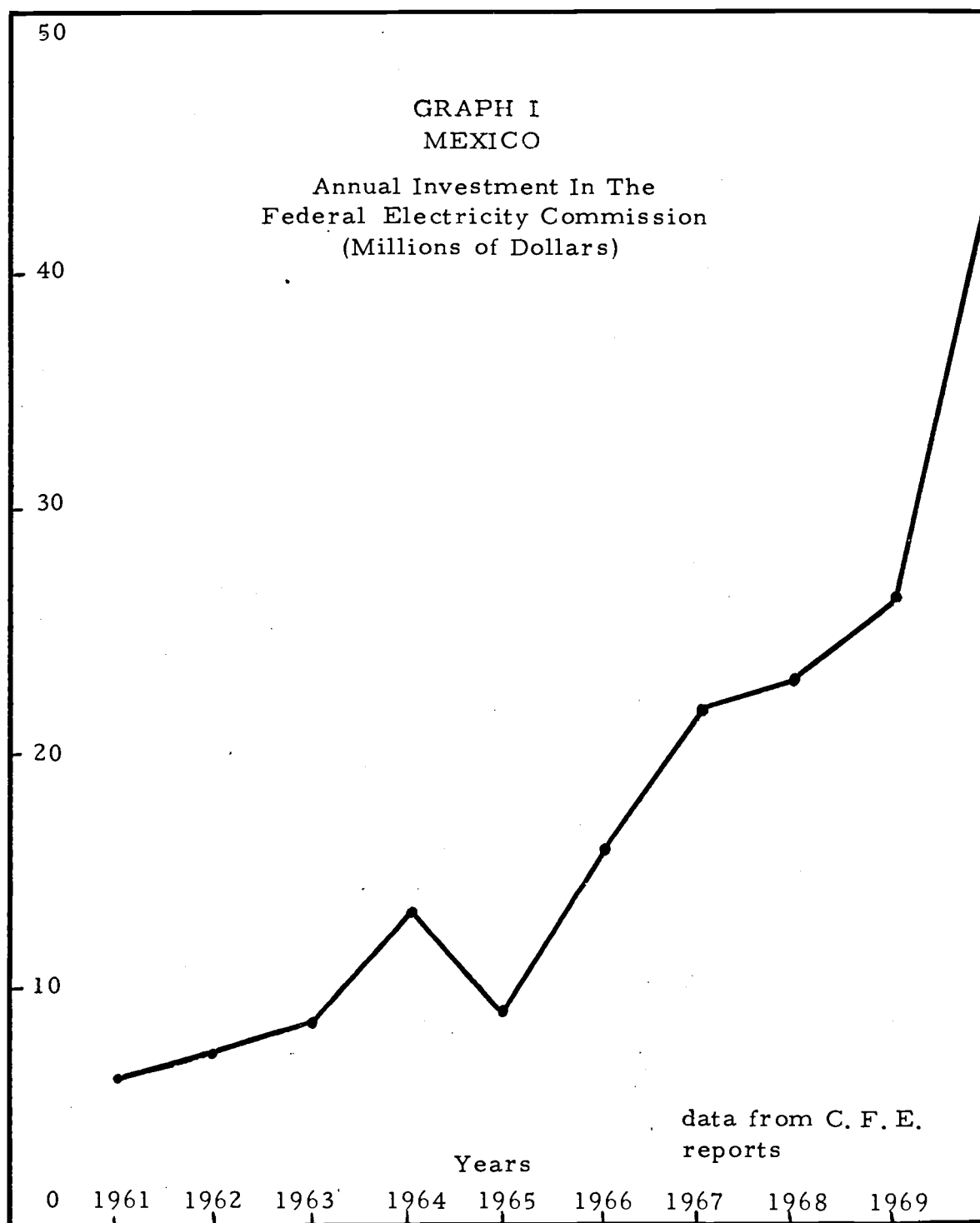
Energy, the base of industrialization, essential factor in the liberation of the human effort, and indispensable element of modern life, must be produced in a sufficient amount and distributed in every part of the republic.¹⁹

New Confidence

José Hernández Delgado, President of the influential Mexican industrial bank, Nacional Financiera, suggests in a recent article, "Confidence as a decisive factor in the growing Mexican economy," why substantial investment in the C.F.E. will now be made. With the complete and final nationalization of the electric energy industry in 1967, the Mexican government made a total commitment to the expansion of the industry. The C.F.E. controlled nearly 98 percent of the industry and almost autonomous decision making power. Investment began to significantly increase because it could be justified both on the basis of recent progress and of the promise for carefully planned expansion.

Investment trend

A brief overview is all that is necessary to note the dramatic increase in investment during the past decade. The graph 1²⁰ reveals the massive support being provided. The investments in the C.F.E. during the five years 1965 to 1970 were almost triple those of the previous five years 1959 to 1964 (\$1,506 million pesos to \$582 million pesos).²¹ The sharp rise of the investment curve after 1967 when the industry was definitively nationalized, reveals the increasing support by the federal government. In addition, foreign banks have manifested their confidence in the future of the electric industry by



significant investment. The World Bank, for example, has loaned the C.F.E. 975 million pesos during the past five years.²²

Several other foreign and domestic banks are becoming increasingly involved in the electric industry. In a July 27, 1971 speech, the new Director General of the C.F.E., Guillermo Villarreal Caravantes, stated that substantial investment is being negotiated for the next ten years with the Nacional Financiera, the International Bank of Reconstruction and Development, and the Banco Nacional de Obras y Servicios Públicos.

Per Capita Growth in Generation

Graph II²⁴ reveals the substantial increase in per capita generation of electricity in Mexico, and helps to put into perspective the development of electricity in Mexico. The per capita generation nearly doubled during the decade of the 1960's and has been predicted to increase an additional 50 percent by 1976. At the same time one should recall that the consumption of electricity in Mexico is small by United States standards. In 1970, Mexico had less than one-thirteenth the per capita generation of the U.S. and only a slightly greater rate of increase.

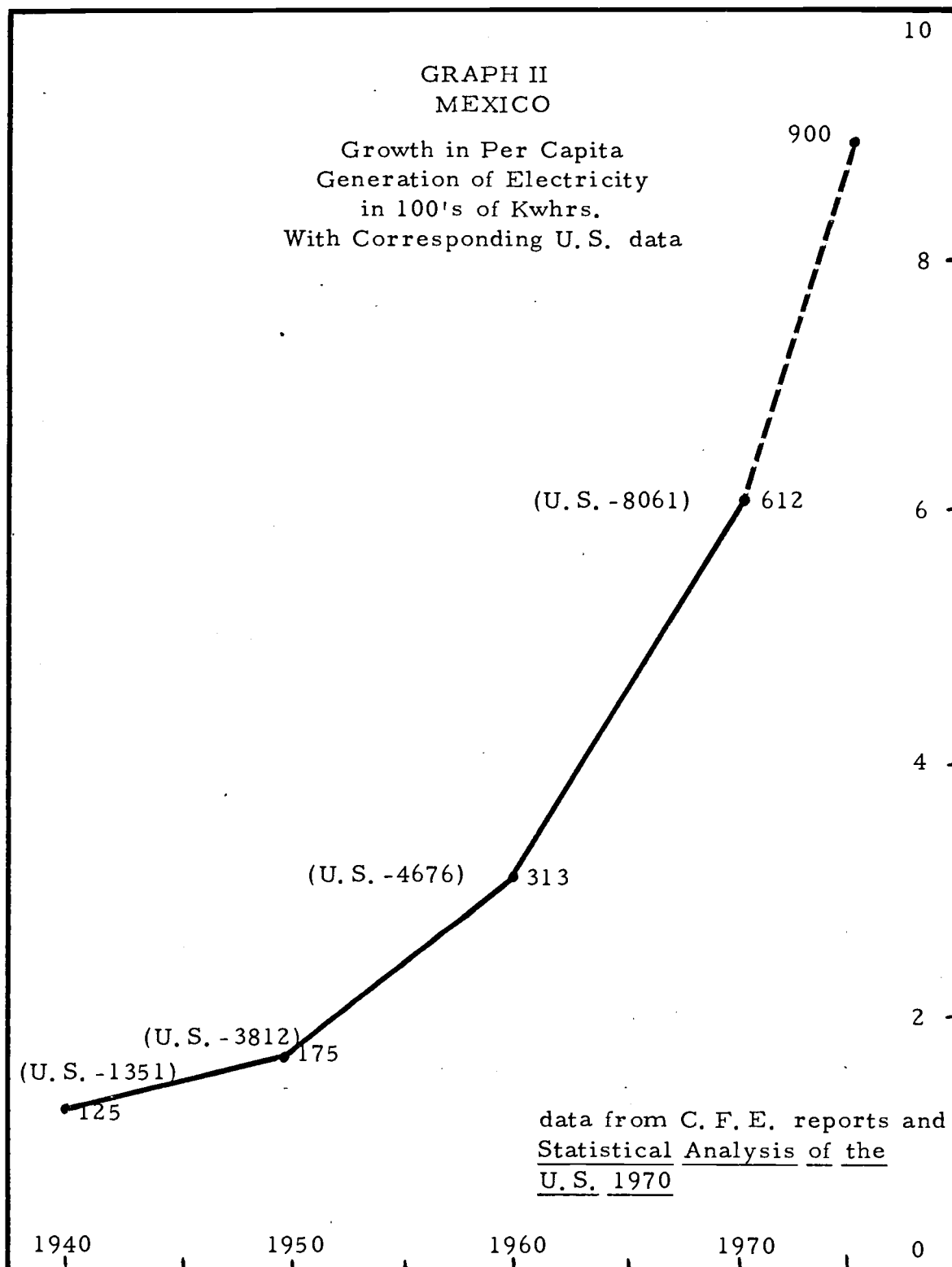


TABLE I. Investments in The Federal Electricity
Commission, 1960-1970

Year	Number of Dollars	Cumulative Dollar Value
1960		21,216,320
1961	6,390,000	27,608,080
1962	7,232,000	34,840,160
1963	8,767,840	43,607,840
1964	13,875,200	57,482,400
1965	8,888,880	66,371,280
1966	16,200,000	82,571,280
1967	22,176,240	94,747,520
1968	23,734,720	128,482,240
1969	26,660,800	155,461,440
1970	43,818,880	199,280,320

The growth curve does not reveal the well-known reality of great differences in availability and consumption in Mexico. Mexico's cities are generally adequately electrified, but many rural areas are either totally lacking connections or have extremely modest consumption. For example, rural homes having electricity commonly utilize only one or two small lights. Chapter IV, which follows, reviews the basic infrastructure which has been accomplished to provide this real growth in consumption.

CHAPTER V

THE EXISTING INFRASTRUCTURE

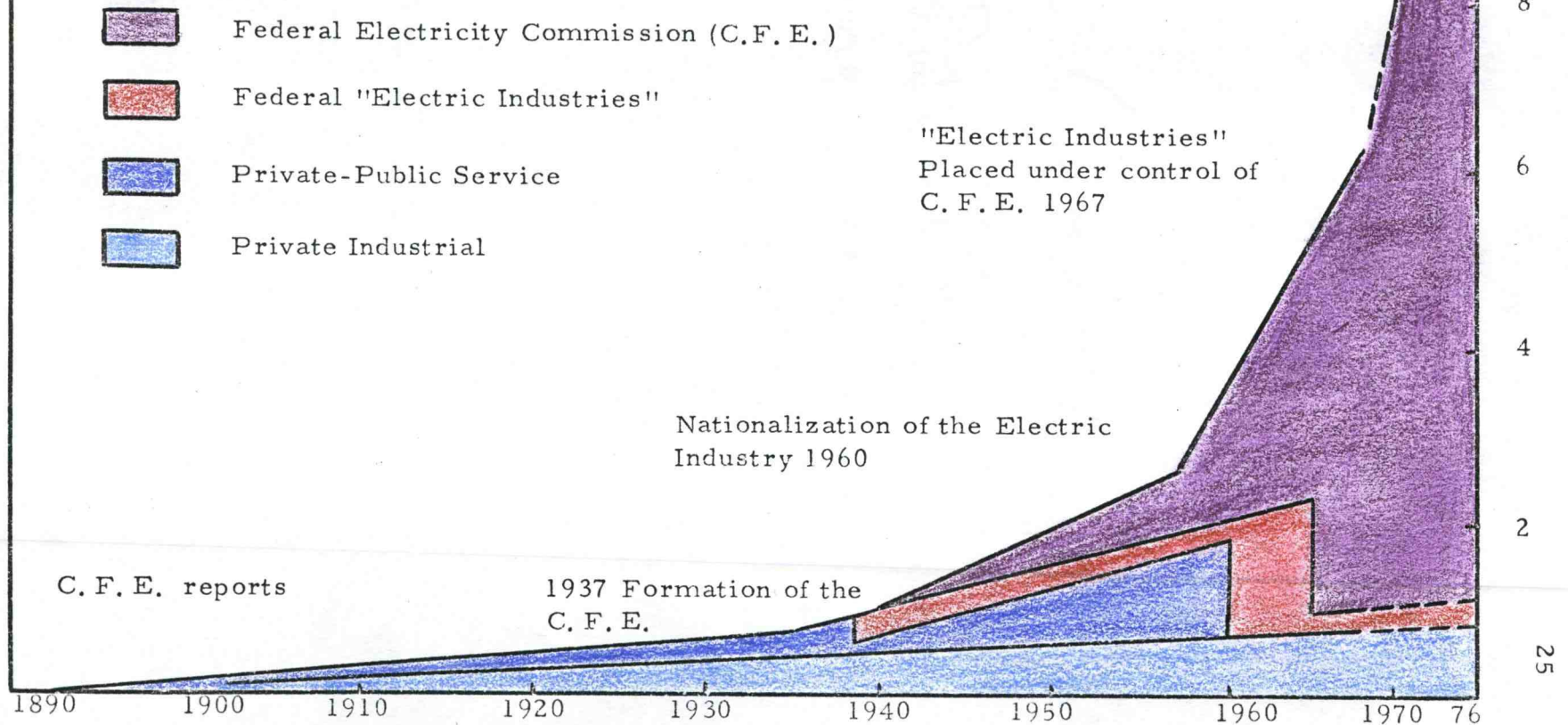
The analysis of the electric energy infrastructure is divided into: generation capacity; a comparison between thermal and hydroelectric installations; plant size realities; and the location of installations. The problem of electrification in rural Mexico is briefly discussed at the end of this chapter.

Generation Capacity

Recent growth of the electric energy industry has been spectacular, while early growth was inadequate and, at best, sporadic. The total installed capacity in 1940 (1879-1940) is roughly equal to the proposed new capacity to be installed during 1971. Graph III reveals development trends of the electric industry, 1900-1976, in terms of installed capacity.²⁵ In addition, the trend of ownership of installed capacity is revealed by the use of four colors. Private industrial service refers to plants owned and operated, by industries such as mining and paper mills, for their own needs. Such plants exist, in spite of nationalization, and should increase modestly in the next few years. The public service, private investment category refers to private investment companies serving the public, particularly the

GRAPH III MEXICO.

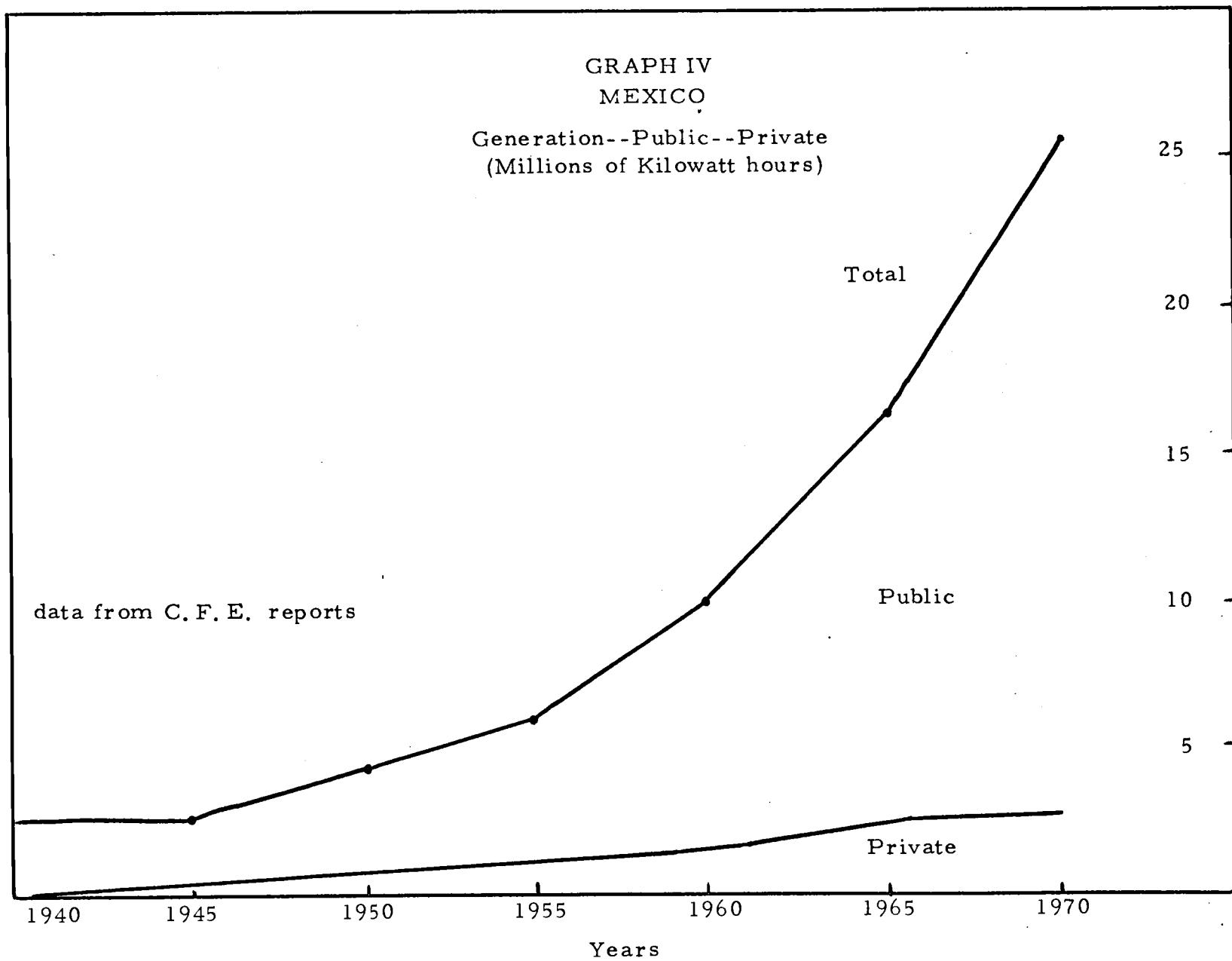
Growth In Installed
Electric Generation Capacity
(Millions of Kilowatts)



Compañía de Luz y Fuerza del Centro which serves a part of Mexico City. Acquired by Federal Government - "Electric Industries" refers to capacity which was purchased by the Federal government in 1960, but not placed under the jurisdiction of the Federal Electricity Commission until 1967. Federal Electricity Commission refers to capacity constructed and later received for operation by the C.F.E. The graph reveals the substantial growth that has occurred since nationalization in 1960. As of 1970 the government operated Federal Electricity Commission accounted for essentially all public service of electricity, the only exception being the small thermal plants operated by Compañía del Luz y Fuerza del Centro -- a company which purchases about two-thirds of its electric energy from the C.F.E. Graph IV²⁶ shows total generation, 1940-1976, by public and private service. Public service in 1969 accounted for 82 percent of total installed capacity but 87 percent of generation.

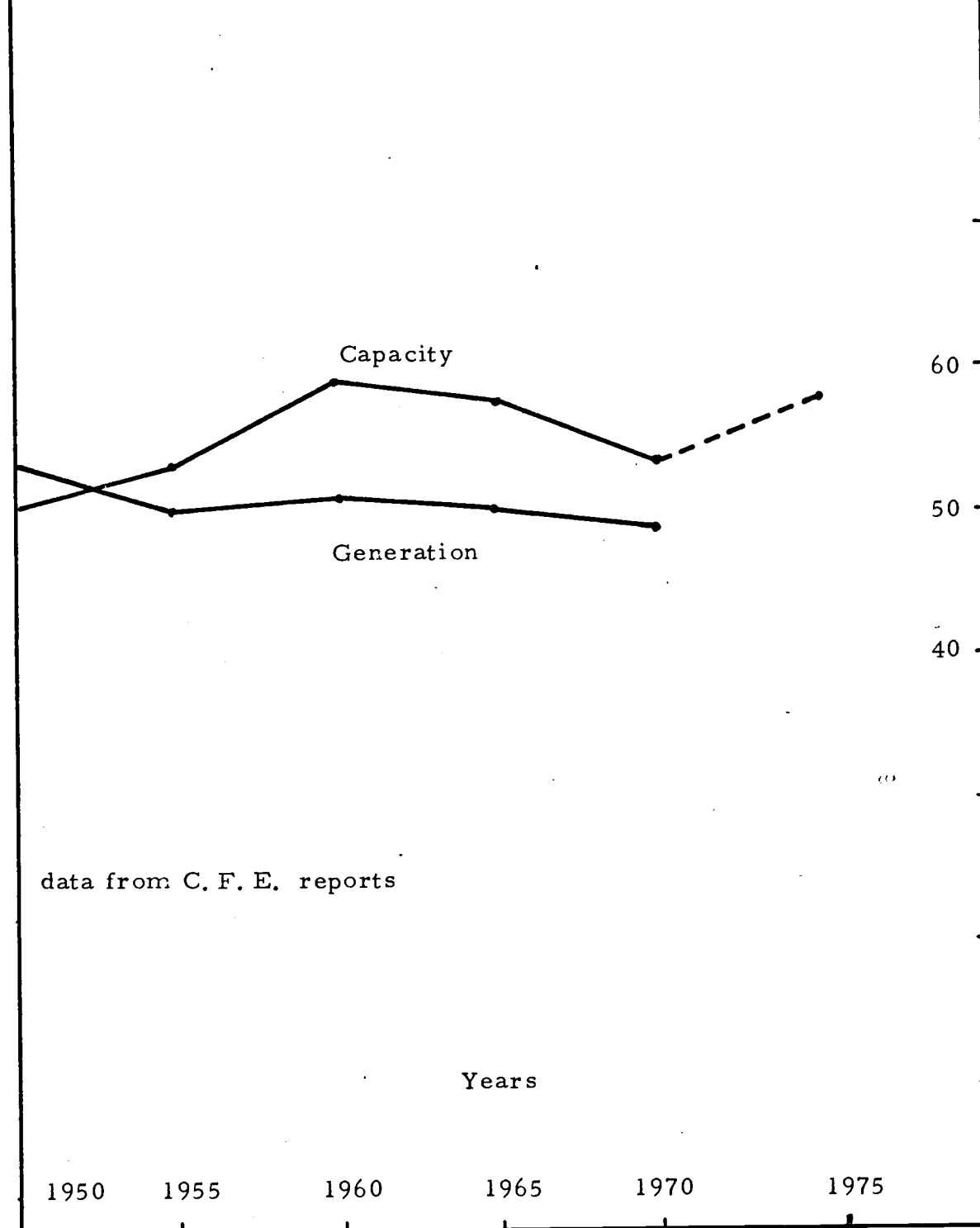
Thermal - hydroelectric relationship

In terms of thermal and hydroelectric plants, in recent decades, Mexico has depended about equally on each. Graph V²⁷ reveals that the trend of investment is slightly favoring thermal development, in spite of recent major hydroelectric installations such as the Infiernillo and Malpaso projects. This trend toward thermal is undoubtedly related to the distance of market-centers of population - from



GRAPH V
MEXICO

Thermal Electric Capacity
and Generation in Percentage of Total



hydroelectric sites and availability of fuels. Also included on the graph is a curve of the percentage of electric energy generation from thermal and hydroelectric installations which surprisingly differs very little.

Plant size realities

A significant reality of Mexico's electric industry is the size of plants. Table II²⁸ reveals that of the total number of plants in existence in 1968, over two-thirds had an operating capacity of less than 1,000 Kw. The C.F.E. accounts for 11 of the 13 large plants. Over 80 percent of the less than 1,000 Kw. size plants are private companys'.

Location of Installations

It is clear that the electric industry in Mexico began with many small plants, mostly thermal, constructed at market centers. As a result, there has been concentration in the major urbanized areas. Only in recent decades has there been the development of the large hydroelectric plants.

Map I²⁹ and Table III³⁰ reveal the capacity of installations by state groups. It is apparent that central Mexico has the most installed capacity as one would expect to find generation facilities near the major population centers. The two central districts, East Central

TABLE II. Total Installed Capacity By Plant Size: Mexico - 1968.

Capacity in Kw.		C. F. E.		Luz Y Fuerza Del Centro		Others		Total	
Plants of		No.	Kw	No.	Kw	No.	Kw	No.	Kw
50 -	99	24	1,586	--	--	182	12,117	206	13,703
100 -	199	18	2,543	--	--	175	23,581	193	26,124
200 -	499	33	10,265	1	384	142	42,832	176	53,481
500 -	999	21	15,752	2	1,344	81	53,784	104	70,880
1,000	1,999	23	30,836	4	5,475	58	76,853	85	113,164
2,000	4,999	35	110,314	2	5,936	48	136,846	85	253,096
5,000	9,999	24	166,936	2	14,247	17	116,533	43	297,716
10,000	19,999	22	321,050	--	--	9	131,770	31	452,820
20,000	49,999	21	647,191	3	121,500	8	244,957	32	1,013,648
50,000	99,999	12	843,645	2	172,445	1	94,500	15	1,110,590
over	100,000	11	2,460,080	2	345,800	--	--	13	2,805,880
Total		244	4,610,198	18	667,131	721	933,733	983	6,211,102

MAP I. MEXICO - Generation Capacity by State Groups - 1968



data from C. F. E. reports

TABLE III. Generation Capacity--Population Data--Number of Installations by State, 1968.

Region of Mexico	State	Population to Nearest Thousands	Installed Kw. Capacity to Nearest Thousands	Number of Installations over 50 K. W.
Northwest	Baja California	870	230	18
	Nayarit	544	17	13
	Sinaloa	1267	196	49
	Sonora	1099	251	35
	Territory of Baja California	128	23	20
Subtotal --		3908	717	135
North	Chihuahua	1613	231	30
	Coahuila	1115	125	46
	Durango	939	201	31
	San Luis Potosi	1282	76	38
	Zacatecas	952	36	28
Subtotal --		5901	669	173
Northeast	Nuevo Leon	1695	541	31
Gulf Coast	Tamaulipas	1457	219	37
Subtotal --		3152	760	68
South	Tabasco	768	46	13
Gulf Coast	Veracruz	3815	428	104
Subtotal --		4583	474	117

TABLE III (Continued)

Region of Mexico	State	Population to Nearest Thousands	Installed Kw. Capacity to Nearest Thousands	Number of Installations over 50 K. W.
Chiapas	Chiapas	1569	414	43
East				
Central	Hidalgo	1194	18	14
Mexico	Mexico	3833	802	52
	Morelos	616	14	11
	Puebla	2508	493	50
	Queretaro	486	10	10
	Tlaxcala	421	1	6
Subtotal --		9058	1338	143
West				
Central	Aguascalientes	338	15	5
	Guanajuato	2270	82	14
	Jalisco	3297	258	58
	Michoacan	2320	257	33
Subtotal --		8225	612	110
South	Colima	241	14	4
Pacific	Guerrero	1597	738	18
	Oaxaca	2172	201	27
Subtotal --		4010	953	49

TABLE III (Continued)

Region of Mexico	State	Population to Nearest Thousands	Installed Kw. Capacity to Nearest Thousands	Number of Installations over 50 K. W.
Yucatan	Campeche	251	21	9
	Territory Quintana Roo	88	7	11
	Yucatán	758	73	23
Subtotal --		1097	101	43
TOTAL --		41,498	6,038	881

Data from C. F. E. reports.

with 22 percent and the West Central with ten percent, account for one-third of the nation's generation facilities. At the same time it is significant that the region accounts for 42 percent of the national population. This relationship reveals the reality that the Central zone includes a very large rural population using modest amounts of electricity. Moreover, the West Central zone especially includes a large area unserved by electricity in the Pacific West in which the civilizing wires have little penetrated. The East Central portion is more homogeneous and in spite of importations of electricity from outside the region, has only 22 percent of capacity for 22 percent of population. Here again, the data masks over the reality of large industrial and urban consumption included with small or non-existent rural consumption.

Not surprisingly, the Northwest has excess capacity as a result of small population and large scale development in the Western Sierras. The Northeast Gulf Coast relationship reveals the concentration of industry in Monterrey. In the South Pacific and Chiapas one finds capacity percentage superior to population revealing large installations and transmission lines to the East Central zone.

Map II³¹ shows the location of Mexico's relatively few large generation plants. The concentration of the largest installations are in central Mexico and many of those which are not close to Mexico

MAP II. MEXICO - Electric Installations with Capacity over 100,000 Kw.



City are nevertheless connected through large transmission tie lines. Two notable examples are the Infiernillo and Malpaso hydroelectric projects. Malpaso planned to have a capacity of 1.1 million Kw. and Infiernillo planned for 1 million Kw. both are tied into the central areas by major tie lines. The concentration of large thermal plants is in the northeastern state Nuevo Leon.

Currently the development emphasis is on integrating a national system. Graph VI³² reveals the commitment of the Mexican government in providing transmission lines. In the last five years there has been an average of more than 6,000 kms. annual installation. The development of long distance transmission lines, generally associated with large projects, has been used to increase service to both the major cities and rural areas.

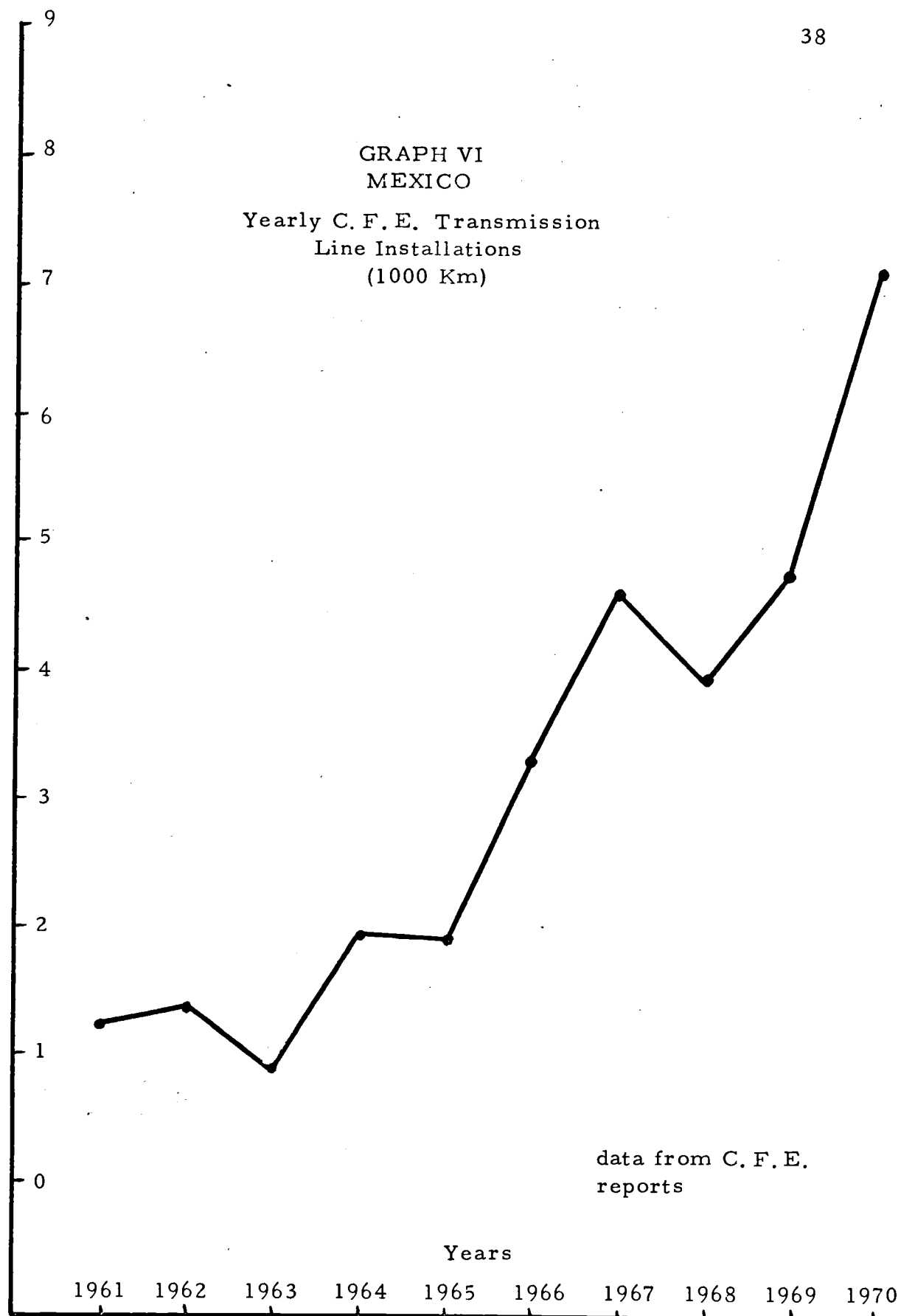


TABLE IV. Transmission Line Installation of The Federal
Electricity Commission, Mexico, 1960-1970

Year	Km Installed	Cummulative Km Installed
1960		4945
1961	2265	7210
1962	2263	9473
1963	1738	11211
1964	2849	14060
1965	2892	16863
1966	4156	21018
1967	5576	26524
1968	4783	31377
1969	5728	37105
1970	9023	46128

CHAPTER VI

THE PROBLEM OF ELECTRIFICATION IN RURAL MEXICO

A reality of electrification in Mexico is an imbalance between the urban areas where nearly 95 percent of the population have service and the rural areas where only about 50 percent of the population are with service. The problem of electrification of rural areas is easy to understand. Many of the small population centers (ranches, villages and ejidos) are in remote areas and commonly miles from any existing facilities, hence the costs of development are high and the reasonable future consumption is small. Rural electrification has further been inhibited by government action in freezing the charges for electricity at the 1962 level, even though installing one light per house in a remote village might cost as much as lighting a whole section of a city. Guillermo Martínez Domínguez, immediate past Director General of the Federal Electricity Commission, states, with regard to the feasibility of the rural electrification program:

. . . commercially it would never be possible to accomplish. It would have to be accomplished for national interest.³⁴

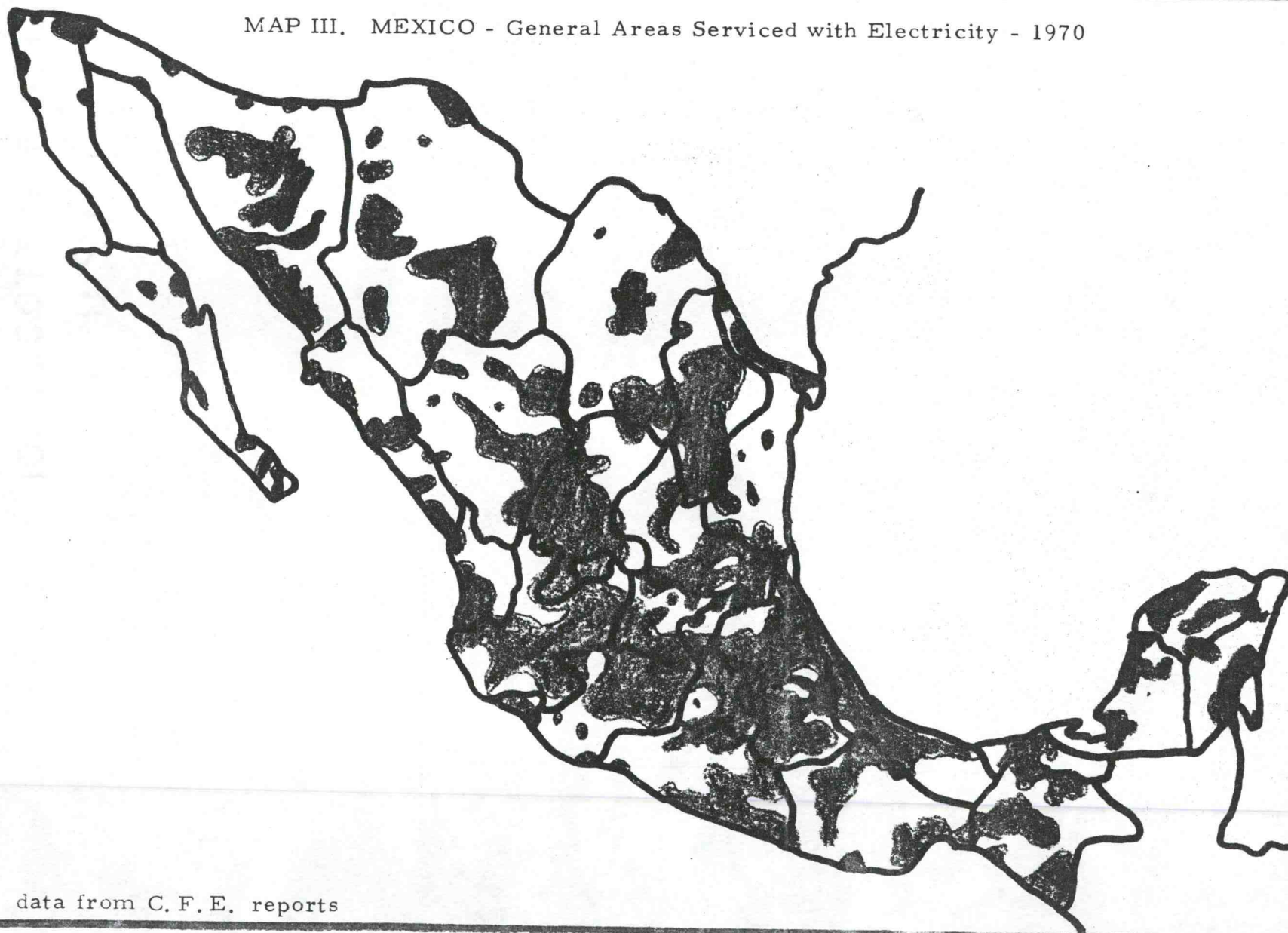
In spite of the inherent problems associated with the rural electrification, real progress has been achieved during the past five

years. During the period 1965-1970, 7,000 new population areas, (ranches, villages and ejidos) were provided with some electricity, tripling what had been completed in all previous years. And, since 1965, over 7,000,000 rural Mexicans have received service from electricity.

Map III³⁵ reveals the general pattern of areas serviced by electricity. It is apparent from the map that the most electrified areas are generally in the central portion of Mexico. The northern third of Mexico is little electrified, but is sparsely populated. Commonly the areas surrounding large installations have service. Comparing the location of areas served with the location of the major installations shown on Map II this reality is revealed. But the map is somewhat misleading as certainly not all the shaded areas are completely serviced by electricity. Nearly 50 percent of Mexico is still without electric service.

Map IV³⁶ more accurately reveals the rural electrified progress by the percentage of electrification by state. The data is population served. Surprisingly enough, areas in the central zone are generally poorly electrified. The explanation most likely is that these are states with large rural populations and in difficult terrain. In contrast, Lower California stands out as being highly electrified, but in reality this probably correlates with small rural population rather than development of rural electrification.

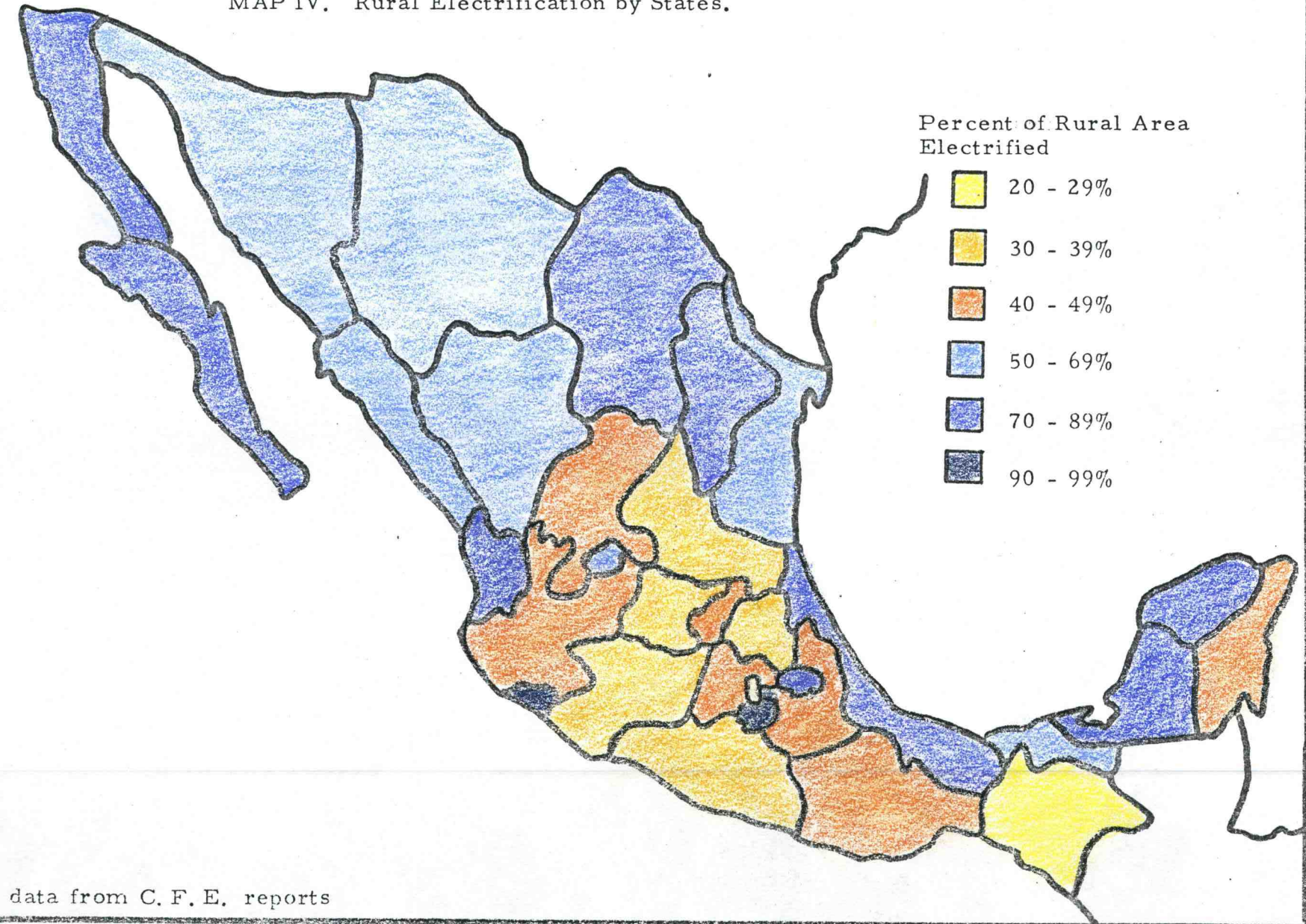
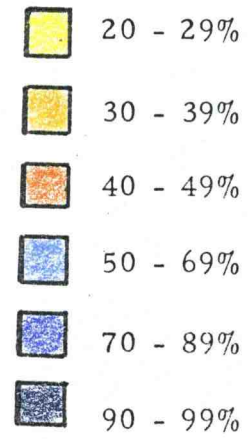
MAP III. MEXICO - General Areas Serviced with Electricity - 1970



data from C. F. E. reports

MAP IV. Rural Electrification by States.

Percent of Rural Area
Electrified



data from C. F. E. reports

The C. F. E. "Packages"

The C. F. E. is currently attempting to effect further rural electrification through the development and implementation of certain "package" electrification offers. The "package" offers are being made available on a rental basis to recently electrified rural homes. Thus, the home owner needs no capital to benefit from such items as: washers and dryers, sewing machines, radios and other appliances which add to the well-being of the family as well as to electric consumption. Larger "packages" are available for the development of basic industry in the rural areas. A third type of "package" includes installations and devices which would aid the farmer. In the past two years, over 300,000 of these packages have been contracted.³⁷

The Future

The Mexican government has a growing concern for raising the living standard of rural Mexico and has been working with the C. F. E. recently to formulate concrete plans for its electrification. Thus, the period of 1971 to 1976 undoubtedly will be characterized by efforts to electrify many new areas. According to the Director General of the C. F. E. efforts will be concentrated on rural areas. The program includes bringing electricity to more than 5,000,000 inhabitants in over 9,000 population areas. The total percent of rural Mexico

electrified in 1970 was about 50 percent. By 1976 it has been estimated that an additional 20 percent will receive service. In fact, during the past six years the investment per capita for the rural electrification program was \$256.79; during the next six years, due principally to the dispersion of persons, this cost has been estimated to increase to \$406.00 per person.³⁸

CHAPTER VII

PROGNOSTICATIONS AND SOME
SYNTHESIZING COMMENTS

Mexico is distinguished by having been in the forefront of the electric energy industry of the world as early as the 1880's. During the early part of the twentieth century, however, political and social problems plagued the industry and until the creation of the Federal Electricity Commission in 1937 there was only limited increase of installed capacity. The Second World War and inadequate government support inhibited the early development of the C. F. E. and the industry. Finally in 1960, decades of discussion were ended by Adolfo López Mateos, President of Mexico, in nationalizing the industry and the government purchase of all existing privately owned plants which had been serving the public. Then in 1967 the final definitive nationalization of the industry was effectuated by a government action to give control of all publicly owned plants to the C. F. E. Since 1967 the expansion and development of the industry has been significant.

In the future the electric industry of Mexico will be called upon to meet major requirements of industrial centers, homes and public services in every city, in every region, in all of the country. It

must satisfy, as well, increasing per capita requirements that serve to raise the standard of living of the Mexican population. According to Guillermo Domínguez:

Before 1965 electrification was a privilege of only a part of the Mexican population.³⁹

The "privilege" concept is rapidly diminishing. The fact is that consumption of electricity is growing at a rate of over 12 percent per year and if this rate continues as projected the capacity of electrical production will need to be doubled within the next six years. To meet this increasing demand and assure that the electric industry is never again a privilege "of only a part of the population", Mexico will have to construct new and larger facilities every year.

FOOTNOTES

1. Guillermo Martínez Domínguez, "Integración y desarrollo de la industria eléctrica de México, la obra 1965-1970," El Trimestre Económico, Vol. XXXVII, No. 150, pp. 455.

2. For historical background see:

Comisión Federal de Electricidad, 25 años al servicio de México, 1937-1962 (Mexico, D.F.: Government Printing Office, 1963), pp. 1-28.

_____. "Comisión Federal de Electricidad" (Mexico, D.F.: Departamento de Prensa y Relaciones Públicas de la Comisión Federal de Electricidad, 1966), pp. 1-24.

_____. "Electrificación base del desarrollo industrial de México" (Mexico, D.F.: Government Printing Office, 1965), pp. 1-38.

Joaquín Villasana, et. al., "Historia de la electrificación en México," Electrificación Rural, No. 10 (May-June 1971), pp. 52-58.

Jorge L. Tamayo, Geografía general de México. 2nd, ed., Vol 4 (Mexico, D.F.: Instituto Mexicano de Investigaciones Económicas, 1962), pp. 343-359.

L. Vincent Padgett, The Mexican Political System (Boston: Houghton Mifflin, 1966).

3. Ibid., Tamayo, p. 346.
4. * Ibid., "Comisión Federal de Electricidad," p. 8.
5. Ibid., pp. 10-11.
6. Op. Cit., Padgett, p. 206.
7. Op. Cit., Villasana, p. 56.
8. Comisión Federal de Electricidad, "Comisión Federal de Electricidad," p. 18.

9. Op. Cit., "Comisión Federal de Electricidad," p. 3.
- 10.* Ibid., p. 16.
11. Op. Cit., Comisión Federal de Electricidad, "Comisión Federal de Electricidad," p. 16.
- 12.* "C.F.E., una organización integrada, al servicio de Mexico," Electrificación Rural, No. 18 (April 25, 1969), pp. 5-6.
13. Op. Cit., Padgett, p. 208.
- 14.* Op. Cit., "Comisión Federal de Electricidad," p. 18.
15. Op. Cit., "C.F.E., una organización integrada, al servicio de Mexico," p. 6.
- 16.* Op. Cit., Domínguez, p. 437.
17. Ibid., p. 438.
- 18.* Ibid., pp. 434-435.
- 19.* Comisión Federal de Electricidad, "Informe Anual, 1964-1965," p. 1.
20. Comisión Federal de Electricidad, "IV Congreso de Electrificación Rural," (Mexico, D.F.: Central de Artes Gráficas, 1971), p. 22.
21. Comisión Federal de Electricidad, "Informe de Actividades, 1968-1969," (Mexico, D.F.: Comisión Federal de Electricidad, 1970), p. 8.
22. Op. Cit., Domínguez, p. 448.
23. Op. Cit., Comisión Federal de Electricidad, "IV Congreso de Electrificación Rural," p. 22.
24. Director General de la Comisión Federal de Electricidad, "Informe," (Mexico, D.F.: Comisión Federal de Electricidad: July 22, 1971), p. 17.

25. Data for 1940-1960:
Nacional Financiera en el desarrollo económico de Mexico, 1934-1964 (Mexico, D. F.: Nacional Financiera, 1964), p. 25.
- Data for 1960-1970:
Op. Cit., Domínguez, p. 455.
26. Data for 1900-1960:
Op. Cit., 25 años al servicio de Mexico, 1937-1962, p. 23.
- Data for 1960-1970:
Op. Cit., Domínguez, p. 455.
- Data for 1970-1976:
Op. Cit., Director General de la Comisión Federal de Electricidad, p. 18.
27. Op. Cit., "IV Congreso de Electrificación Rural," p. 24.
28. Op. Cit., Pedroza, p. 17.
29. Ibid., p. 13; Op. Cit., "IV Congreso de Electrificación Rural," p. 18.
30. Ibid., p. 13; p. 18.
31. Nacional Financiera, Nacional Financiera en el desarrollo económico de Mexico, 1934-1964 (Mexico, D. F.: Nacional Financiera, 1964), p. 30.
32. Op. Cit., "IV Congreso de Electrificación Rural," p. 25.
33. Ibid., p. 25.
34. * Op. Cit., Domínguez, p. 439.
35. Comisión Federal de Electricidad, "Informe Anual de Actividades," (Mexico, D. F.: Comisión Federal de Electricidad, 1970), p. 8.
36. Op. Cit., "IV Congreso de Electrificación Rural," pp. 15-25.
37. Op. Cit., Director General de la Comisión Federal de Electricidad, pp. 20-22.

38. Ibid., p. 18.

39.* Op. Cit., Domínguez, p. 437.

* Translated from Spanish.

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Domínguez, Guillermo Martínez. "La electricidad y los combustibles en el desarrollo económico de Mexico," Mexico, D.F.: Comisión Federal de Electricidad, 1957.

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APPENDIX

TABLE I : STATISTICS OF THE ELECTRIFICATION OF MEXICO:
1950; 1955; 1960-1970.

Data for 1950, 1955, 1960:

Nacional Financiera en el desarrollo economico de
Mexico, 1934-1964, (Mexico, D.F.: Nacional
Financiera, 1964), p. 25.

Data for 1965-1970:

Op. Cit., Domínguez, p. 455.

TABLE II : TOTAL INSTALLED CAPACITY: MEXICO, 1968.

Op. Cit., Pedroza, p. 15.

TABLE III: GROWTH OF ELECTRICITY GENERATED, 1964-1970

Op. Cit., Domínguez, p. 453.

TABLE IV: STATISTICAL ANALYSIS OF THE RURAL ELECTRIFICATION OF MEXICO BY STATES

Op. Cit., Comisión Federal de Electricidad,

"IV Congreso de Electrificación Rural," pp. 5-15.

TABLE V : GENERAL RESULTS OF WORK COMPLETED BY THE
C.F.E. DURING THE PAST TWO PRESIDENTIAL TERMS

Comision Federal de Electricidad, "Informe de
Actividades, 1968-1969," (Mexico, D.F.: Comisión
Federal de Electricidad, 1970), p. 8.

TABLE I. Statistics on the Electrification of Mexico.

	1950	1955	1960	1965	1966	1967	1968	1969
Installed cap. (1000) Kw.	1235	1930	3021	5393	5614	5794	6081	6987
In hydro. plants	607	922	1328	2214	2542	2562	2613	3333
In thermal plants	628	1008	1693	3179	3072	3232	3458	3654
Public service	1011	1551	2308	4175	4538	4656	4864	5705
Private service	224	379	614	1218	1076	1138	1207	1282
Generated energy (Million Kwh)	4423	7002	10636	17245	18843	20658	22781	25554
In hydro. plants	1949	3447	5197	8864	10118	11017	12642	13406
In thermal plants	2474	3555	5439	8381	8725	9641	10139	12148
Public service	3549	5616	8524	14208	15715	17443	19444	22239
Private service	874	1386	2112	3037	3128	3215	3337	3315

TABLE II. Total Installed Capacity: Mexico, 1968.

Service	Hydroelectric		Thermal		Internal Combustion		Total		% 1000 Kw.
	No.	1000 Kw.	No.	1000 Kw.	No.	1000 Kw.	No.	1000 Kw.	
Public (Government)	96	2,872.2	36	1,987.5	130	417.6	262	5,277.3	85.0
Public (Special)	13	6.6			42	5.9	55	12.5	0.2
Public Total	109	2,878.8	36	1,987.5	172	423.5	317	5,289.8	85.2
Private	100	47.7	125	510.9	390	215.5	615	774.1	12.4
Mixed	23	14.7	7	127.9	21	4.6	51	147.2	2.4
National Total	232	2,941.2	168	2,626.3	583	643.6	983	6,211.1	100.0
% 1000 Kw		47.4		42.3		10.3		100.0	

TABLE III. An Analysis of Electric Energy Generation 1964-1970.

Figures in million Kwh	1964-65	1965-66	1966-67	1967-68	1968-69	1969-70
Energy generated-C. F. E.	11,729	13,739	15,220	17,200	19,500	22,177
Percent of yearly growth	16.8	17.1	10.8	13.0	13.4	13.7
% of growth over 1964	16.8	36.8	51.6	71.3	94.2	120.9
Energy generated by Co. Luz y Fuerza del Centro	2,527	2,000	2,100	2,100	2,000	2,200
Energy generated by mixed service plants-public ser.	86	85	90	100	110	120
TOTAL energy-public ser.	14,342	15,824	17,410	19,400	21,610	24,498
Energy generated by private and mixed service plants	2,907	3,085	3,290	3,300	3,400	3,502
TOTAL energy generated in Mexico	17,249	18,909	20,700	22,700	25,101	28,000
Imported energy	86	76	70	140	125	150
TOTAL energy consumed in Mexico	17,335	18,985	20,770	22,840	25,135	28,150
Percent of yearly growth	10.7	9.5	9.4	10.0	10.0	12.0
% of growth over 1964	10.7	21.3	32.7	46.0	60.6	80.0

TABLE IV. Statistical Analysis of the Electrification of Mexico by States.

State	No. Persons Urban Zone (1000s)	Percent Urban	No. Persons Rural Zone (1000s)	No. Persons Electrified Urban (1000s)	No. Persons Electrified Rural (1000s)	Percent Rural
Aguascalientes	215	64	123	204	79	64
Baja California	744	86	126	707	93.5	74
Territory of Baja California	69	54	59	66	47	79
Campeche	161	64	91.5	153	80	79
Coahuila	814	73	301	773	255.5	85
Colima	166	69	75	158	67	90
Chiapas	439	28	1,130	417	257	23
Chihuahua	1,064	66	548	1,011	312	60
Durango	394.5	42	545	375	267	50
Guanajuato	1,181	52	1,090	1,121.5	334.5	31
Guerrero	575	36	1,022	546	381.5	37
Hidalgo	334	28	859.5	317.5	291.5	34
Jalisco	2,670	81	626	2,537	270.5	43
Mexico	2,338	61	1,495	2,224	734.5	49
Michoacan	1,067	46	1,253	1,014	429	34
Morelos	431	50	185	410	165.5	77

TABLE IV. (Continued)

State	No. Persons Urban Zone (1000s)	Percent Urban	No. Persons Rural Zone (1000s)	No. Persons Electrified Urban (1000s)	No. Persons Electrified Rural (1000s)	Percent Rural
Nayarit	272	50	272	258	209	77
Nuevo Leon	1,305	77	390	1,239.5	300	77
Oaxaca	608	28	1,563.5	577.5	741	47
Puebla	1,179	47	1,329	1,120	577.5	43
Queretaro	175	36	311	166	130	42
Territory of Quintana Roo	32.5	37	55.5	31	19.5	35
San Luis Potosi	500	39	782	475	258	33
Sinaloa	545	43	722	517.	379.5	53
Sonora	725	66	373.5	689	211	56
Tabasco	261	34	507	248	284	56
Tamaulipas	1,005	69	451.5	955	237	52
Tlaxcala	198	47	223	188	195	87
Veracruz	1,793	47	2,022	1,704	520	87
Yucatán	485	64	273	461	244	89
Zacatecas	295	31	656.5	280	307.5	47

TABLE V. General Results of the Work Completed by the Federal Electricity Commission During the Past Two Presidential Terms

	1959-1964	1965-1970
INVESTMENT	582,401,000 pesos	1,505,742,000 pesos
NUMBER OF ELECTRIFIED AREAS	2,148	6,665
NUMBER OF PERSONS BENEFITTED	2,660,600	5,752,582
KM OF TRANSMISSION LINES INSTALLED	11,469	28,660