REPUBLIC OF THE PHILIPPINES

REPORT ON LONG-RANGE POWER DEVELOPMENT PROGRAM IN THE VISAYAS

Volume II

March 1973

Overseas Technical Cooperation Agency
Government of Japan

Republic of the Philippines

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Preface

The Government of Japan, in response to the request of the Government of the Philippines, undertook to conduct a study for the long-range power development program in the Visayas region, Republic of the Philippines and entrusted the execution of the study to the Overseas Technical Cooperation Agency.

Being cognizant of the importance of power development program in the region in the light of Four Year Development Plan as well as of social and economic significance of infrastructures as a basis for development, the Agency organized a survey team comprising six members, headed by Mr. Tsutomu Kidahashi and sent it to the Philippines for a period of 88 days from October 10, 1972.

Thanks to the kind cooperation of the Government of the Philippines and the organizations concerned, the study could have been carried out quite satisfactorily. On the basis of the interim report, which was submitted while the team was in the Philippines, the team made again a comprehensive study of the data and information gathered after its arrival in Japan, and thus the final report is now ready for presentation.

The mission assigned to the team was to make a power development program for the entire Visayas region as well as to review the feasibility report which had been prepared by the National Power Corporation. The former is summarized in Vol. I and the latter in Vol. II. What the team recommends is to have a long-range plan targeting the year 1987 with the economic, social and power implications, and is highly, we think, conducive to the future development of the country.
I sincerely hope that this recommendation is implemented as scheduled in the report.

It is also my pleasure that the report will prove helpful to the social development and thus contribute to the economic relationship and friendship between Republic of the Philippines and Japan.

Finally, I wish to take this opportunity to express my appreciation and gratitude to the officials of the Government of Republic of the Philippines for the wholehearted cooperation and support extended to us in the execution of the mission.

March, 1973

Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency

ELECTRIC POWER DEVELOPMENT COMPANY, LTD.

8-2, MARUNOUCHI, 1-CHOME, CHIYODA-KU, TOKYO, JAPAN.

CABLE ADDRESS:
ELECTPOWER TOKYO

Mr. Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency

Dear Sir:

Submitted herewith is the report on the Long-Range Electric Power Development Program in the Visayas, Republic of the Philippines. The report consists of two volumes; Volume I covering the entire region of the Visayas, and Volume II depicting the details of studies made on the feasibility of the Electric Power Grid on the island of Cebu.

The Overseas Technical Cooperation Agency (hereinafter called OTCA), for the purpose of formulating the long-range electric power development program, organized and sent an engineering team consisting of six experts of Electric Power Development Co., Ltd. (or otherwise known as EPDC) and OTCA to Republic of the Philippines for the period of October 1972 through January 1973.

After conducting the site investigations, and based on the data and information made available to the team by the Government of the Philippines, as well as, international organizations, such as, Asian Development Bank, International Bank for Reconstruction and Development, the United Nations and Economic Commission for Asia and the Far-East, the team prepared and submitted an interim report to the Government of the Philippines in January 1973 before leaving the Philippines.

The interim report has been amplified and refined into further details in Japan by mobilizing experts and engineers of EPDC, as well as, electronic computers for system analysis to form the present final report.

Located between Luzon and Mindanao, the Visayas have been developed along with the expansion of entrepots in the region. Cebu is the center of Vasayan commerce. Also, noteworthy is the recent industrial development of Cebu which has been taking place at a quick tempo. Adverse effects on the economic circle brought about by floating pesos on the world exchange market in 1970 is now diminishing, and it is a general outlook that the economic recession is coming to an end. It is believed, at this transitional stage from recovery to development, that the reenforcement of power industry, by constituting an island wide grid connected with large scale generating facilities, is indispensable to support the economic development; the island wide grid being capable of supplying reliable and low-cost energy. In order to meet the projected demand in the years from 1976 to 1980, an increment of 100 MW will be required in the generating capacity, which, including the transmission and transforming facilities, will require a total capital investment of US$20 million. This development program, as expatiated in the report, is believed economically justifiable.

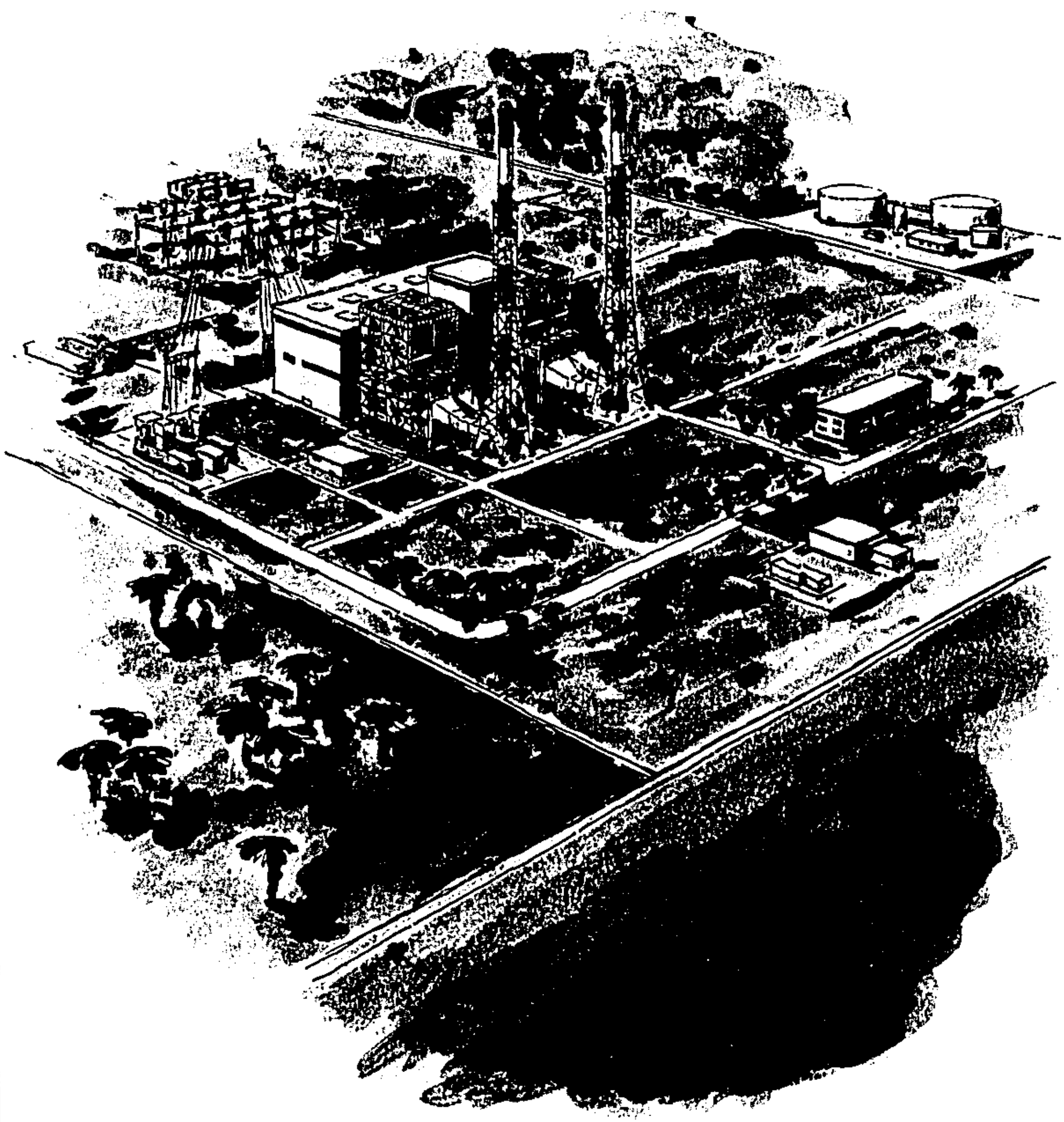
In closing, it is wished to express the heartfelt gratitude to the officials concerned of the National Power Corporation, the National Economic Council, the Presidential Economic Staff, the Embassy of Japan to the Philippines, the Government of Japan and the Asian Development Bank, as well as, the OTCA, for their generous assistance and cooperation in performing the studies.

March, 1973

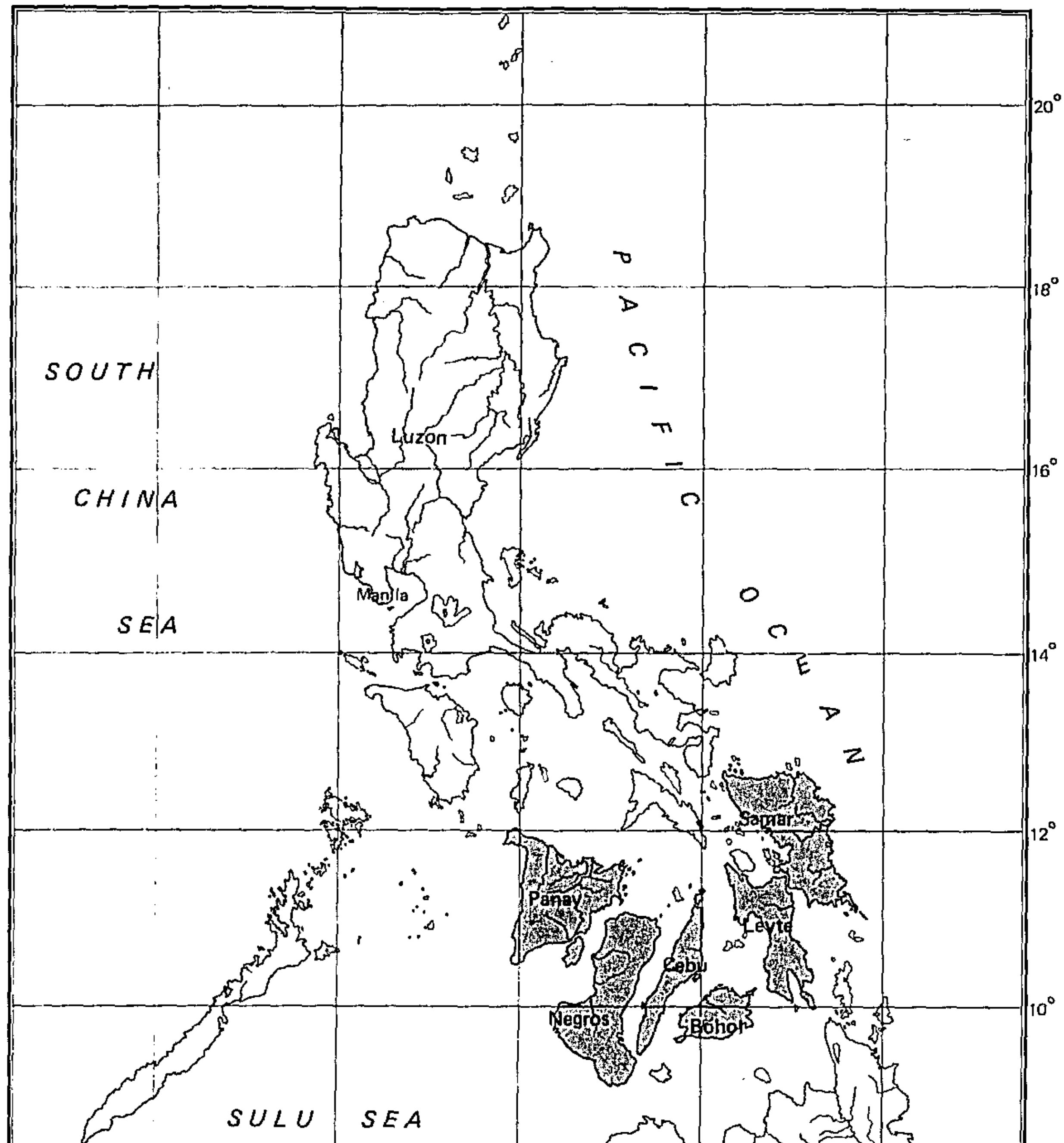
Yours respectfully

T. Kidahashi

Tsutomu Kidahashi, Chief
Japanese Survey Team
for Long-Range Electric
Power Development Program
in the Visayas Region



Artist's imaginary view of NPC's power plant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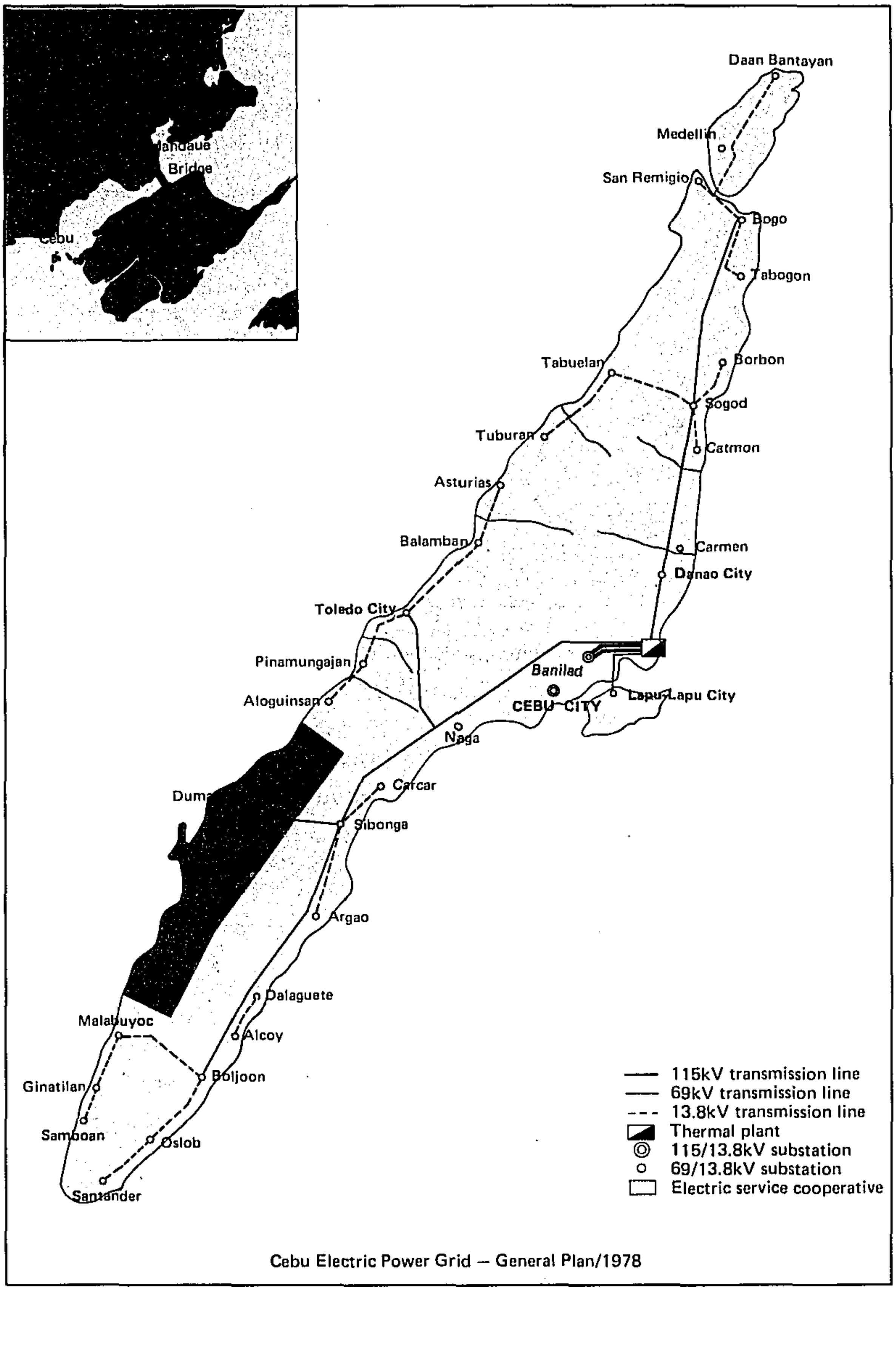


Cebu Electric Power Grid — General Plan/1978

Contents

Chapter 1 Introduction

1-1 Objective of Study

In response to the request of the Government of the Philippines, the survey team has been dispatched to the Philippines by the Government of Japan to perform field investigations in connection with the (i) demand forecast, (ii) power resources and their development, (iii) expansion program of transmission and transformation systems, (iv) system analysis, and (v) economic evalution, thereby to formulate an electric power development program in the Visayas including generation, transmission and transformation of electricity covering a period of up until 1987. The program formulated is compiled in the report together with the descriptions on the process of studies.

1-2 Background

(1) Aware of the importance of the infrastructure in developing the country, the Government of the Philippines is also intensifying the facilities and installations in the field of electric power industry. Due to the geographical conditions and peculiar nature of power industry, the country has been divided, in planning power development program, into three regions, Luzon, Mindanao and the Visayas. Development is being implemented in Luzon and Mindanao under the auspices of

IBRD and ADB respectively.

(2) In the Visayas, there are power utilities of small scale only, in addition to industrial power plants, the small islands being divided into smaller franchise territories. Cognizant of this present situation of the Visayas, the Government of the Philippines requested the Government of Japan to extend technical cooperation in formulating power development program to supply less expensive and high quality energy.

(3) In response to the request, the Government of Japan agreed to make and constitute the scope of technical cooperation as enumerated in 1-3 hereinunder, and organized and dispatched a survey team consisting of six experts for investigations at site from mid October 1972 to early January 1973. The results of investigations and studies conducted in the Philippines were compiled in an interim report submitted to the Government of the Philippines before the team left the Philippines.

(4) The interim report has been, after return to Japan of the survey team, further studied and refined to form the present report.

1-3 Scope of Studies

(1) Areas studied cover and include the islands of Panay, Negros, Cebu, Bohol, Leyte and Samar.

(2) The studies include preparation of long-range power demand forecast in each island covering a period of more than 10 years; establishment of implementation program for construction of power plants, transmission lines and substations; and preliminary study on the interconnections between the islands.

(3) The studies also include review on the Feasibility on the Development of the Cebu Electric Power Grid (see 1-7) prepared by the National Power Corporation (hereinafter called NPC) and establishment of implementation and financial program, as well as, analysis of the feasibility established in NPC report.

1-4 Survy Team

The team consisted of the following six members of EPDC and OTCA:

Cheif: Tsutome KIDAHASHI
Foreign Activities Dep't
EPDC

Member:	Masahiko IKEDA Foreign Activities Dep't. EPDC	Economic and financial analysis

Hiroshi KAGAMI Foreign Activities Dep't. EPDC	Market survey and load forecast
Kazuo FUSE Hydro-Electric Engineering Dep't. EPDC	Power development planning and cost estimation
Jiro KURODA Development Survey Div. OTCA	Macro socio-economic survey
Yoshikazu INOUE Operation & Maintenance Dep't., EPDC	Power network planning

1-5 Peroid of Survey

The survey was conducted for a period of 88 days from October 10, 1972 to January 5, 1973.

1-6 Principles of Study

(1) Load Forecast and Its Relation to Economy

The power demands and power utilitites in the Visayas and Cebu should be considered in the light of economic activities of the Philippines, as well as, the Visayas. In order to arrive at a more probable forecast of load, analysis should be made from various aspects. Therefore, the economy of the Philippines, as well as, the Visayas was carefully studied and duly taken into consideration in estimating the future load.

At the same time, in consideration of that the development of the Philippines is, in one way or another, connected or linked with the development of ECAFE countries, the Philippines being a member country of ECAFE, attention was also paid to her position in the entire ECAFE group.

(2) Program Formulation and Investment

The development program was formulated with a primary emphasis on the economy to the extent that the engineering practices would allow. Reserve capacity was considered as 10 percent of the total installed capacity of a system, giving more favor to the economy. Construction cost is one of the most important factors in determining a development program. In the report, it was estimated based on the recent international bid prices, as well as, the past records of the country.

(3) Report

The report consists of two volumes; Volume I pertaining to the power development program of the Visayas region as a whole, and Volume II describing into details of the Cebu Electric Power Grid which is the project of an urgent demand. The same descriptions may be found in Volume I and Volume II. Such descriptions found in Volume II were intentionally repeated for the convenience of readers, since Volume II is a complete report itself concerning the feasibility of the Cebu Electric Power Grid.

1-7 Report Prepared by NPC

NPC has prepared a feasibility report on the Cebu Electric Power Grid in May 1972, and established the Visayas Regional Office in Cebu with the first assignment to it to follow up the purport of the report, of which content is as follows:

(1) The report proposed to construct a thermal power plant near Cebu City in 1976, a plant accommodating two 75 MW units, and additional two units of the same capacity to be operated one by one in 1980 and 1985;

(2) and to construct transmission line network, including substation, with 115 kV and 69 kV lines as trunk lines, thereby to promote electrification of the island in line with the increase in generating capacity.

(3) The total construction cost of the first two units together with the corresponding transmission lines and substation was estimated at US $ 36 million including the domestic currency equivalent of US$ 10.5 million.

(4) The report justified the economic soundness of the power grid project in terms of the rate of return (rate base) by stating that the rate of return of 8 percent, which is considered as the desired minimum of power utilities in the Philippines, would be attained in 8 years after date of operation.

Chapter 2 Summary and Recommendation

The present report concerns the electric power grid development in the island of Cebu. The National Power Corporation had conducted studies on the power grid and prepared a feasibility report (hereinafter called NPC Report) in May, 1972. In the report, NPC has proposed to construct a power plant with two 75 MW steam turbine generators and appurtenant transmission lines and substations in 1977 with a total capital investment of 36 million U.S. dollars. The present report has been prepared after checking and reviewing NPC report to recommend a feasible power development program, which is summarized in the followings:

2-1 Electricity Demand

(1) The most part of power demand in Cebu has been met by the supply of Visayas Electric Company (VECO) which is supplying power within a limited area of Cebu City and its surroundings. In 1971, per capita energy production of VECO was 310 kWh with an electrification ratio of 45 percent within its service territory, while, in the total Cebu, they were respectively 110 kWh and 20 percent only.

(2) Two approaches were employed in estimating the future demand in Cebu in the years of 1973 to 1990. One was macroscopic approach projecting the growth of energy consumption in relation to the development of national economy forecasted as a target in the Four Year Development Plan FY 1972-75; and the other was an analytical method which is based on detailed information of the present situation of sectorial as well as areal electricity demand.

(3) In both approaches, the demand was estimated based on the following presuppositions:

(a) The political stituation of the Philippines will be stable, and the national economy will be developed steadily.

(b) The government of the Philippines will be positively engaged in the promotion of electrification program.

(c) The power rate schedule will be kept low as far as practicable.

(4) The macro forecast was established based on the relation between per capita GDP's and per capita electricity productions of countries of the world. Based on the macro forecast, the future power demand of Cebu was projected up to 1990. The projection gives an annual growth rate of 14 percent on the average up to 1980 and thereafter 12 percent.

(5) In the analytical method, Cebu was divided into two: one is Metropolitan Cebu and the other Rural Area. In the former, the future demand was estimated according to the sectors and based on the past growth of demand. Two separate estimates were prepared. They are probable load forecast which was established with conservative regard on the past record and higher load forecast with emphasis on favorable factors. In the latter, the future power demand was projected based on the population by applying electrification ratio. The demand of industries that have now their own generating units of large scale was not considered in the probable load forecast, but was duly taken into account in the higher load forecast.

(6) Studies by analytical method were performed on the assumption that the present electrification ratio of 5 percent in rural Cebu should be raised, in compliance with the target of electrification program of the government, to be the current electrification ratio of about 42 percent in Metropolitan Cebu.

(7) The forecast established in the report predicts that the electricity demand will grow at an annual rate of 15 percent till 1980 and thereafter at 14 percent up to 1990, which is a little higher forecast when compared with NPC Report. If the higher load forecast is the case in 1980, the development program established in the report should be accelerated and advanced by about two years. In that year, the probable load forecast is 146 MW in peak demand and 732 million kWh in annual energy production which are over four times of 1970. In 1985, these figures will further increase to 273 MW and 1, 380 million kWh.

2-2 Power Development Program

(1) The power supply requirements obtained from the forecasted demand will increase by 125 MW by 1980 and by 260 MW by 1985, both including 10 percent reserve and after retirement of old facilities It will be in 1974 that the demand in Metropolitan Cebu will exceed the power supply capability of VECO. However, it is virtually impossible to install generating facilities by 1974, therefore, the development program was formulated for the period of 1976 to 1987.

(2) In formulating the power development program, economy was primarily considered among other factors. It was adopted to introduce as large unit capacity as permissible having regards to system reliability in order to reduce the energy cost, by regarding the reserve capacity as 10 percent of peak demand instead of maximum unit capacity which is the general practice in the past in the Philippines. Due to the change in the concept of reserve capacity, as much as 9 million U.S. dollars converted to present worth in 1974, can be saved in the capital investment for the generating facilities during the period of 1975 till 1987.

(3) In Cebu, the power development program should solely depend on fossil fuel that can be used by steam turbines and gas turbines as well as diesel engines because there is no hydro power potential nor geothermal energy. A coal fueled thermal power plant is conceivable in Cebu since there are several coal mines in operation on the island. At the present time, however, prospect of stable supply of coal for a long-run has not been established, and cost of coal as mined on a large scale is not known. Therefore, the steam turbine was assumed to be fired by heavy oil in this report.

(4) Five alternative plans were prepared all satisfying the requirement of the system in order to arrive at the best combination of these generators. The sizes of generator units are 10 MW diesel units, 25 MW gas turbine units and 50 MW and 75 MW steam turbine units.

(5) By any means, a steam turbine generator will not be able to be put in operation before 1978. Therefore, the combinations were confined to those of steam turbine units with either diesel units or gas turbine units. The gas turbine and diesel units were considered to supplement the shortage in power supply capability in 1976 and 1977.

(6) It is the conclusion arrived at in this report that the combination of 25 MW gas turbine generators and 50 MW and 75 MW steam turbine generators (designated as Plan GS-2) is the most effective from the economical as well as technical point of view. It was revealed by the study that the program with a reserve capacity equivalent to maximum unit capacity is not economical. The development program is to install a total capacity of 375 MW with total investment requirement of 65.7 million U.S. dollars. The energy cost at sending end is expected to be 10.6 mills per kWh in 1980 and then decline to 9.5 mills per kWh in 1985.

2-3 Implementation Program

(1) The implementation program includes, among the facilities proposed in the development program, the installation of two gas turbine generators and one steam turbine generator and the construction of appurtenant transmission lines and substations. The site proposed by NPC for the construction of thermal power plant at Liloan is considered suited in respect of the distance to the load center and the spacious area. However, investigations on supply of boiler water is an urgent requirement. The gas turbine proposed by this report was also planned to be installed in the same premises.

(2) The gas turbine generators will be installed for the purposes to supplement the power supply shortage in 1976 and in 1977 and to supply peak power after 1978 when a steam turbine unit starts its operation, as well as, to make possible black start of the thermal power plant.

(3) The reliability of the grid is high in Metropolitan Cebu, the load center, and somewhat low in the rural areas where island wide electrification and economical power supply are the primary purposes.

(4) Double circuit 115 kV line will be constructed to connect the thermal power plant with VECO system, while single circuit 69 kV lines will be extended into rural areas. In NPC report, 115 kV lines are proposed to electrify rural areas. However, in view of the anticipated power flow and voltage drop in the years up to 1990, 69 kV is judged to be sufficient.

(5) The lengths of transmission lines to be constructed by 1978 are 13 kilometers of double circuit 115 kV line, 265 kilometers of single circuit 69 kV lines and 250 kilometers of 13.8 kV lines. Seven 69 kV/13.8 kV substations, 35 MVA in total capacity, will be built.

(6) Gas turbine units will be installed within one and half years after placement of order, and steam turbine units within 3 years. Therefore, the construction period proposed in the report will give an ample time for completion of the project including transmission lines and substations.

2-4 Financing Program and Economic Evaluation

(1) The total capital investment requirement for the implementation of the project which will in part become operational in 1976 is US$ 20.1 million for disbursements in 1974 to 1977, US$14.7 million in foreign currency and US$5.4 million in domestic currency, resulting in a reduction of US$ 16 million from that of NPC report.

(2) The sectorial distribution of the total capital investment is US$ 4,770, 10,820 and 4,480 thousand respectively for gas turbine generators, steam turbine generator and transmission and transformation facilities.

(3) Studies were made based on the three different assumptions of power rates to be adopted by NPC when it wholesales power to utilities and cooperatives.

	VECO		Small utilities	
Rate - 1	13.4 mills/kWh	(9 centavos/kWh)	16.4 mills/kWh	(11 centavos/kWh)
Rate - 2	14.9 "	(10 ")	17.9 "	(12 ")
Rate - 3	16.4 "	(11 ")	19.4 "	(13 ")

The rate of sales to VECO is a little less than the cost expected of the VECO's new unit under construction. The rate to the other small utilities is far less expensive than the prevailing costs.

(4) The economic soundness of the project is vulnerable to the fuel cost. If the price of Bunker C oil is 50% up the purchase price for Bataan Thermal Plant, the internal rate of return will be 7 percent, which, if the rate is set at Rate-1, will require fairly soft loans. With application of Rate-2, however, it will become 8.9 percent.

(5) On the rate base, a return of 8 percent against the net operating assets, a critical point in the present practice in the Philippines, will also require the application of Rate-2 at the same fuel costs as in (4) above.

(6) If a fund is raised at an annual interest rate of 7.5 percent, which is the prevailing rate of international financing institutions for the foreign currency requirement, cash flow will be unbalanced with the power rate of Rate-2. In order to have the cash flow balanced, it should be raised at 4 percent rate or lower. If a credit of Japanese government is obtainable at an interest rate of 3.5 percent, the cash flow will be in the black from 1976, and $ 1.2 million of cash will be generated annually after 1988 when the domestic currency borrowing will have been redeemed.

2-5 Conclusion

The Cebu Power Grid Project as proposed in this report is technically feasible, and the economic phase is also sound with power rates lower than those of private utilities and with earning enough to purchase fuel oil. Therefore, it is recommended to implement the project in the early stage. The project, aiming at the electrification of entire Cebu, complies with the government's policy of power industry in the Philippines. By the implementation of the project, the rural inhabitants will be served by electricity at a rate similar to that of Metropolitan Cebu, at the same time, VECO, the largest utility in Cebu, will be able to waive the investment on generating facilities, thereby to expand and reinforce the distribution network with such savings.

Necessary actions to expedite the implementation of the project are recommended to be taken by NPC, as well as, by the government so that funds can be raised at a low interest rate, which will in turn serve to supply low-cost energy, and that investigation work at site can be started.

2-6 Recommendation for Smooth Implementation of the Project

Recommendations are made in connection with the preparatory steps to be taken by NPC. The first is the estabishment of coordinating committees between NPC and power utilities in Cebu, and the second is the training of NPC engineers especially of middle class. The third is negotiation for the advantageous procurement of fuel oil. The last is the periodic review on the power development program.

Chapter 3 Natural and Economic Environment

3-1 Natural Conditions

3-1-1 The Philippines

Republic of the Philippines, consisting of approximately 7,000 islands, lies about 800 kilometers off the south-east coast of Asia. To the west and north is the stormy China sea, east the Pacific Ocean where typhoons originate, and south the Sea of Sulawesi and the coastal waters of Borneo. Eleven islands have an area of over 3,000 square kilometers each, namely, Luzon, Mindanao, Samar, Negros, Palawan, Panay, Mindoro, Leyte, Cebu, Bohol and Masbate, and an aggregate area of these eleven comprises 96 percent of the total of 30 million hectares.

The islands, featured by irregular configuration of coastlines, volcanic mountain ranges, isolated volcanoes, irregular masses of hills and mountains and narrow coastal plains, have volcanic, coral and all principal rock formations. The highest peaks are Mt. Mayon (2,423 meters) in Luzon, Mt. Kanlaon (2,466 meters) in Negros, and Mt. Apo (2,955 meters) in Mindanao.

The plains lying amid the mountains, e.g., the central plain of Luzon, the Bicol plain of southeastern Luzon, the Cagayan plain of northern Luzon, the central plain of Panay, and the Agusan and Cotabato valleys in Mindanao, have the densest populations of the islands except in Cebu, where the people live mostly on the coastal plain.

Climate

The archipelago has a decided variety of climate. Temperature differences are very small, ranging from 23 to 30 degrees Centigrade in monthly average throughout the country. However, rainfall differences give a criterion to classify the Philippine climate into four. The first has two pronounced seasons, one dry in winter and spring and the other wet in summer and autumn. This prevails generally over the western part. The second has no dry season but a pronounced rainy period in winter; generally, on the Pacific side. The third has no very pronounced maximum rain period, but a short dry season; generally, over the central plain of Luzon and the central islands. The forth has no dry season and no very pronounced maximum rain period; generally, in Batanes, northeastern Luzon, Camarines, Albay, northern Cebu, northern Negros and most of central eastern and southern Mindanao.

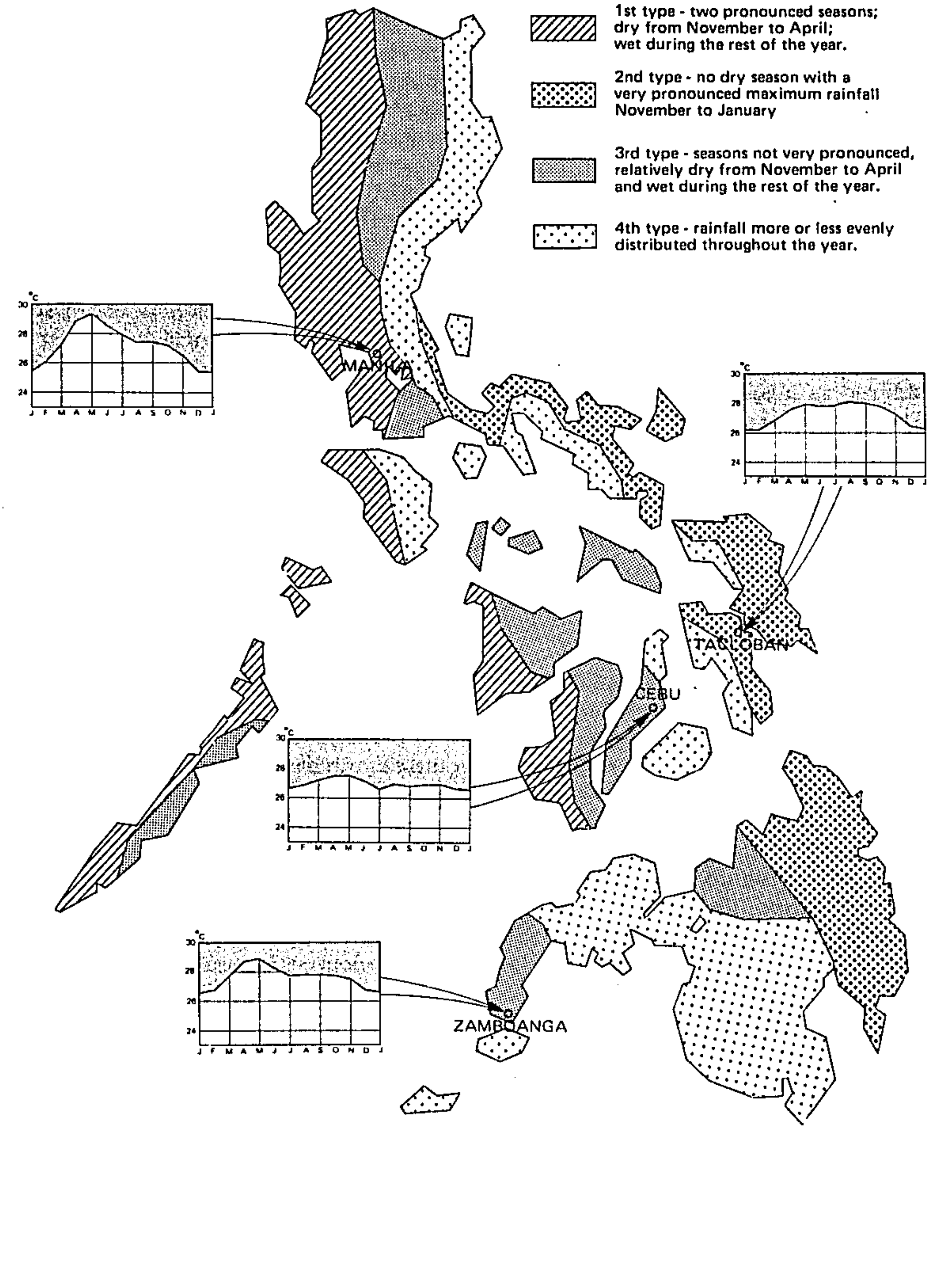
Typhoons strike the islands from the east to the southeast, then curve to the north, sometimes crossing the land, sometimes only touching the eastern shores. Both rainfalls and winds bring about damages to property, but more destructively are the rains which cause floods.

Population

Today, the Philippines is inhabited by about 38 million people. The first census held in 1903 showed the population of the Philippines to be 7,635 thousand. The rate of population growth was a little over 2 percent per annum up until 1940's. However, the last census in 1970 disclosed an annual growth rate of as high as 3.1 percent averaged over the preceding decade. Medical knowledge and application has reduced mortality rate and raised life expectancy from 37.2 years in 1905 to 52.5 years in 1965.

Table 3-1 Population of the Philippines: 1903 to 1970

Census year	Population	Increase		Averaged annual rate increased(%)
		Number	Percent	
1903	7,635,426	...	...	...
1918	10,314,310	2,678,884	35.1	1.90
1939	16,000,303	5,685,993	55.1	2.22
1948	19,234,182	3,233,879	20.2	1.91
1960	27,087,685	7,853,503	40.8	3.06
1970	36,684,486	9,596,801	35.4	3.01



Rainfall Pattern and Monthly Average Temperature

Aware of the rapid increase in population, the Government launched family planning program as part of Four-Year Development Plan, aiming at one percent reduction in the annual growth rate of population in the comming 10 years.

Language spoken is diversified innumerably into divisions and subdivisions. Principal divisions, but not covering the whole, are Visayan, Tagalog, Iloilo, Bicol, Pampangan, Pangasinan, etc., which are, in may cases, not communicable with one another. Linguistic zoning represents local linkage of economic activities at one time before recent migration movement started. Much is expected from the dissemination of the national radio and television broadcastings which use Tagalog, the standard Philippine language, to unify the language throughout the country.

Labor

It was reported that in fiscal 1969 there were 11,706 thousand persons considered as labor force. The sectorial distribution of labor force was changing. The labor share of agriculture, including forestry, hunting and fishing, dropped from 63.0 percent to 55.4 percent during the period of 1959 to 1969. Obviously, this drop was due to the growth of industry, including tertiary industry. The production index of industry alone, not inclusive of the tertiary industry, increased from 80.7 to 144.8 during the same time period, while that of agriculture from 82 to 116.

Unemployment

Unemployment is large in the Philippines. Revealed unemployment, or the ratio of persons totally unemployed to the labor force, was 7.3 percent in 1969; 9.1 percent in urban area and 6.5 percent in rural area, urban life being attractive, yet fewer chances of employment in cities. Urbanization is taking place in many parts of the Philippines, at some places, rapidly. But, industries are hardly catching up with the pace of ever increasing population. However, to look at the number of employed persons who, working less than 40 hours a week, are reportedly wanting additional work, this urban-rural pattern in employment situation is the reverse. They are designated as visibly underemployed. The visibly underemployed can be seen more in the rural area, partly, if not totally, attributable to the seasonal fluctuation in labor requirement of agriculture.

Migration Movement

There are large variations among provinces in the percentage of population growth. Provinces where sites have been chosen for new industrial expansion and where favorable conditions to agriculture are prevailing are attracting immigrants. They are Bukidnon (113.4 percent in incremental ratio during years 1960 to 1970), Rizal (95.3 percent), Occidental Mindoro (70.8 percent), Agusan del Sur (86.5 percent) and Davao Oriental (87.0 percent) in the top five. The Visayas is a region where the lowest percentage (18.3 percent) was recorded which is apparently a consequence of emigration movement out of the Visayas to such provinces as enumerated above.

Natural Resources

(Timber)

Out of the total land area of 30 million hectares in the Philippines, over 6 million have now been identified as timberland. While reforestation program is underway in open lands and along watersheds. Logs and lumber are now leading export materials of the country, comprising over 25 percent of the total export. However, timberlands in the Visayas occupy only 12 percent of Visayan lands, while it is 28 percent in the entire Philippines.

(Mineral Deposit)

The Philippines is endowed with abundant mineral resources. The precious metal production of gold and silver was 2. 2 million ounces valued at 134. 4 million pesos in fiscal 1970. Copper deposits occur mostly along the Philippine fault zone running northwest-southeast across the Visayas, and its production is prominent, 151 thousand metric tons in fiscal 1970. Other mineral productions are iron ore, chromite ore, pyrite cinders, manganese ore, zinc, molybdenum, lead and nickel. Limestone formation is providing a fair ground for the establishment of cement factories. If the lands are further explored, mining industry in the Philippines, even including fossil fuel, will be promising. The Visayas is not an exception in this future prospect of mining industry, in view of the present large scale exploitations of mineral deposits, such as, magnetic sand and copper ore respectively in the islands of Leyte and Cebu.

3-1-2 Cebu

Cebu island lies between $9^{o}25'$ and $11^{o}17'$ north and $123^{o}18'$ and $124^{o}03'$ east. Located in the midst of the crumpled edge of the Asiatic continental platform, the island is formed of a single folded mountain range with a few narrow coastal plains. It is about 200 kilometers long and 30 kilometers wide at greatest dimension, and has an area of 508,839 hectares.

The island is situated in the center of the Visayas which is comprised of six major islands, 400,000 to 1,370,000 hectares in size, and numerous small islands. The Visayan islands are scattered in the water between Luzon and Mindanao, two largest islands of the Philippines.

Although mountains are lying close to the coast, Cebu, with the vantage location and its irregular coast line which provides fine anchorage, had established itself as a trading and commercial center of the Visayas. In the early 20th century, the population of Cebu amounted to over 8 percent of the Philippines' total, whereas it is 4.8 percent today, although steadily increasing at an annual rate of about 2.0 percent in the last decade. The area of Cebu is 1.8 percent of the total Philippines.

Topography

The mountain range covers almost entire length of the island. However, no outstanding spurs are seen. Volcanic activity is nil. It is a continuous undulation of folded or faulted formation throughout. The surface is corroded and scoured by numerous water streams. As a result, the slopes are steep in respect of the heights of peaks that are ranging, with a few exceptions, below 1,000 meters above sea level. Arable land is limited, and population is scattered along the coast only.

Climate

The climate of Cebu belongs to the third type which is characterized by a short dry season in winter except northern tip of the island where they have no dry season. Typhoons pass over the island several times a year associated with strong winds which cause occasional damages to agricultural products.

Population

Cebu's population, according to the census report of 1970, was 1,634 thousand which gives a population density of 3.22 per hectare. This is the highest among all the provinces in the Philippines.

Peculiar is the history of population growth in Cebu. In 1903, Cebu was inhabited by 653 thousand. During the period of 1903 to 1918, it had increased to 855 thousand with an annual growth rate of 1.9 percent on the average which was more or less the same as that of the Philippines as a whole. Thence, however, the growth rate went down attributable to an emigration movement to other islands, whereas the Philippines' total was increasing at a rate of about 2.1 percent.

Table 3-2 Population of Cebu

	1909	1918	1939	1948	1960	1970
Population	653	855	1,068	1,123	1,333	1,634
Annual growth rate on average (%)		1.8	1.1	0.6	1.4	2.0
Percentage to Philippines' total	7.56	8.29	6.67	5.84	4.92	4.45
Density/ha	1.29	1.68	2.10	2.21	2.62	3.22

The component ratio of Cebu population was the largest in 1918, which gives an implication that the importance of Cebu in the Philippines' economic activities and development was at its peak in the late 1910's. However, it may be said that the mountainous topography had hampered the population growth especially in rural areas, and helped accelerate emigration movement.

Today, backed up by the growth of large manufacturing industries and functional business of transshipment services, the population is growing at a steady rate of 2 percent approximately.

Illiterates number more than 20 percent in the age group of 15 years old and over, which, due to the small number of schools in Cebu, is quite high as compared with the total Philippines. Children at the age of 15 or more are hesitant to go to out-of-town school.

3-1-3 Natural Resources for Electricity in Cebu

Normally, electric power is being generated from the following resources:

Hydro resources

Coal

Fuel oil (including natural gas)

Geothermal energy and uranium

(1) Hydro Resource

Hydro power generation is economical only when sufficient head is available, or constant quantity of water discharge is obtainable. Needless to say, combination of high head and constant discharge is more favorable. Cebu lacks both. At least, there is no conceivable site that bears a potential worth consideration in this report.

(2) Coal

According to the NPC report, there is a found total of 35 million metric tons of coal deposits distributed at several locations in Cebu. Their calorific value is 4,900 to 6,800 kcal. per kilogram (9,500 to 12,800 BTU per pound). Mining is operational at four sites with a monthly production of about 4,000 metric tons in total. The operation is being done by means of picks, shovels and wheelbarrows.

In contemplating a coal-burning thermal power plant project, the following conditions should be duly taken into account:

(a) Fuel cost at power plant should be reasonable as compared with other fuel, i.e., oil.

(b) Stable production and supply of coal must be ensured at least for a life time of power plant.

(c) Stable chemical component of coal to meet the design criteria of boiler must be strictly observed. (High technical level is required in coal-dressing and quality control at coal mines).

The statistics of ECAFF shows that the coal production in the Philippines started decreasing in the early 1960's, 53 thousand metric tons in 1969 being one third of that in 1960. This figure conflicts with that given in NPC report. Transfer from solid fuel to liquid fuel is a world-wide tendency in power industry. This tendency seems to have been stressed in the Philippines where coal deposits are distributed in thin layers of young formation. Such a resource, as compared with oil, is disadvantageous especially when viewed from the standpoint of stable supply over a long period. This disadvantage will be further underlined by the construction cost which will have to include the coal yard, crasher and conveyer, in addition to a pier with unloading facilities. All of these will result in an increment of approximately 20 percent in the construction cost; 20 percent over the construction cost of a oil-burning thermal power plant.

On the other hand, operation of coal-fired thermal power plant would contribute to the conservation of foreign currency reserve and further to the creation of employment opportunities at coal mines and transportation business of coal.

With these considerations in mind, comparison was made based on data made available by NPC between the oil fired and coal fired thermal power plants, both having two units of 50 MW capacity. The energy cost of the two were calculated in the method described in Chapter 6. The fuel costs were assumed to be 13.65 mills per liter (9.15 centavos per liter: fuel cost Case 1) for oil and \$5.1 per ton (34 pesos per ton) for coal, the purchasing price of VECO at the end of 1972.

Table 3-3 Annual Cost Comparison

(in thousand US\$)

	Oil fired		Coal fired	
	Fixed cost	Variable cost	Fixed cost	Variable cost
Interest	819	-	983	-
Depreciation	590	-	708	-
Operation & Maintenance	526	93	631	112
Fuel cost	-	2,214	-	1,407
Total	1,935	3,271	2,322	1,519
Cost/kW (US\$)	19.35		23.22	
Cost/kWh (mill)		3.87		2.69
Total cost/kWh (mill)	7.25		6.80	

Table 3-3 reveals that the coal fired power plant is economical than the oil fired owing to the less expensive coal. If the present level of coal price can be maintained into the future, it would be advantageous to construct a coal fired steam power plant. Therefore, it is believed worth-while to conduct detailed investigations on the feasibility of coal fired steam power plant.

There are many steam power plants in southeast Asia that are equipped with coal burning facilities remaining idle since their constructions. They were designed to burn both coal and oil, but practically no coal has been used. Therefore, adoption of coal as fuel should be decided prudently. A breif report was prepared by a geologist of NPC after visiting the coal mines on Cebu at the end of 1972. However, no detailed investigations have been conducted.

Investigations should cover prospecting of coal deposit, quality test, method of transportation, costs of mining and transportation, treatment of ash, etc. Especially, the cost of mining should be estimated paying due attention to the mining facilities required to mine coal on a large scale. The projection of stable supply of coal should also be established duly taking into account the technical level and financial ability of the mining company. If the superiority of coal over oil is guaranteed after conducting all the investigations stated in the foregoing, coal burning steam power plant will have to be constructed. At the present stage, however, it is judged to be prudent to formulate a long-range development program with oil burning steam power plants.

(3) Fuel Oil

In the Philippines, no oil vein, including that of natural gas, that can provide economical fuel has been found. Therefore, domestic oil consumption is totally dependent on import. Oil deposits are said to be existing in Panay, Cebu and Leyte, and exploration works are on going. However, no finding has been reported.

(4) Geothermal and Uranium

There has been no report at all on the possibility of magmatic heat or uranium deposit existing in Cebu. It is believed that there is no power resources in Cebu except for fuel oil imported. Cebu's power industry will have to rely on the import of oil for a foreseeable length of time in the future.

3-2 Economic Environment

3-2-1 Philippine Economy

(1) Present State of Philippine Economy

The economy has been growing at more than 6 percent annually in real term in the preceding several years, getting ahead of the projected target of the Four

Year Development Plan. The growth rate in 1970-71 by NEC announcement was also at 6.5 percent. The Government and NEC, having been amending the Plan on a previous-years' performance basis by the name of rolling plan, and upgraded the growth target.

This remarkable high rate of growth is, supposedly, due to the rapid growth of private capital formation, which has been covering the relatively slowing down attainments of agriculture and mining sector. This state is a sort of what is called "private-sector leading type". The per capita income, however, is growing at somewhere around 3 percent because of high population growth of 3 percent or more.

Table 3-4 Gross National Product

Year	1963	65	66	67	68	69	70
GNP (billion pesos)	19.0	23.0	25.7	28.1	29.6	31.8	39.3
Estimate (million US dollars)	7,191	8,931	8,562	8,852	10,308	11,837	12,590
Per capita GNP (US dollars)	238	245	251	255	297	331	342

With this recent growth of economy, however, the imports of capital goods and machineries have increased significantly, to cause an unstability of international baclance of payments of the country as well as to decrease the country's international reserve.

Table 3-5 External Trade and International Reserve by Central Bank

(in million US dollars)

Year	Imports	Exports	Balance	International reserve
1965	807.6	768.5	- 39.1	188.50
1966	852.8	828.2	- 24.6	166.09
1967	1,062.2	821.5	-240.7	179.77
1968	1,150.2	857.3	-292.5	161.40
1969	1,131.5	854.6	-276.9	120.66
1970	1,090.1	1,061.7	- 28.4	250.96
1971	1,186.0	1,121.8	- 64.2	375.46

As is common to most of developing countries, the Philippines is import-dependent on its economic structure, and therefore subject to the pressure from the balance of payment. The Government introduced the floating exchange system in February 1970 and strived to build up the vital economy through financial and monetary measures. The new peso-dollar ratio was 6.25, which was about 60 percent devaluation. By this new system, the balance of payments got into the improving line and the Central Bank's international reserve increased, showing a healthy sign of getting rid of the foreign exhange crisis. In the year 1971, being identified as the one of economic growth, the country was, on the other hand, suffering inflational tendency. The 20 percent growth in nominal terms could be reportedly counted for 5 percent increase in production and 15 percent increase in price, which, if true, is suppressing the people's consuming life considerably.

Table 3-6 Consumer Price Index

Year	Manila (1955=100)		Outside Manila (1957=100)	
1965	140.4	% increase	138.8	% increase
1966	149.1	6.5	145.2	4.6
1967	157.6	5.7	153.8	5.9
1968	158.1	0.3	155.2	0.9
1969	160.4	1.4	157.9	1.7
1970	188.2	17.3	181.0	14.6
1971	224.0	19.0	225.4	24.5

The structural feature of the Philippine economy is known as agriculture-dependence and in fact, it depends on agricultural sector as much as 30 percent of GNP through 1960's. In the year 1971, adverse conditions such as typhoon, tungro (rice stem borer) disease and curtailment of agricultural subsidy, depressed the rice production as shown in the relative slowness in the growth ration and forced the country to import rice. The rise in consumers' price as shown above is reported to be partly due to the rise in rice price. That the rice production, which is so influential to the whole economy, fell short of the target meant a sort of a warning to the whole production and regionally speaking to Luzon without doubt.

Table 3-7 Gross Domestic Product by Kind of Economic Activity

Year	GDP (million pesos)	% Distribution					
		Agriculture	Industry	Construction	Wholesale & retail	Transport	Others
1960	13,390	27	18	3	11	3	24
1963	19,048	26	18	3	9	3	23
1968	29,616	30	18	3	9	3	24
1969	31,782	32	18	3	9	3	24
1970	39,346	30	19	2	8	3	22

Among agriculture, sugar and coconut industries, the important dollar earners, did successfully and had been thought to have increased their crops by 10 and 20 percent respectively. The year 1971 favoured these traditional crops especially since both could enjoy the windfall of peso devaluation altogether.

Table 3-8 Production of Selected Commodities of Agriculture

(in thousand metric tons)

Year	1965	1966	1967	1968	1969	1970	1971
Rice	3,993	4,073	4,094	4,561	4,445	5,223	5,343
Coconut product							
Copra	1,471	1,485	1,577	1,542	1,516	1,656	1,574
Desiccated coconut	63	72	83	51	44	70	106
Coconut oil	627	657	576	656	566	766	810
Copra meal or cake	200	263	204	207	195	255	317
Sugar product							
Sugar, centrifugal	1,557	1,402	1,560	1,595	1,596	1,927	2,051
Muscovado	63	58	62	63	64	61	51

Manufacturing is on the way of recovery in general. Since it was affected in many ways by devaluation in 1970, the activity in 1971 was sluggish except those which were favored by the Government with dollar allocation for their imported inputs. Those active industries were chemical industry and textile industry. The former, having increased its exports outstandingly since 1969, had also shown a smooth growth in 1971. Chemical industry, as well as textile industry, is known as high import and export dependency. The government, being cognizant of the significance of export and industry diversification, is giving some assistance and this growth is responding to it. Oil industry were distressed both by the devaluation and OPEC agreements and have been petitioning for their product price increase to cover the increased price of crude oil. They had to wait for the decision of Price Control Council. The price zooming of crude oil, however, gave much influence on such industries which used oil as needed inputs or material as electric utilities. Since the operating costs of electric utilities are mostly occupied by fuel cost - somewhere around 55 percent - and many of those utilities are indebted to the foreign makers for plant units facilities, OPEC agreement and the devalution hit them hardest. Utilities are now in a very difficult position where they can hardly find their way out. The rate increase seems now to be the only way left. Public Service Commission had been reluctant to raise the tariff in view of the price escalation and therefore kept the petition pending. The utilities have many problems to be solved in the future.

Table 3-9 Index of Physical Volume of Selected Production in Manufacturing (1955=100)

Year	1965	1966	1967	1968	1969	1970	1971
Food manu-facturing	201.1	209.7 (4.2)	224.3 (6.9)	227.1 (1.2)	236.5 (4.1)	229.3 (-3.1)	257.2 (12.1)
Textile	328.0	328.6 (0.1)	344.0 (4.8)	332.4 (-3.4)	332.6 (0)	327.1 (-1.7)	392.9 (20.1)
Chemicals	187.9	196.1 (4.3)	199.4 (1.6)	197.0 (-1.3)	207.9 (5.5)	225.7 (8.5)	254.9 (12.9)
Non-metal mineral products	269.2	287.9 (6.9)	297.3 (3.2)	326.4 (9.7)	329.9 (1.0)	314.7 (-4.6)	316.4 (0.5)
Metal products	330.2	347.2 (5.1)	347.2 (0)	335.9 (-3.3)	371.5 (10.6)	322.3 (-13.3)	328.2 (1.8)
Elect machinery	323.6	340.4 (5.2)	412.5 (21.2)	437.5 (6.0)	501.1 (14.5)	574.5 (14.6)	563.5 (-2.0)
Miscellaneous products of petroleum	161.0	208.4 (29.4)	231.5 (11.1)	282.7 (22.1)	328.4 (16.1)	342.1 (4.2)	361.0 (5.5)
Pulp & paper	270.0	253.2 (-6.3)	272.1 (7.5)	247.8 (-9.0)	244.2 (-1.4)	223.6 (-9.4)	284.3 (27.2)

Note: Indices in parentheses show the percentege increase or decrease to the previous year.

(2) Some Structural Features of Philippine Economy

The following observations have been made on the basis of "Inter-Industry Relations Study of the Philippine Economy: 1965" prepared jointly by Bureau of Census and Statistics (BCSO) and University of the Philippines (UP), the part of which is disclosed in 1971. This table is a 97 x 97 matrix. The characteristics of the Philippine economy presented here could be found through studying this I-O table, which could be summarized as follows:

(a) Agricultual sector vs. non-agricultural sector

(b) High import dependence and low-flexibility of export

(c) Role of the government sector

Agricultural Sector vs. Non-Agricultural Sector

The country's total value-added in 1965 was 25,600 million pesos and the composition of net national income is shown in Table 3-10.

Table 3-10 Net Value Added

(in million pesos)

	Compensation for employee	Operational surplus	Rent	Net Value added
Primary ind.	2,738	2,348	415	5,501
Secondary ind.	2,912	3,611	0	6,522
Tertiary ind.	3,142	5,498	1,082	9,722
Final demand	1,613	0	0	1,613
Total	10,405	11,457	1,496	23,359

The ratio of value added by industry is shown when one sees the column of "Compensation for employee". Primary industry earned 26.3 percent of total wage value-added, secondary 28.0 percent and tertiary 45.7 percent. Referring to the number of employee by industry, we tried to work out the value-added per employee in different industries in the Philippines.

Table 3-11 Value-Added (VA) per Employee

	Number of employee (thousands)	% Share to the total (%)	VA/employee (pesos)
Primary ind.	5,914	57.43	463
Secondary ind.	1,161	11.27	2,507
Tertiary ind.	3,223	31.30	975

As shown clearly, the income level of primary industry such as agriculture, fishery, forestry and mining is relatively low. One can easily sense that laborers in these sectors are largely unskilled and illiterate and have low living standard, and high incidence of diseases. When one sees the total of each column of Table 3 - 10, then the ratio of income by participation type in industry is shown. Namely, wage value-added counted 44 percent, whereas operational surplus and rent, which is to be interpreted as employers' earnings, 56 percent. In order to enhance the income and the living standard of laborers, the Minimum Wage Law was enacted in June 1970, thus giving an opportunity to the country to solve the gap problem. The effect of this Minimum Wage Law is analyzed on the assumptions that (1) the unit production costs of the industries remain same as in 1965, (2) inter-dependence among the industries is kept as it was in 1965, (3) the supply elasticity of industries is constant and (4) there is no time-lag in price fluctuation. On these assumptions, the effect can be known by virtue of I-0 table. The total expenditures of the final demand sector was raised up by 46.48 percent. On the products whose wage-contents are supposedly high, this Minimum Wage Law gave directly much effects. Some were compelled to raise their unit cost by 60 percent or more. Agriculture was one of those cases. In the sense that agricultural products might have raised its cost by this Minimum Wage Law, the relative depression of agriculture in 1971 may partly be imputed to this Law.

On the other hand, when one sees the column of operation surplus, he will notice that the operational surplus brought by secondary and tertiary industries are bigger than that of agriculture. This may reflect the relative high value-added and capital accumulation in those industries. To support this discussion, industrial cost is usefully introduced. (See Table 3-12 below.) The ratio of value-added to the total cost of industry is high in the case of tertiary industry. The components of the cost of industries also disclose that the wage cost decreases in tertiary and secondary industries compared with that of primary industry and that the deprectiation cost is overwhelmingly big in the secondary and tertiary industries, with that of primary industry remaining small. One can sense the social marginal productivity of secondary and tertiary industries is high.

Table 3-12 Value and Percent of Surplus in Relation to the Total Industry Cost

	A: Operational surplus (Million pesos)	B: Industry cost (Million pesos)	A/B (%)
Agriculture	1,374	6,320	21.7
Forestry & fishing	808	2,043	39.5
Food manufactures	1,234	6,339	19.5
Textile products	289	989	29.3
Chemicals	247	820	30.1
Petroleum products	339	776	43.7
Iron & steel products	42	214	19.7
Electrical machinery	135	436	30.9
Transport equipment	137	546	25.0
Services, total	5,498	15,300	35.0
Trade, wholesale, retail	3,204	4,949	64.7

Therefore there exists a big difference in marginal revenue between agricultural sectors and industrial and service sectors. Can this be enough to explain that traditional and mono-cultural agriculture and modern and capitalistic industries do coexist in the Philippines without having their capital stock in-and-out flow each other, thus without interferring with each other? We, however, should not forget the fact that there is a predominance of agricultural employee in its number and yet this majority, about 57 percent of total employees, is living on agriculture which is of low marginal productivity and is easily subject to such outside conditions as climate. Various indices clarify the difference between the greater Manila area and the outside Manila area. One can feel the need of fostering and encouraging the rural industries. In this regard, Board of Investment (BOI) has been strenuous to have industries dispersed throughout the country with policies of granting dispersal incentives. So far, unfortunately this has not been proved so successful. The more maneuvers of BOI and the Government are to be expected.

Above all factors which constitute the present agriculture of the Philippines, the land reform should be highlighted. Land reform was proclaimed by Presidential decrees No. 2 and No. 27, respectively on September 26 and October 21, 1972. Decree 27 reads "since reformation must start with the emancipation of the tiller of the soil from his bondage..... order the emancipation of all tenant farmers as of this day, October 21, 1972; This shall apply tenant farmers of private agricultural lands primarily devoted to rice and corn under a system of share-crop or lease-tenancy, ... "In all cases, the landowner may retain an area of not more than seven (7) hectares, if such landowner is cultivating such area or will now cultivate it, . . . "

Such reform is one of the main objectives of the Government under Martial Law, and if carried out successfully, it will cause to generate drastic changes in economy of the nation. Emancipation of tenant farmers means their complete enrolment into the circle of money circulation. They will come into the circle with much strong morale to work. Productivity will be raised, and directly reflected in the increase of purchasing power which will, in turn, serve to stimulate private capital investment in the fields of services and industries of such products as will directly consumed by farmers. Growth of hinterland has a mighty power to develop the country.

Although not counted for in this report, effects to be brought about by the land reform will greatly help electrify the rural area of the country.

High Import-Dependency and Low Flexibility of Export

In 1965, total import marked 4,273,617,000 pesos (exchange rate = 3.9 pesos) and its absorption can be shown as follows:

Table 3-13 Industrial Imports Absorption

	Value of imports	
	Million pesos	% share
Manufacturing	1,276	29.9
Households	1,137	26.6
Services	750	17.5
Gross fixed capital formation	705	16.5
Agriculture, forestry & fishery	233	5.5
Net inventory change	146	3.4
Exports	19	0.5
Government	8	0.2
Total	4,274	100
Final demand	2,015	47.1
Intermediate	2,259	52.9

From Table 3-13, it will be understood that only 27 percent of total imports is absorbed by household sector and the rest, 73 percent, is inflowing into the national economy stream, directly or indirectly, in the form of capital goods, productive goods or inputs for intermediate transactions, thus conducive to the increase of national income. What counts here is the "extent" of converting imports to exports, or of compensating dollars for imports by dollars earned through exports. It is taken for granted that the financial and monetary policies of the government have to be favorable for export industries enabling them to expand in scale and scope. Because the expansion of the Philippine economy depends, without doubt, on how high it can draw up the ceiling set by the balance of payments. When exports are not successful and balance of payments aggravates, very common and frequent discussions are "country's import-dependence is too high," "Regulations on imports should be imposed," and "Among existing import industries, those which are not so contributive to the national economy should be suspended right away," etc. Setting aside the question whether the views are right or wrong, the comparison of the value of industry's import and the value of total output of the industry will give some indication on this matter.

Table 3-14 Import Dependency

	A: Value of imports (1,000 pesos)	B: Total industry sales (1,000 pesos)	% share A/B
Other services*	211,498	401,263	52.71
Petroleum refinery products	296,723	773,226	38.37
General bardware	89,221	265,502	33.60
Iron & steel basic shapes	71,828	214,396	33.50
Private communication	37,463	131,251	28.54
Motor vehicles & parts	110,145	425,524	25.88
Other manufactured products	22,701	105,925	21.43
Private construction	304,423	1,528,900	19.91

* Other services means those services other than electricity, gas, water, business services, personal services, recreational services, private education, banking, non-banking lending institution, insurance, real estate, rental of fixed assets and private hospitals.

Table 3-14 above is a mere comparison. In reality, the industries which are sometimes under dispute are those whose absolute value of imports are big. In 1965, industries whose imports exceed one hundred million pesos are petroleum products, other services, made-up textile products, knitting and textile mill products and motor vehicles and parts. Those exceeding twenty million pesos are general hardware, iron and steel basic shapes and forms, paper and other paper products, printed and published materials, private communication, medical and pharmaceutical products, metallic mining, other manufactured products, electricity and tires and other rubber products. These industries can be judged indispensable for modern life. The import dependency of the country is clearly high. The comparison of the total value of industry's imports and its total value-added will pinpoint the contribution of the industry to national income. If the industry's value-added exceeds its imports, it can be said conducive numerically, in the sense that the industry that depends on imported inputs generates enough value-added in the course of working on these inputs as well as add possibly to the national economy.

Table 3-15 Value-Added/Imports Ratio

	A: Industry Net value-added	B: Import Million pesos	A/B
Other service	164.5	211.5	0.78
Made-up textile products	176.1	156.3	1.13
Iron & steel basic shapes & forms	78.2	71.3	1.10
Private construction	361.0	304.4	1.19
Petroleum refinery products	370.1	296.7	1.25
Private communication	40.9	37.5	1,09
General hardware	122.1	89.2	1.37
Paper & other paper products	150.0	57.5	2.61
Electrical appliances	63.1	17.6	3.59
Knitting & textile mill products	417.2	128.6	3.25
Structural & architectural metal products	61.3	17.0	3.61
Air transportation	72.7	15.8	4.59
Electricity	109.1	29.7	3.67
Metallic mining	172.0	27.3	6.29
Industrial chemical	108.7	13.3	8.15

From the results of Table 3-15 above, every industry except other service is producing more value-added than its import and thus contributing to national economy.

But this result is not still enough to justify those importing industries. Problems are still left unsolved. If the exchange rate of dollar to peso is not $1.00 = 3.9 pesos or in other words, if the devaluation takes place, the import's value expressed in peso will hike up and consequently the ratio shown has to come below down. The point in question is the value of dollar to the peso or to the Philippine economy, which is hidden behind the talble. The true evaluation and deduction of this problem requires to go further looking into the shadow price or accounting price of dollar. On the basis of the accounting price, the industry can be more indicatively discussed if it should keep importing or not.

The another aspect of international trade is export. In 1965, total export recorded 3,100 million pesos, and most of them were raw materials, which is shown in Table 3-16 below.

Table 3-16 Export

	Value (million pesos)	% share to total
Coconut (copra)	627.8	20.3
Forestry	520.4	16.8
Metallic mining	295.4	9.5
Abaca & fiber	87.2	2.8
Sugar	504.7	16.3
Made-up textile	98.0	3.2
Plywood	99.0	3.2
Desiccated coconut	365.6	11.8

It can be easily understood that coconut, sugar, forestry, metallic mining are the major export items and these four share 74.6 percent of the total Philippine export. The Philippine export is verified to be lacking for price elasticity of supply and to be of the type which is heavily dependent on the outside conditions. Aside from sugar whose quota and price are given, an example of copper mining export in 1971 is typical. It increased the production by as much as 70 percent of that in the previous year and yet earned the same dollar as the previous year due to the decrease of international marked price. In other words, country s balance of payments in its structure is solely depending on these outside factors.

For the further details of export industries, the following two coefficients are worked out; (1) direct export content and (2) direct and indirect export content, which can be known by means of premultiplying the column vector of export coefficient of industries by the transpose of inverse matrix. Comparison of these two content coefficients in each of export industry brings about the fact that those industries whose differences in two coefficients are big are important industries not only as export industries but also as those whose inputs to the rest of economy play a significant role. In other words, the differences of export industries which have some intermediate transactions with other industries are bigger than those of industries which are exporting solely the raw materials. If the country attempts to take off from the mono-cultural export structure, these industries with high differences are to be fostered and encouraged.

Table 3-17 Comparison of Direct Export Content and Direct and Indirect Export Content

	Direct and indirect export content	Direct export content	Difference
Desiccated & other coconut products	0.01481	0.64240	0.37241
Pressure bonded boards (plywood and venear)	0.79881	0.58103	0.21778
Coconut and copra	0.55681	0.33305	0.22376
Lumber	0.26181	0.07625	0.18556
Other vegetable oils and fats	0.24519	0.00032	0.24487
Washing and cleansing compounds	0.23444	0.01568	0.21876
Metallic mining	0.86381	0.84268	0.02113
Forestry	0.58617	0.57097	0.01520
Abaca and other fibers	0.56736	0.56738	0.00898
Sugar and sugar confectionery products	0.48714	0.46041	0.02673
Processed fruits and vegetables	0.32510	0.27888	0.04622

Role of the Government Sector

Table 3-18 GNP & Composition

in million pesos

Year	1961	1965	Actual 1970	Estimate 1971
GNP	16,846 (100%)	25,660 (100%)	31,320 (100%)	33,042 (100%)
1. Personal consumption	12,047 (71.51%)	20,175 (78.62%)	24,007 (76.65%)	25,180 (76.21%)
2. Government consumption	1,529 (9.08%)	2,127 (8.29%)	3,038 (9.69%)	2,835 (8.57%)
3. Gross domestic capital formation	1,830 (10.87%)	2,757 (10.75%)	7,041 (22.48%)	6,678 (20.21%)
a. private		2,413	6,359	6,223
b. government		344	682	455
4. Net inventory change	1,762 (10.46%)	1,773 (6.91%)		
5. Exports	1,332 (7.91%)	3,100 (12.08%)	4,482 (14.31%)	5,921 (17.92%)
6. Less: Imports	1,656 (9.83%)	4,274 (16.67%)	5,669 (18.10%)	6,272 (18.99%)

From Table 3-18 above, the ratio of government expenditures i.e., (the sum of government consumption and government capital formation where both figures are available) to the total gross national products is obtained as below.

Year	1961	1965	1970	1971
Ratio	9.08%	9.62%	11.87%	9.96%

The government role of the Philippines in its economy has been alleged to be too small. The figure supports such assertions. It was even small comparing with the developing countries. In 1965, 59.2 percent of government expenditure was spent on compensations for employees and only 12.5 percent on services of roads, bridges, ports and harbors and other public services. The government has been spending very little on construction of roads, bridges and ports and harbors which can offer the external economy to the rest of the economy. The so-called social overhead capital has been lacking outstandingly in the Philippines.

Money supply (in million pesos)

Year	1965	1966	1967	1968	1969	1970	1971
Money supply	3,067	3,371	3,783	3,982	4,754	5,047	5,567
% change		9.9	12.2	5.3	19.4	6.2	10.3

On the other hand, the efforts made by the Government to support economic growth are seen in monetary policies. Since 1969 on, the money supply by the Central Bank is increased considerably to facilitate smooth money circulation.

One remark on this point should be cited. The statistics in 1965 taught us the import-dependence of construction is very high. If the government keeps spending on public investment, it has to be cautious not to stimulate the inflational tilt as well as to overload balance of payments of the country.

3-2-2 Cebu Economy

Geographically, population is largely centered around Cebu City and Mactan which are facing each other across Opon strait, and Toledo on the west coast. Cebu City and Mactan will be linked by a bridge which will replace ferries now in operation in the near future. They are the cities that have grown up from port towns.

Utilizing the mineral resources of the island, there are one copper mining, three cement factories, one glass factory and one coal mining. Mineral resources are abundant, and the size of some of these establishments are fairly large. As major agricultural processing industry, there are two sugar centrals and coconut oil manufacturer. In addition, there is one beer brewery of large scale. Besides, there are many middle sized and minor industries.

The economy is characterized by its role of transshipping ports which are connecting up north Luzon, down south Mindanao and the rest of the Visayas. It is said to have seen its best days, but still its function is significant for the entire Visayas and northern Mindanao. The record of 1970 and 1971 regarding the volume handled at various ports in the Philippines will facilitate the understanding of the situation.

Table 3-19 reveals that Cebu is handling the biggest volume of cargoes in the Philippines. Historically, Cebu was at one time more active in economy than Manila, although the latter, being favored with the "hinterland", surpassed the former. These two are still premier cities. The figure in Table 3-19 declined in 1971 since the economy was sluggish in the year. Even this figure can elicit the role played by Cebu in the sense that country's economy is directly reflected in the record of Cebu port.

Table 3-19 Ports Comparison

	Clearances (thousand tons) 1970	1971	% Change
North Manila	523	397	-24.1
Cebu	1,349	932	-31.0
Iloilo	155	187	20.6
Cagayan de Oro	118	201	69.3
Zemboanga	73	123	68.5
Davao	155	131	-14.3

Chapter 4 Present Power Utilities

4-1 Salient Feature of Power Utilities in the Philippines

Contrasting enough with the other ECAFE countries, the power utilities of the Philippines are operated primarily by private enterprises, with franchise allotted to each utility. This, however, is hampering the growth of power industry, especially in electrifying the rural areas, and a reform measure is underway.

In the Philippines, power is supplied by private utility companies, NPC, and local autonomies. The private utility companies numbered 335 in 1970, and MERALCO outstandingly is the largest of all. Their sizes as of 1969 are shown in Table 4-1.

The energy production of MERALCO and NPC alone amounted to over 90 percent of the total, and the remaining some 8 percent was produced by as much as 454 power utilities, which, corresponding to 400 kW of installed capacity if averaged, overtly indicates how small the 454 utilities are.

Of the total energy production, component ratio of hydro, steam and diesel is 26:69:5. The weight of steam, the highest presently, is expected to increase in view of the development plan which is primarily composed of construction of steam power plants.

Table 4-1 Electric Utilities in the Philippines

	No. of utilities	Installed capacity (MW)	(%)	Energy production (million kWh)	(%)
Private utilities					
MERALCO	1	990	58	4,320	66
Other utilities	334	172	10	410*	7
Publicly owned utilities					
NPC	1	534	31	1,645	25
Municipal utilities	121	7	1	60*	1
Total	456**	1,703	100	6,522	100

* estimated
** as of 1970

The growth of energy production in the whole Philippines recorded 13.7 percent in the annual average during the period of 1959 to 1969. Per capita energy production in 1969 was 220 kWh, which can be ranked in the middle group of ECAFE countries. Figures 4-1 and 4-2 give various trends of production growths in ECAFE region.

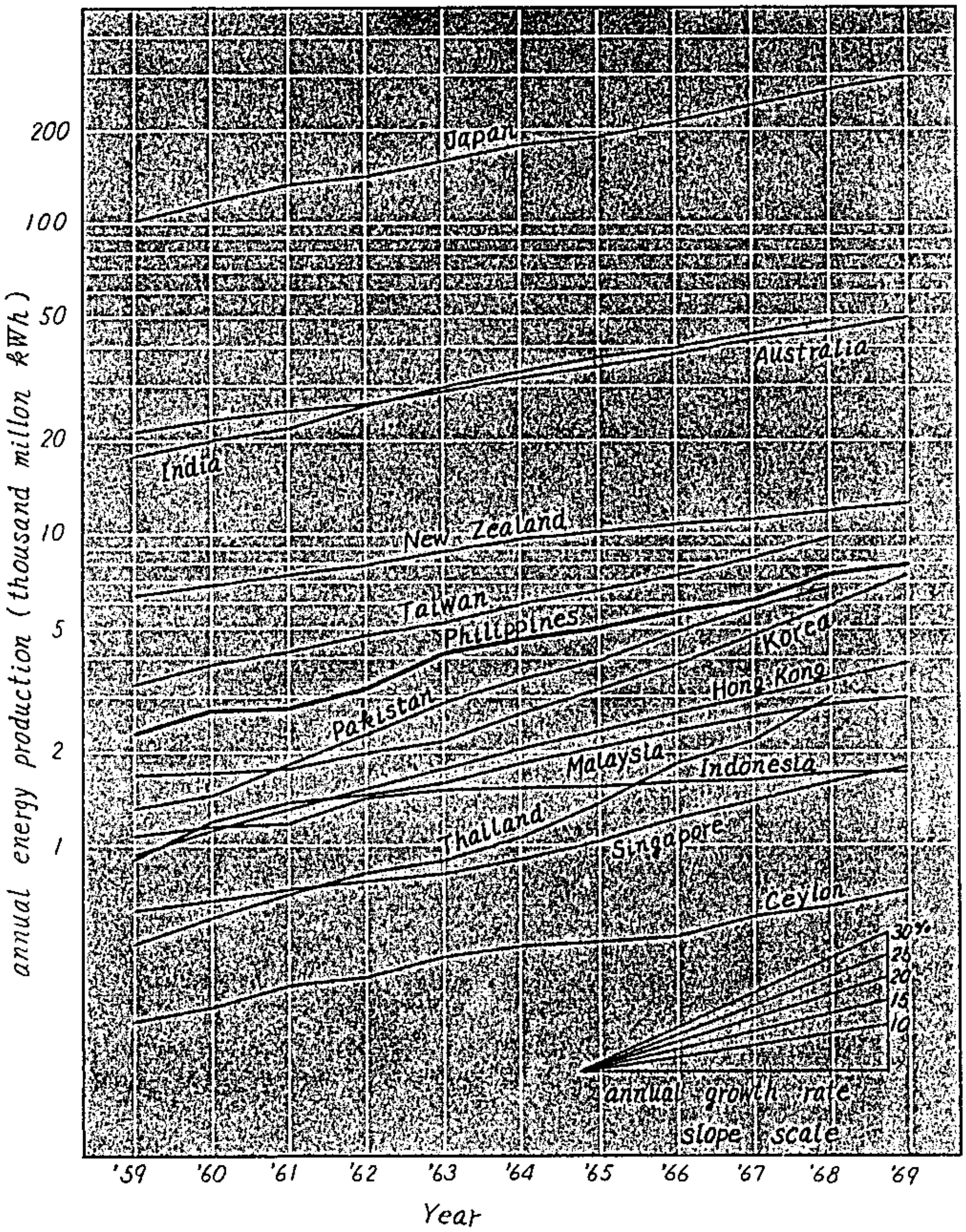
In Luzon, in which is great Manila, there are 230 kV system connected to hydro power plants of NPC and 138 kV system of MERALCO. These two systems are interconnected at Balintawak Substation to constitute so-called Luzon grid. A program has been contemplated and already being implemented by NPC to expand the Luzon grid.

Mindanao is endowed with hydro potentials. Mindanao grid is being established at a voltage of 115 kV with the Maria Cristina Hydro Power Plant as its central power source, supplying low cost energy to the public. The industrial areas around Cagayan de Oro and Iligan, north of Mindanao, were built up with this less expensive energy.

In the Visayas, because of its insular formation, a large single system is not possible, and isolated systems centered around cities and towns are common. Visayan Electric Company (VECO), holding its franchise in and around Cebu City, the second largest city in the Philippines, ranks the second in scale among private utilities following MERALCO.

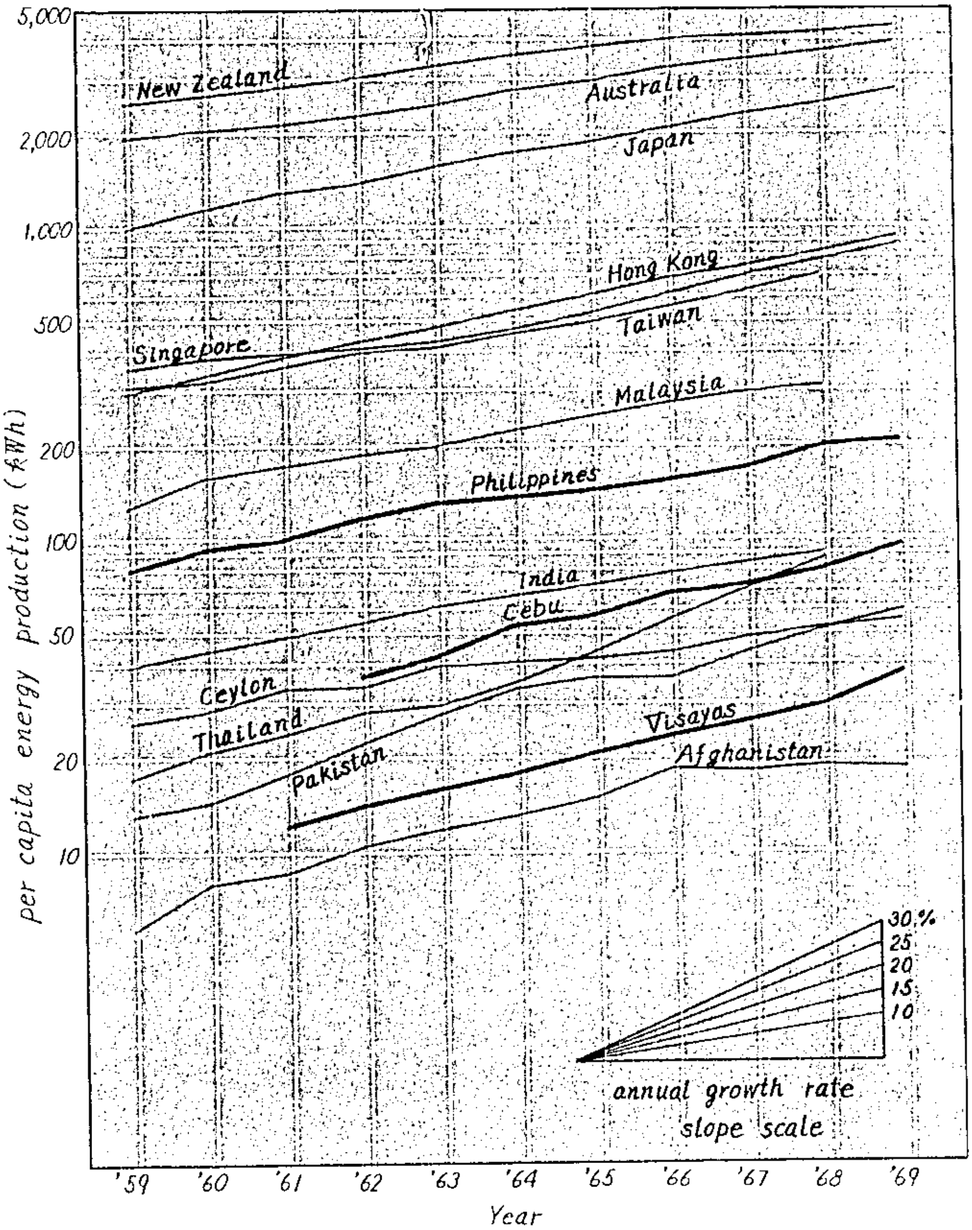
The natural and geographical conditions are different from one region to another, and the power industries are varied accordingly. Power rate schedules are also various. In Luzon where there are large scale steam plants of MERALCO

Fig. 4-1 Trend of Energy Production in ECAFE Countries



and hydro resources harnessed by NPC at low cost, people are enjoying less expensive energy. A residential customer whose monthly consumption is 100 kWh is paying 10.6 centavos per kWh, while a customer of VECO has to pay 23 centavos per kWh. The power rate schedules of major utilities in the Visayas are illustrated in Table 4-2 in comparison with that of MERALCO. Since NPC is not supplying power to final customers, the power rate of NPC is not comparable with those of the utilities mentioned in the above. Power sales revenue of NPC was: 0.058 pesos, 0.027 pesos and 0.082 pesos per kWh respectively in Luzon, Mindanao and the Visayas in FY 1971/1972; the 0.058 pesos in Luzon dose not include power for pooling with MERALCO.

Fig. 4-2 Per Capita Energy Production in ECAFE Countries



The Power Development Council (PDC) and the Public Service Commission (PSC) are the competent government agencies of power industries in the Philippines; the former carrying out nation wide development planning and coordination between the power utilities, and the latter administering the utilities by granting approvals on franchise area and power rate schedules. NPC, however, may be characterized by its peculiar position in this framework as described later.

Of the private utilities, 184 joined together to form the Philippine Electric Plant Operator's Association (PEPOA). Recently, for the purpose to provide financial and technical assistance to the utilities, founded was the Utilities

Table 4-2 Comparison of Power Rate Schedule

(in pesos/kWh)

	Residential (kWh/month)		Commercial (kWh/month)			Industrial (kW)			
	100	200	200	500	1,000	50	100	200	500
MERALCO	0.106	0.128	0.182	0.181	0.157	0.109	0.109	0.109	0.109
VECO	0.23	0.20	0.225	0.22	0.20	0.14	0.117	0.117	
Dancar	0.231	0.191	0.21	0.192	0.186		none		
PECO	0.257	0.203	0.287	0.253	0.241	0.148	0.144		
Diaz	0.297	0.218	0.40	0.35	0.344	0.167 (0.177)	0.166 (0.177)		
Dumaguete (VECO)	0.172	0.148	0.19	0.18	0.188	0.099			
Tacloban	0.275	0.238	0.238	0.215	0.208	0.099 (0.105)			
Ormoc	0.368	0.309		none		0.137			
Catbalogan	0.24	0.22		none			none		

Note:

1. Energy consumption of industrial load is assumed at 50% load factor
2. Figures in parentheses are on-peak rate

Development and Finance Corporation with equity participation by PEPOA and three financial institutions.

Franchise System

A utility operator should be in possession of franchise which is obtainable in two ways. One is through the Congress with approval by the President, and the other with a permit of municipal council of the town. In the former case, the franchise granted by the Congress will be absolute and mandatory on the part of the Public Service Commision to issue the corresponding permit or certificate of public convenience. In the latter case, however, it is only temporary and must be referred to the Public Service Commission for final approve.

With the franchise granted, the operator is entitled to operate utility business within the franchise territory. The utility operation is subject to franchise tax which is variable according to the franchise grantee, or the operator, within a range of 2 to 5 percent of the gross earnings from the business. Recent grantees will have to pay 5 percent. At the same time, the business operation is restricted in terms of the maximum rate of return of 12 percent on rate base.

A public utility is a monopoly in the franchise area. However, it seems to be not obligated to supply electricity to all or any percentage of the inhabitants in the territory. Private utility is always controversial in the profit motivated operation against public welfare. In fact, it is the profit motive rather than the public interest that controls the action and operation of utilities. Especially small utilities tend to concentrate their services into urban area, leaving rural areas not electrified.

Petty as described in 4-1, private utilities are unable to replace old facilities with new; present old facilities are getting no way but much older. Consequently, the level of services are, as may be seen today, very low. Hike of power rate has not been approved by the Public Service Commission. There were apparently the dictates of public opinion behind it. On the other hand, the introduction of floating rate on pesos in 1970 have caused to raise the prices of all the goods and services, as well as, to increase the debt service payment, which has driven many of the local utilities in pecuniary embarrassments.

Rural Electrification

According to data made available by the National Electrification Administration (NEA), the electrification ratio in the Philippines was 22.5 percent in 1971. This means that electricity is served to only one person out of five. In actual figures, only 8.5 million people are receiving electricity out of the Philippines' total 37.7 million, and the remaining some 29 million are living without having the benefit of electricity. Of the electrified 8.5 million, about 70 percent is distributed in and around Manila and a few large cities. Rural areas of the country are hardly electrified.

However, it can not be expected much from the local utilities who are all small in scale as can be seen in 4-1, to electrify rural areas, since the rural electrification will require fixed capital investments aplenty which is beyond the capacities of the utilities. This was the background when NEA was established in 1969 with a target to extend electric service to all prospective customers on so-called area coverage basis. NEA is a lending institution to provide funds, as well as, technical and professional assistance to public service utilities, especially to electric cooperatives for construction of power plants, transmission lines and distribution lines that are designed for rural electrification. The function of NEA was modeled on the National Rural Electric Cooperative Association of USA, which is extending technical and financial assistance to NEA. Japan, also, participates in the assistance in terms of reparation program by providing funds to procure materials. The present target with which NEA is primarily undertaking is to establish one cooperative in each province during the period of 1972 to 1974. Two pilot cooperatives are already in operation; one in Negros Occidental and the other in Misamis Oriental, respectively called VRESCO and MORESCO. The performances and achievements of these two pilot cooperatives will be very much informative and instructive in implementing the establishment of new cooperatives.

Another target of NEA, which is contemplated in a long range, is to establish power grids in Luzon, Mindanao and the Visayas by 1980 with a goal to electrify the entire Philippines within a twenty year period. Being one of the programs on which the government puts strong stress under the Martial Law, electrification is expected to be pushed forward with a great force of momentum.

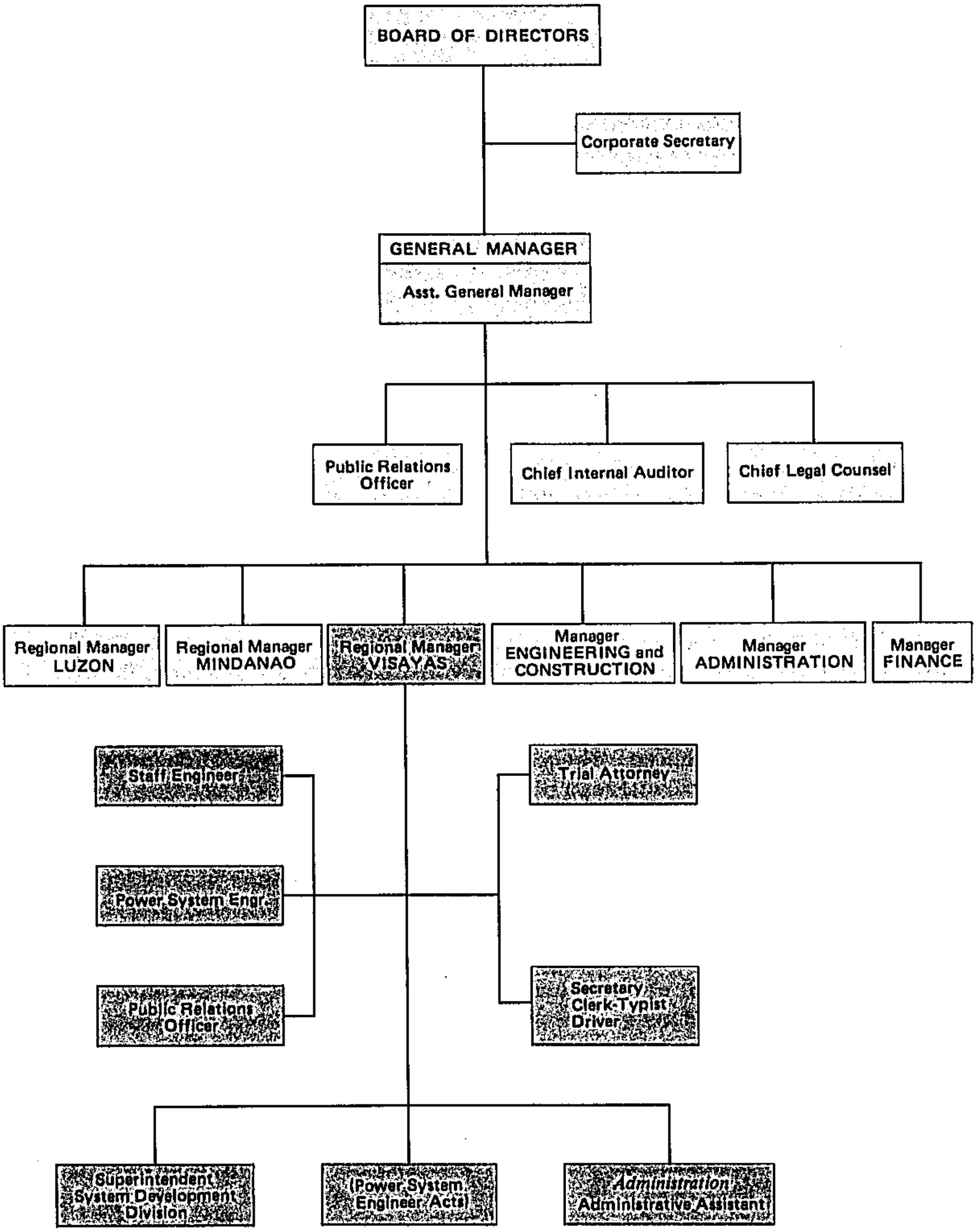
It is a general policy to establish a cooperative at such a place with high priority where utility service is not available. However, there will be cases, so is true with VRESCO, in which a cooperative will be selling energy to small utilities which will have come in the territory of cooperative. In a way, the establishment of cooperatives may be considered as a challenge by the government to private utility owners who are incompetent for fulfilling their task of extending their services into rural areas. As the area coverage of cooperatives will expand, electrification will take place to cover the whole country.

4-2 National Power Corporation (NPC)

NPC was organized in 1936 for the purpose to investigate and develop hydro-electric power potentials in the Philippines. Later on, its activities have come to include the development of other electric power resources. At present, NPC is carrying out investigations on various power plants and power resources, construction and operation of power plants and transmission lines thereby to wholesale energy to other power utilities. The energy wholesale revenue is now the major single item of its earnings. By an amendment of Act in 1960, NPC was remodeled into a corporation issuring stocks to the only share holder of the government. The authorized capital, that has been paid-up in full, is 300 million pesos.

The executive body of NPC is called the National Power Board consisting of seven members appointed by the President. The General Manager shall be the

Fig. 4-3 Organization Chart of NPC



ex-officio Vice-Chairman of the Board.

Since its foundation as a government agency NPC has been engaged in the construction of major hydro power plants and the pertinent transmission lines and substations. Luzon grid and Mindanao grid are the achievements.

In 1972, NPC's first thermal power plant was completed at Bataan with an installed capacity of 75 MW to meet base load. The second stage construction of the power plant is now examined at financing level. The major installations of NPC are as follows:

Luzon

In combination with the second stage construction of Bataan Power Plant, it is proposed to extend the grid in Luzon to almost the double in the total length of the present transmission lines. In addition, an aggregate capacity of substations was 1,200 MVA in 1970.

Table 4-3 NPC Installations in Luzon

Power Plant		Installed capacity (MW)
Caliraya hydro		36
Ambukiao hydro		75
Binga hydro		100
Angat hydro		212
Bataan thermal		75
	Total	498
Trunk transmission lines		**Length (km)**
230 kV		480
115 kV		200
69 kV		680

Mindanao

There is Maria Cristina hydro power plant, 150 MW in installed capacity, on the Agus river originating from Lake Lanao. Preparatory works are underway for an addition of the fifth unit in the plant, as well as, for the construction of Agus No. 2 power plant at a site upstream of Maria Cristina. The voltage of trunk transmission line is set at 69 kV at the present time which will be hightened to 138 kV when the upstream project is completed.

The Visayas

There are no NPC facilities in the Visayas except two small hydro power plants.

NPC Charter

An amendment was approved by the government in September 1971 of the Charter of NPC, with the result that the powers and functions of NPC have been amplified and strengthened. The outline of amendments are as follows:

(a) The powers and authorities of the National Power Board and the General Manager were reinforced. NPC now has authority to determine and fix its power rate schedule by itself provided that the NPC's rate of return does not exceed 10 percent, which is quite a privilege in view of the other power utilities whose power schedule can not be fixed or altered without approval by PSC. Although PSC has power to exercise jurisdiction over all cases contesting the power rates fixed by NPC and to render decision thereon within 90 days after the complaint is filed with PSC, the power rate schedule fixed by NPC may stay effective until the decision is rendered.

(b) The limit of outstanding debt at any time was raised to 500 million pesos in domestic currency and US$ 200 million in foreign currency which had been 500 million pesos including US$ 100 million previously.

(c) NPC has become exempted from all texes, duties and fees, which is serving today to lower the power rates of NPC as much.

(d) In the Board, there are three members representing one each region of Luzon, Mindanao and Visayas, while in the organization of NPC, there are three regional managers assigned to the regions. Further, power rate schedule will be set up independently by the region. Such regionalized policy is indicative of the intention of the government to intensively develop a retarded region.

The number of employees of NPC as of May end 1971 was 2,300 approximately including about 700 engineers. Pursuant to the amendments to the Charter of NPC, three regional offices were established in 1972 in Luzon, Mindanao and the Visayas. The Visayas Regional Office was placed in Cebu City, the central city of the region. Organization of the office, although not complete yet, is shown in Fig. 4-3.

Presidential Decree No. 40

On September 21, 1972, the entire Philippines were placed under Martial Law with a hope to build a new society with various attempts to renovate the whole country. On November 7, 1972, the basic policies were clarified by Presidential Decree No. 40 for the electric power industry. According to the decree, it is a declared policy to electrify the entire country by assigning NPC to the construction of power plants and transmission lines forming grids in the major islands, at the same time, by setting-up cooperatives for expansion of distribution networks.

Noteworthy is the role assigned by the decree to NPC. It is clearly stated in the decree as "The setting-up of transmission line grids and the construction of associated generation facilities in Luzon, Mindanao and major islands of the country, including the visayas, shall be the responsibility of the National Power Corporation (NPC) as the authorized implementing agency of the State." The existing private and municipal utilities are expected to function as distributors of energy produced by NPC in the future, except where such utilities will stay outside the area covered by NPC grids.

4-3 Power Industry in Cebu Island

In Cebu Island are Visayan Electric Co. (VECO) supplying energy in and around Cebu City, Dancar Industries Inc. with Danao as its load center and Mactan Electric Co. supplying energy to Mactan Airport, practically an airport of Cebu City, in addition to Lapu-Lapu City, as well as, 17 power utilities that are run privately or by municipalities, each with an installed capacity of less than 100 kW. The area to be covered by the Cebu grid embraces a total of 46 cities and towns. Of the 46, 13 are enjoying 24 hours service, 23 receiving electricity during the hours of roughly 18:00 to 24:00 hours with low reliability and 10 are staying outside the service territory of any utility.

The electrification ratio in Cebu is estimated as follows:

Cebu City and its vicinity (service territory of VECO)	48 percent
Mactan island (service territory of Mactan Electric Co.)	13 percent
Danao and its vicinity (service territory of Dancar Industries Inc.)	17 percent
Other towns served	5 percent

Visayan Electric Co. (VECO) is the largest power utility in Cebu supplying energy to Cebu City and Mandaue City with the generating facilities shown in Table 4-4.

The four units of steam turbine generators are so old that the energy produced is uneconomical although efforts are being made to lower the cost by burning locally mined coal together with heavy oil. Therefore, it is planned to retire these four units when an ample generating capacity becomes available. The diesel units started operation all after 1964. Today, installation work of one 5,000 kW diesel unit is making headway, and in 1974 another diesel unit is planned to be operational. The trunk distribution lines of VECO are operated at 13.8 kV today. However, in view of a tendency that industries are coming up to the north of Cebu City where land is less costly, VECO has decided to raise the voltage to 115 kV so as to be able to transmit power to the future industrial center. Some of the materials for the 115 kV transmission lines are already procured. Such a leap in voltage from 13.8 kV to 115 kV might leave some problems in economy which requires consideration in relation to the supply area, size of demand and power flow.

Table 4-4 VECO Installations

No. of unit	Unit capacity (kW)	Type	Total capacity (kW)	Date of operation
2	1,800	Steam	3,600	During World War II
2	5,000	Steam	10,000	1959 & 1962
5	4,500	Diesel	22,500	1964-1969
3	5,000	Diesel	15,000	1970-1972
Total 12			51,100	

Load Demand

The past records of energy production, peak demand and annual growth rate are shown in Table 4-5 for the years of 1962 to 1971.

In 1971, the total energy production was 180 million kWh and the maximum peak demand 35 MW. The number of inhabitants in the service territory in the same year is estimated to be about 580 thousand, giving the per capita energy production as 310 kWh annually, which is comparatively shown below.

Cebu (VECO franchise area)	310 kWh
Manila	875 kWh*
Philippines	220 kWh

*quotient of total energy production of MERALCO in 1970 divided by total population in Bulacan, Manila, Rizal and Laguna.

During the period of 1962 to 1969, annual energy production grew at an average of 18.6 percent, however, it went down to 5.7 and 3.8 percent in 1970 and 1971 respectively. This drop in growth rate was explained by VECO as one of the sequential outcomes of stagnant economy and price escalation caused by floatation of pesos on the world exchange market.

In 1972, however, a symptom is seen of recovery in the growth rate. Re-

Table 4-5 ENERGY PRODUCTION

VISAYAN ELECTRIC CO., INC. (VECO)

		Unit	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	Average	Remarks
Energy generation														
	Steam	GWH	43.2	58.0	71.2	67.4	75.7	73.3	71.6	57.2	73.4	42.0	-	
	Diesel	"	10.7	5.6	3.7	20.3	31.0	47.3	71.3	106.3	99.3	137.2	-	
	Total	"	53.9	63.2	74.9	87.7	106.7	123.6	142.9	163.5	172.7	179.2	-	
Percentage	Steam	%	80.1	91.2	95.1	76.8	71.0	61.7	50.1	35.0	42.6	23.4		
	Diesel	%	19.9	8.8	4.9	23.2	29.0	38.3	49.9	65.0	57.4	76.6		
Rate of growth	Steam	%		33.3	23.6	-5.3	12.3	0.7	-6.1	-20.2	28.5	-42.8	-0.3	Growth rate
	Diesel	%		-47.9	-34.5	455.9	52.4	52.5	50.5	49.1	-6.6	38.2	32.7	('62-'69)
	Total	%		17.2	18.4	17.9	21.6	15.8	15.7	14.4	5.7	3.8	14.3	18.6
Maximum demand		MW	13.0	14.8	16.6	19.5	22.3	24.4	28.4	30.9	31.9	34.8		('62-'69)
Rate of growth		%		14.2	12.2	17.7	13.9	9.7	16.4	8.8	3.2	9.1	11.6	13.2
Energy sold		GWH		47.5	56.2	67.5	83.8	96.9	112.3	124.5	141.6	147.4		
Transmission loss		"		15.7	18.6	20.2	22.3	26.6	30.6	39.0	31.1	31.8		
Percentage		%		24.8	25.9	23.5	21.4	21.5	21.4	23.8	18.0	17.8		
Annual load factor		%		48.8	51.5	51.2	54.4	57.8	57.4	60.5	61.8	58.8		

portedly, an annual growth rate of about 11 percent is expected in 1972. The average annual growth rate of energy production was 14.3 percent during the period of 1962 to 1971.

The growth in peak demand generally followed the trend of energy production. It was at a rate of 11.6 percent annually when averaged over the same period of 1962 to 1971. The difference between the peak demand and energy production in the growth was derived from the improvement of load factor from 50 percent to 60 percent.

Sectorial composition of load has remained almost the same during the last decade; 28:23:45:4 for residential, commercial, industrial and other uses. In other words, all the sectorial loads have grown at the same rate.

The industrial load is high in component ratio as compared with other large cities in the Visayas, indicating the advanced industrialization of Cebu City. It is 32 percent in Iloilo in Panay island and 28.1 percent in Bacolod in Negros Occidentals.

In fact, principal industries in Cebu as described later are equipped with their own generating units and not receiving supply from VECO. These industrial power plants are relatively large in scale and carrying considerably high load factors as compared with that of VECO. Aside from Atlas Mining, a total energy production of industrial power plants was almost equivalent to the total energy sales of VECO in 1971. Therefore, the industrial load of Cebu, again not including Atlas Mining, is amounting up to 60 to 70 percent.

The number of customers was 44,500 in total in 1971. Of the total, 43,900 or 99 percent were categorized as residential customers, including those charged with flat rate, and commercial customers. Assuming one customer consists of seven persons, the ratio of population receiving VECO's service is obtainable as 48 percent. The customers are increasing in number at an average annual rate of 6 to 7 percent since 1962. The 1971 statistics showed discontinuity in the sectorial number of customers due to a change in classification of commercial and industrial customers.

The residential customers charged with flat rate is 7 percent in number against total residential sector in 1971, and it has been decreasing along the line of VECO's policy to meter the volume of consumption since 1968 to cease to exist in the near future. Annual consumption per residential customer with meter rates was 1,100 kWh in 1971, while that of flat rate was 360 kWh. The consumption of the former, almost 100 kWh a month, is indicative of that Cebu has attained a certain level of urbanization.

Although slow in 1970 and 1971, average growth rate of energy sales or energy consumption over the years 1963-1971 was 7 percent per annum, and to look at the period of 1963-1967 only it was more than 8 percent.

Energy consumption per commercial customer is about six times of that of a residential customer, and has been increasing at 5 percent in annual growth rate which is somewhat lower due to the change of classification criteria of this sector than the actual tendency. If adjusted on the basis of old rate schedule, the actual increase was 10.1 percent per annum during the period of 1963 to 1970.

In the industrial sector, the load was growing at an average growth rate of 10.4 percent annually. Per customer consumption of this sector has increased greatly from 35 thousand kWh in 1971 to 160 thousand kWh in 1971, attributable to the change in customer classification; small customers once classified in industrial sector is now classified as commercial, leaving only large customers as industrial.

The power sales revenue of VECO was 24 million pesos in 1971, with sectorial ratio of 35:26:34:5 for residential, commercial, industrial and others, respectively. In the years of 1963 to 1971, the power sales revenue increased at 18.2 percent on the annual average while energy sold at 15.2 percent. The defference largely stemmed from renovation of the power rate schedule effectuated in 1969. To take an example a residential customer consuming 100 kWh a month, is spending 22 pesos on electricity monthly.

The average revenue from sales of energy per kWh is 20.9 centavos in residential sector, and 18.5 centavos (88.5 percent of residential) and 12.5 centavos (60 percent) for commercial and industrial sectors respectively.

The energy production less the energy sold is a sum of station service energy and distribution loss. This sum was recorded as 25 percent in the years of 1963 to 1965. A quarter of energy produced did not reach customers. However, it has been decreasing to 21.5 percent in 1966 to 1968 and further down to 18 percent in 1970 and 1971. Such decrease is attributed to the shift of operation from steam units of low efficiency to diesel units of higher efficiency, the latter requiring less station service energy, as well as, to the rectification of distribution lines. Also, annual load factor was improved from 50 percent which was the normal performance in early 1960's to 60 percent in 1969 on.

To see the daily load curves in 1971, it will be noted that the peak appears between 18:00 and 19:00 hours and the load pick-up in the morning is very quick while its drop-off after peak is almost sudden. Daily load factor is approximately 70 percent on Wednesdays and 60 percent on Sundays.

It was informed by VECO engineers that the maximum peak of a year used to appear on or around X'mas day. In recent years, however, the maximum peak has been shifted to sometime in June or July when corn mills are in full operation and the temperature goes up highest demanding cool wind of air conditioners which have recently been generalized rapidly. This trend is considered to continue into the future.

Electric Cooperative

A cooperative area has been set up on the west coast in the southern part of the island, covering an area of about 600 thousand hectares which encompasses seven towns of Barili, Dumanjug, Ronda, Alcantara, Moalboal, Badian and Alegria.

A feasibility study is completed by NEA on the establishment of the cooperative which is numbered among the 36 cooperatives NEA is intending to establish by 1974. The cooperative aims at supply of electricity to one half of the population in the cooperative area which is estimated to be 124 thousand by 1974. The toal investment requirement including those for expansion program for three years after start of operation in addition to the initial construction cost of power plants and transmission and distribution lines, is estimated as US$ 3.1 million (or 20 million pesos). Fund will be raised by NEA in the form of a soft loan to the cooperative with 2 percent annual interest rate, and 30 years repayment with 5 years grace period. It is programmed that, within 10 years after commencement of operation, electrification ratio will be raised to 86 percent, and the energy consumption per residential customer will also be raised from the initial stage of 38 kWh per month to 91 kWh per month. The generating facilities will have a capacity of 4,500 kW in the beginning which will be increased to 12,000 kW during the same period. A residential customer consuming 38 kWh per month, which is the average in the initial stage, will pay 10.25 pesos for his consumption which will correspond to 27 centavos per kWh on the average. This is a little higher than the average of VECO's present power rates for residential customers.

Dancar Industries Inc.

Dancar Industries Inc. is a power distribution company, purchasing power from its parent company of Universal Cement and distributing same to consumers in Danao, Carmen and Compostela located about 20 to 40 kilometers to the north of Cebu City. Total energy sold was 1.1 million kWh in 1971 which is a little less than one percent of that of VECO, although growing at an average rate of 18 percent annually over the period of 1962 to 1971.

Mactan Electric Co.

In 1971, Mactan Electric Co. sold a total of 970 thousand kWh against the peak demand of 330 kW. At the present time, Mactan is linked with Cebu City by means of ferries. A bridge, now under construction between Mactan and Mandaue, is expected to be completed in 1973 to help accelerate the development of economic activities.

Industrial Power Plants

Table 4-6 gives a list of industrial power plants in Cebu province, which was prepared by NPC, together with their installed capacity, peak demand and energy production. Total peak demand in 1971 of these plants, 12 in number, is estimated to be over 80 MW, and the energy production, according to their records, totaled to 584 million kWh. VECO's records in the same year were 34.8 MW in peak demand and 179 million kWh in energy production. These figures are nothing but to indicate the magnitude of industrial power plants in Cebu.

The load factors are also as high as 83 percent on the average with the result that the energy production is large in relation to the size of peak demand. With a few exceptions, all the industries are located at places where VECO has not extended its service. Such locations seemed to have necessitated them to

Table 4-6 Self-Generating Industrial Plants in 1971

	Industrial plant	Location	Products	Installed cap. (kW)	Max. demand (kW)	Annual energy production (million kWh)	Annual load factor (%)
1.	Atlas Mining	Toledo	Copper	103,000	59,000	442.5	86
2.	Universal Cement	Danao	Cement)		7,800	54.6	80
3.	Danao Sugar Central	"	Sugar)	23,200	300	1.1	40
4.	Danao Ice Plant	"	Ice)		400	3.2	91
5.	APO Portland Cement	Naga	Cement	10,000	4,000	28.0	80
6.	San Miguel Corp.	Mandawe	Beer and glass	5,700	3,700	22.2	69
7.	Ludo	Cebu	Coconut oil	5,900	3,000	21.0	80
8.	Bogo-Medellin Sugar Central	Bogo	Sugar	2,315	800	2.4	34
9.	General Milling Corp.	Lapu-Lapu	Flour	—	500	2.5	57
10.	White Manufacturing	Asturias	Cement	—	500	3.0	68
11.	Acoje Soy Sauce and Glass	Liloan	Soy Sauce and glass	1,200	500	3.0	68
12.	Argao Coal Mines	Argao	Coal	—	200	1.0	57
	Total			—	80,700	584.4	83
	Total excluding Atlas Mining			—	21,700	142.0	75

have their own power plants. Excepting those of Atlas, Universal Cement, Apo Cement, San Miguel and Ludo, the industrial power plants are old, and the power demands are all below 1,000 kW. This gives a ground to presume that the energy cost is not low. Of the industrial plants, the largest is what Atlas Consolidated and Development Corporation has in Toledo City on the west coast of the island to produce copper concentrate from its copper mines. Its production ranks among the ten largest copper mines in the world. Mining is a combination of underground block-caving and open pit methods with use of large mining equipment. In 1971, the production of copper concentrate with a grade of 27.9 percent was 287 thousand tons, exported in part to Japan. According to information obtained from NPC, the Corporation has an installed capacity of 103 MW, producing monthly energy of 37 million kWh on the average against the peak demand of 59 MW. However, these facilities and demand were not considered in this report since it has been advised by the Corporation to NPC that the Corporation will suffice itself with its own energy into the future. No other industries have clarified as this their attitudes toward the future electric supply.

Universal Cement is a parent organization of industrial group established around Danao and Carmen, supplying to the group, including a sugar central and an ice plant, energy produced at its own power plant. Notwithstanding, or rather to heighten the efficiency of the industrial group as a whole, the sugar central is equipped with a steam turbine-generator unit burning bagasse.

Apo Portland Cement, once a government-owned organization, has been operational since before World War II with abundant limestone resources in Cebu. San Miguel Brewery in Cebu is one of the two largest beer breweries in the Philippines with relatively new installations. Coconut oil production of Ludo is among the top group in the Philippines. Relocation of the factory to the reclaimed land is reported.

Chapter 5 Load Forecast

5-1 Policy

In order to build a new power system, a large amount of fixed capital investment, as well as, a long time period — 5 to 10 years — will be required for construction of power plants and transmission lines. Therefore, it is a must to seize the future projection of load accurately to avail of the limited amount of funds to the fullest extent.

In the developing countries, where economy is quite fluid and embraces possibility of encountering drastic changes, which may well reflect as a sudden increase or decrease in power demand, it is very hard to project a magnitude of future demand.

Cross-checking method was employed in the study in order to arrive at a more probable forecast. Projection established in one study was checked with a result of another.

The future demand of Cebu was estimated, in principle, on the basis of the past trend in each sector. The total demand was obtained as a sum of sectorial demands. This estimate, however, is valid on the assumption that there is no discontinuity between the past and the future in terms of the social and economic conditions. Further, a projection established as such will be questionable if it covers too long a period. Therefore, a macroscopic approach which seizes the demand forecast in relation to the growth of GNP was also employed to make known a general trend in the long run.

The relation between the growth of power industry and GNP is only comprehensible on the nation-wide basis, and therefore, not applicable as it is to a specific part of the country. However, to the extent that a nationwide tendency will, in some way or other, influence - although this is vice versa - every part of the country, a regional projection may be checked with that of the country.

Load forecast of the study covers a period of 19 years from 1972 to 1990. For the purpose to formulate an implementation program and to evaluate its economic feasibility, forecast of 15 years will be long enough. However, in view of various future projections of other sectors many of which are contemplated on a basis of 5 years unit, the forecast for 19 years ending in 1990 was prepared for the convenience of reference to other sectors. Whereas, the development program was formulated for the period of up to 1987 covering 15 years.

The area coverage includes Cebu island and Mactan island, following the same track of NPC report. The other three islands belonging to Cebu Province were not included for that the interconnections of these islands with Cebu are not conceivable because of the small demands of the islands.

The total number of cities and towns falling in the coverage of the report is 46.

5-2 Presupposition of Forecast

A projection covering a period of as long as 19 years into the future should be based on numerous presuppositions, positive and negative. Principal presuppositions set up prior to forecasting the future load are the followings:

Firstly, the political situation of the republic will be stable, and the national economy will develop steadily. In concrete terms, the growth of national economy will continue along with the line given in Four-Year Development Plan, 1972 - 1975, maintaining the annual growth rate of 7 percent in real term.

Secondly, as one of the primary concerns of the government, the electrification program will be implemented continuously and positively so that no barrio will be left untouched by electric service in 1990 when the electrification ratio of entire Cebu becomes on a par with the present level of Cebu metro area.

Thirdly, the power rate schedule will be kept low and the service will stay attractive to customers. In Cebu, the power market is limited with no common basis for comparison with Manila. Therefore, there will be a limit in itself in pursuing the economy of scale. In view of the very probable rise in oil price in the future and the anticipated escalation of prices of general goods and services, it is a hard task to sustain the present level of power rates long into the future.

However, all possible attempts should be made by NPC, e.g., attempts to raise funds with soft loans, to purchase facilities at low price, to curtail operation and maintenance cost with its original contrivance, etc.. Less expensive energy will hasten the increase of customers, as well as, the growth of per customer consumption, conducing to the sooner installation of large units which will, in turn, serve to yield economy of scale. Thus, production and consumption will be stimulating each other to create favorable ground for expansion of power industry.

5-3 Macro Forecast

(1) Correlation with GNP

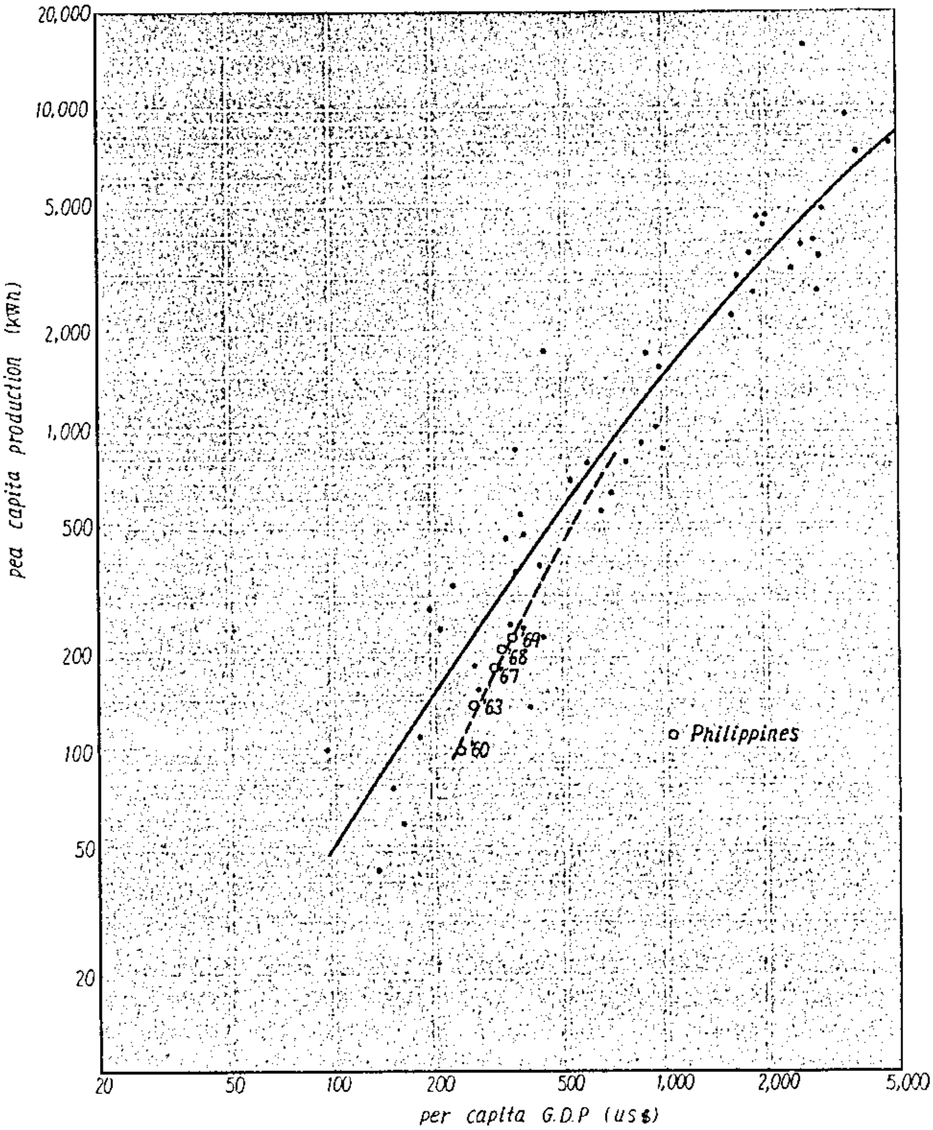
It is well known to all that the energy production of a country is closely correlated with the country's potential of economy. Economic activities will be expressed most comprehensively by the index of GNP. Electricity is being consumed, for both consumptive and productive uses, in all sectors of economic activities. Therefore, in the long run, a trend of growth in GNP is closely followed by the power industry, although deviations will be observed in a short range. Again, it is true to say that the growth of power industry will hoist the level of GNP. Such close correlation will give a ground to project macroscopically the future power demand based on the projected general trend in economy as a whole. In the present study of the Philippines, this macroscopic approach was tried.

Per capita GDP's and per capita energy productions of major 54 countries in 1969 were plotted in Fig. 5-1. Here, GDP's were used as substitutes of GNP's, due to non availability of data. Sources of data are UN Statistical Year Book - 1970 and Statistical Year Book - 1970 of ECAFE. As can be seen from the figure, a certain consistency exists between per capita GDP and per capita energy production. In other words, they are growing high more or less keeping the relation represented by the correlation curve drawn in the figure. The Philippines is plotted below the curve, which is indicative of that the electrification of the country is behind the world average in relation to per capita GDP. This is a reflection of the large population, as much as 80 percent of the total, left unserved by power utilities. Fixed capital investment was not sufficient in this sector. To change the view, the Philippines has a large potential of power demand. Therefore, if a proper portion of social overhead capital is directed to electrify the entire country as aimed by the government, the location of the Philippines spotted on the figure will move upward coming close to the correlation curve. Plotted chronologically in the figure, the Philippines has been climbing up a slope steeper than the correlation curve.

(2) Assumptions

The total population of the Philippines was 36,850 thousand in 1970. The annual growth rate was registered as 3.0 percent on the average over the years of 1960 to 1970. The per capita energy production was 220 kwh.

Fig. 5-1 Per Capita GDP and Per Capita Energy Production



As a projection into the future, the Philippine GDP was assumed to grow at an annual rate of 7 percent in real term, which is the target set forth in the Four-Year Development Plan, 1972 to 1976. At the same time, 8 percent of annual growth rate was taken into consideration as it is also probable that the Philippines' economy will grow at a faster pace as experienced in Korea, Taiwan and Thailand. On the other hand, adverse conditions may rise in the future against the Philippines' economy. Therefore, studies were also made based on a slowed down pace of 6 percent. In any case, the population growth was assumed to be 3.0 percent per annum. Even if the growth rate goes down to 2.0 percent in 1980 and further to 1.5 percent in 1990, the annual growth rate of kWh will not change beyond 1.0 percent. Such small effect on energy production projection justifies the adoption of constant 3.0 percent of population growth in this study.

(3) Load Forecast

With the assumptions described in the foregoing, the total energy production of the Philippines were projected as shown in the table below, together with the annual growth rates over the years of 1970 to 1980 and 1980 to 1990.

Table 5-1 Forecasted Energy Production (in million kWh)

	Growth rate of GDP (%)	1980	1985	1990
Case 1	6	23,800 (10.2%)	36,100	53,200 (8.4%)
Case 2	7	28,200 (12.0%)	45,900	73,100 (10.0%)
Case 3	8	33,200 (13.6%)	58,500	95,100 (11.2%)

To see the past records of the Philippines, the energy production has increased at an annual growth rate of 13.7 percent on the average in the years of 1959 to 1969, which almost corresponds to Case-3 in their growth rates. In order to obtain the correlation in energy production, as well as, growth rate between the entire Philippines and Cebu, which is the island in question, records of 1962 to 1969 were examined. During the period, the energy production of the total Philippines grew at 14.4 percent in the annual growth rate averaged, while it was 17.0 percent in Cebu. They were respectively 100 and 118 in ratio. With this ratio assumed to continue until 1990, the rate of growth in energy production of Cebu is obtainable as shown in Table 5-2.

Table 5-2 Load Growth Forecast for Cebu Grid

	1980	1990
Case 1	12.1%	9.9%
Case 2	14.2%	11.8%
Case 3	16.0%	13.2%

From Table 5-2, it may be said that the energy demand will grow in Cebu at a rate between 12 and 16 percent annually until 1980, and most probably at 14. 2 percent, thereafter, slowing down to a little less than 12 percent until 1990. These figures were used to confirm the load forecast established by the analytical method.

5-4 Load Forecast by Analytical Method

(1) Areal Division and Policy of Forecast

In estimating analytically the future power demand in the island of Cebu, including Mactan, the franchise areas of VECO, Dancar Industries Inc. and Mactan Electric Co. were considered as one, and designated as Metropolitan Cebu, since economy of these areas is outstandingly active. The total energy production of the three utilities amount to over 90 percent of the island's total; the three utilities having electrified 40 percent of the inhabitants within their franchise areas. The future power demand was projected based on the past records of the respective utilities. The load was forecasted as a sum of sectorial loads of the respective utilities in the future. Therefore, analyses were made on the sectorial trend in growth of demand of each utility.

One half of the island's population is in Metropolitan Cebu, and the other half, staying in rural area, is electrified only by 5 percent. In the rural area, where coconuts are primarily grown, sporadic power demands are all small. Assisted by NEA, the Provincial Electric Cooperative Team of Cebu (PECT) conducted a survey on how to electrify the rural area by dividing it into four districts. As a result of the survey, a district embracing municipalities of Barili, Dumanjug, Ronda, Alcantara, Moalboal, Badian and Alegria and covering an area of 26 percent of the island was selected for an ambitious go of rural electrification. An electrification ratio of 42 percent, which is equivalent to that of the present Metropolitan Cebu, was assumed to be attained in rural Cebu by 1990. The state policy on rural electrification described in Chapter 4 was expectedly considered to encourage the realization of this assumption. The process of such electrification was analyzed by drawing on the feasibility studies of nine cooperatives in the Visayas and the actual achievements of VRESCO that started its service in 1966.

(2) Higher and Probable Forecast

Two separate forecasts were prepared; one is conservative, serving to provide a basis to establish implementation program, and the other is prepared for a rapid growth of demand in order to foresee the degree of acceleration in capital investment requirement. In this study, the former is called probable forecast and the latter higher forecast.

(3) Self Generating Industries

In Cebu are industrial power plants as listed in Table 4-6. Excepting Atlas Mining that is expecting no power supply from outside, the total maximum demand of these industries is 21.7 MW. It is not altogether economical for an industry equipped with a power plant of more than 3,000 kW in installed capacity to receive power from a utility. The size and efficiency of power plant and the fuel used there (mostly Bunker C oil) will sometimes offer a negative ground to receive power from outside. Therefore, two cases were considered; one in which all the industries will be connected to and served by utility lines, and the other in which the industries with an installed capacity of 3,000 kW or more will not be receiving power from utilities. The former case was the basis of higher load projection and the latter for probable load projection.

5-4-1 Load Forecast in Metropolitan Cebu

(1) VECO System

Principal and the most important in Metropolitan Cebu, VECO System was analyzed of its past ten years records in connection with the sectorial growth of demand both in number of customers and in per customer demand, with the results shown in Table 4-5. The stagnant economic activities derived from the introduction of the floating exchange rate system were clearly reflected in the VECO's generation record. The annual growth rate, registering 18.6 percent on the average for the years of 1962 to 1969, has dropped to 5.7 percent in 1970 and further down to 3.8 percent in 1971. In the study, the annual growth rate averaged over the years of 1962 to 1971 was adopted as that of probable load projection since the future load thus estimated can be considered as the expected minimum. On the other hand, in view of the recent remarkable recovery in the growth rate, as well as, the general tendency of fast growth in demand seized in the macro forecast, the averaged annual growth rate during the years of 1962 to 1969, which represent the growth unaffected by economic stagnancy, was taken to be the rate of higher load projection.

Land Reclamation Area

In the foreshore to the northeast of Cebu City, a 160 hectares land was reclaimed by Cebu Development Corporation in 1969 with the purpose to establish a commercial center, as well as, a bonded area for improvement trade.
At present, 30 percent of the reclaimed total have been sold to business proprietors, and the roads being improved. According to information made available by the Cebu Development Corporation, peak demand of 40 MW is expected in the reclaimed land in 1982 including that of factories in the bonded area. However, this report forecasts 10 MW of demand only even at maximum in 1982, which corresponds to below 10 percent of the then total of VECO's industrial and commercial customers in number. Consequently, the demand in the reclaimed land may be considered in the picture of natural growth in demand of VECO's franchise area. In projecting the probable load, the reclaimed land was deemed as a part of natural expansion of VECO's territory, while it was considered separately in the higher load projection, serving to increase the future demand as an addition to the present growing demand of VECO.

The past tendency of growth was applied as it was for the years up till 1980. Thereafter, the growth rate was estimated to slow down by 2 to 3 percent as may be seen in Table 5-3 since the increase of new customers, which are generally small, would serve to lower the average per customer demand.

Table 5-3 Figures Used for Load Forecast in VECO System

	1971	Past trend Rate of growth		Rate of growh			
				Probable		Maximum	
		'62-'69 (%)	'62-'71 (%)	'72-'80 (%)	'81-'90 (%)	'72-'80 (%)	'81-'90 (%)
(1) No. of customers							
Residential	36,165	7.8	7.4	7.0	7.0	8.0	8.0
Commercial	5,195	7.3	6.7	6.5	6.5	7.5	6.5
Industrial	411	6.4	6.0	6.0	6.0	6.5	6.5
Flat-rate	2,496	3.8	3.8	-	-	-	-
Street lighting	16	8.1	8.1	7.0	7.0	7.0	7.0
Gov. buildings	248	4.1	4.1				
(2) Consumption per customer	(kWh)	(%)	(%)	(%)	(%)	(%)	(%)
Residential	1,122	9.0	8.2	8.0	6.0	9.0	8.0
Commercial	6,513	10.3	10.1	10.0	7.0	10.5	7.5
Industrial	161,176	12.8	10.4	10.5	7.5	12.5	9.5
Flat-rate	360	6.3	6.3	-	-	-	-
Street lighting	106,844	0	0	0	0	0	0
Gov. buildings	16,817	5.7	10.9				

Summary

The load forecast of VECO System is summarized in Table 5-4. When compared with the power sales of MERALCO system, per customer consumption in the residential sector of VECO is expected to become on a par with that of the present Manila in 1982, and in the commercial sector it will be in 1984. When it comes to the industrial sector, per customer consumption of VECO is incomparably small due to the difference in size of industries.

(2) Dancar System

Purchasing energy from its parent organization of Universal Cement Company, Dancar Electric Corporation is supplying electricity to Danao City and to the municipalities of Compostela and Carmen through its distribution lines. Universal Cement Company has a sugar mill and an ice plant as its affiliated firms. The total power generating capacity of the mills and plant amounts to 23,200 kW, all linked to constitute a power system.

Table 5-4 Summary of Load Forecast for Cebu Island

		1st yr. 1972	3rd yr. 1974	5th yr. 1976	7th yr. 1978	9th yr. 1980	11th yr. 1982	14th yr. 1985	19th yr. 1990	Growth per annum '72-'80	Growth per annum '80-'90
(1) Maximum demand											
Cebu City area	MW	40.9	54.3	72.7	96.3	127.6	162.0	242.0	459.5	15.3 %	13.8 %
Danao City area	"	0.4	0.6	0.8	1.1	1.5	2.0	3.0	6.0	18.0	15.0
Mactan area	"	2.3	2.4	2.5	2.5	2.6	2.7	2.9	3.3	1.5	2.4
Sogod area	"	0.8	1.1	1.4	1.8	2.3	2.8	3.8	6.0	13.9	12.9
Bogo area	"	1.3	1.7	2.1	2.7	3.3	4.1	5.5	8.7	12.4	12.9
Sibonga area	"	0.7	1.4	2.1	2.9	3.9	5.0	7.1	12.1	23.8	12.2
Toledo City area	"	0.5	1.0	1.5	2.1	2.8	3.7	5.2	8.8	23.8	12.2
Boljoon area	"	0.3	0.6	1.0	1.4	1.8	2.4	3.4	5.7	23.8	12.2
Total	"	47.2	63.1	84.1	110.8	145.8	184.7	272.9	510.1	15.2	13.3
(2) Annual Production Energy											
Cebu City area	CWH	215.1	285.6	382.0	506.3	670.9	851.4	1,271.7	2,415.0	15.3 %	13.8 %
Danao City area	"	1.8	2.5	3.5	4.8	6.6	8.7	13.2	26.5	17.7	14.9
Mactan area	"	11.3	11.5	11.8	12.1	12.5	13.0	13.9	15.9	1.3	2.4
Sogod area	"	4.7	5.4	6.2	7.4	8.8	10.6	14.3	23.9	8.2	10.5
Bogo area	"	4.2	5.1	6.4	8.0	10.1	12.7	17.9	31.5	11.8	12.0
Sibonga area	"	1.5	3.0	4.9	7.3	10.5	14.5	22.5	43.4	27.5	15.2
Toledo City area	"	1.1	2.2	3.6	5.4	7.7	10.6	16.5	31.7	27.5	15.2
Boljoon area	"	0.7	1.4	2.3	3.4	4.9	6.8	10.6	20.4	27.5	15.2
Total	"	240.4	316.7	420.7	554.7	732.0	928.3	1,380.6	2,608.3	14.9	13.5
(3) Annual Load Factor	%	58.3	57.5	57.0	57.0	57.1	57.3	57.8	58.2	-	-

Table 5-4 Probable Load Forecast For Cebu Island

	Unit	1st yr. 1972	2nd yr. 1973	3rd yr. 1974	4th yr. 1975	5th yr. 1976	6th yr. 1977	7th yr. 1978
(I) Cebu City Area								
1) Visayan Electric Co.								
No. of customers								
Residential	Thousand	39.0	42.2	45.6	48.2	51.4	55.0	58.8
Commercial	"	5.5	5.9	6.3	6.7	7.1	7.6	8.1
Industrial	"	0.4	0.5	0.5	0.5	0.6	0.6	0.6
Flat-rate	"	2.2	1.7	1.2	0.7	0	0	0
Street lightings Gov. buildings	" "	0.3	0.3	0.3	0.3	0.4	0.4	0.4
Total	"	47.4	50.6	53.9	56.4	59.9	63.6	67.9
Consumption per customers								
Residential	MWh	1.2	1.3	1.4	1.5	1.7	1.8	1.9
Commercial	"	7.2	7.9	8.7	9.5	10.5	11.5	12.7
Industrial	"	178.1	196.8	217.5	240.3	265.5	293.4	324.2
Flat-rate	"	0.4	0.4	0.4	0.4	-	-	-
Street lighting Gov. building	" "	26.5	26.5	26.5	26.5	26.5	26.5	26.5
(Average)	"	(3.7)	(4.0)	(4.3)	(4.8)	(5.4)	(5.8)	(6.3)
Annual consumption								
Residential	GWh	47.2	55.3	64.3	73.8	84.8	97.9	112.9
Commercial	"	39.6	46.4	54.3	63.7	74.5	87.4	102.3
Industrial	"	78.4	92.5	106.6	125.0	148.7	173.1	201.0
Flat-rate	"	0.8	0.6	0.4	0.3	0	0	0

8th yr. 1979	9th yr. 1980	10th yr. 1981	11th yr. 1982	12th yr. 1983	13th yr. 1984	14th yr. 1985	19th yr. 1990	Growth rate per annum (%)	Remarks
63.0	67.4	72.1	77.2	82.6	88.3	94.5	132.5	7.0	
8.6	9.2	9.8	10.4	11.1	11.8	12.5	17.2	6.5	
0.7	0.7	0.7	0.8	0.8	0.9	0.9	1.3	6.0	
0	0	0	0	0	0	0	0	-	
0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.9	7.0	
72.8	77.8	83.1	89.0	95.1	101.6	108.6	151.9	6.3	
2.1	2.2	2.3	2.5	2.6	2.8	2.9	3.9	8.0-6.0	)
14.0	14.0	14.9	16.0	17.1	18.3	19.6	29.4	10.0-7.5	) See Table 5-3
358.3	385.1	414.0	445.1	478.5	514.3	552.9	793.4	10.5-7.5	)
-	-	-	-	-	-	-	-	-	
26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	0	
(6.9)	(7.3)	(7.8)	(8.1)	(8.8)	(9.4)	(9.9)	(13.5)	7.6	
									('72-'85)
130.4	148.3	168.0	190.7	216.4	245.5	277.8	520.7	14.3	14.6
119.8	136.6	155.7	177.4	202.1	230.3	262.6	504.4	15.1	15.7
236.5	269.6	306.4	351.6	401.9	457.8	519.7	999.7	15.1	15.7
0	0	0	0	0	0	0	0	-	-

Table 5-4 Probable Load Forecast For Cebu Island (Cont'd)

	Unit	1st yr. 1972	2nd yr. 1973	3rd yr. 1974	4th yr. 1975	5th yr. 1976	6th yr. 1977	7th yr. 1978
Street lighting	GWh	7.4	8.0	8.5	9.0	9.8	10.4	11.4
Gov. building	"							
Total	"	173.4	202.8	234.1	271.8	317.8	368.8	427.3
2) Non-Utilities								
Aooja Glass Plant	GWh	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Total (1+2)	"	174.4	205.8	237.1	274.8	320.8	371.8	430.8
Transmission	%	18.0	17.5	17.0	16.5	16.0	15.5	15.0
Energy production	GWh	215.1	249.4	285.6	328.9	382.0	440.0	506.3
Annual load factor	%	60	60	60	60	60	60	60
Maximum demand	MW	40.9	47.5	54.3	62.6	72.7	83.7	96.3
(II) Danao city area								
1) Dancar Industries Inc. Energy sold	GWh	1.3	1.6	1.9	2.2	2.6	3.1	3.6
2) Non-utilities	GWh	0	0	0	0	0	0	0
Total	"	1.3	1.6	1.9	2.2	2.6	3.1	3.6
Transmission loss	%	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Energy production	GWh	1.8	2.1	2.5	2.9	3.5	4.1	4.8
Annual load factor	%	50	50	50	50	50	50	50
Maximum demand	MW	0.4	0.5	0.6	0.7	0.8	0.9	1.1
(III) Mactan area								
1) Mactan Electric Co. Energy sold	GWh	1.1	1.2	1.3	1.4	1.5	1.6	1.8

8th yr. 1979	9th yr. 1980	10th yr. 1981	11th yr. 1982	12th yr. 1983	13th yr. 1984	14th yr. 1985	19th yr. 1990	Growth rate per annum (%)	Remarks
11.9	12.7	13.5	14.6	15.7	16.7	17.8	24.9	7.0	7.0
498.6	567.2	643.6	734.3	836.1	950.3	1,077.9	2,049.8	14.7	15.1
3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0	0
501.6	570.2	646.6	737.3	839.1	953.3	1,080.9	2,052.8	14.7	14.9
15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	-	
590.2	670.9	760.7	851.4	987.1	1,121.5	1,271.7	2,415.0	14.3	14.8
60	60	60	60	60	60	60	60	-	
112.3	127.3	144.7	162.0	187.8	213.4	242.0	459.5	14.3	
4.3	4.9	5.7	6.5	7.5	8.6	9.9	19.9	18.0-15.0	18.0% 1972-1980 15.0% 1981-1990
0	0	0	0	0	0	0	0	-	
4.3	4.9	5.7	6.5	7.5	8.6	9.9	19.9	-	
25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	-	
5.7	6.6	7.5	8.7	10.0	11.5	13.2	26.5	16.1	
50	50	50	50	50	50	50	50	-	
1.3	1.5	1.7	2.0	2.3	2.6	3.0	6.0	10.1	
1.9	2.1	2.3	2.5	2.7	3.0	3.2	5.0	9.0	

Table 5-4 Probable Load Forecast for Cebu Island (Cont'd)

	Unit	1st yr. 1972	2nd yr. 1973	3rd yr. 1974	4th yr. 1975	5th yr. 1976	6th yr. 1977
2) Non-Utilities							
General Milling Corp	GWh	2.5	2.5	2.5	2.5	2.5	2.5
Civil aeronautic	"	6.1	6.1	6.1	6.1	6.1	6.1
Total (1 + 2)	GWh	9.7	9.8	9.9	10.0	10.1	10.2
Transmission loss	%	15	15	15	15	15	15
Energy production	GWh	11.3	11.4	11.5	11.7	11.8	12.0
Annual load factor	%	55	55	55	55	55	55
Maximum demand	MW	2.3	2.4	2.4	2.4	2.5	2.5
(IV) Sogod Area							
1) Utility & rural elect.	GWh	0.5	0.7	1.0	1.3	1.7	2.1
2) Non-utility	"	3.0	3.0	3.0	3.0	3.0	3.0
Total (1 + 2)	GWh	3.5	3.7	4.0	4.3	4.7	5.1
Transmission loss	%	25	25	25	25	25	25
Energy production	GWh	4.7	5.0	5.4	5.8	6.2	6.8
Maximum demand	MW	0.8	1.0	1.1	1.3	1.4	1.6
(V) Bogo Area							
1) Utility & Rural Elect.	GWh	0.7	1.1	1.5	1.9	2.4	3.0
2) Non-utility	"	2.4	2.4	2.4	2.4	2.4	2.4
Total (1 + 2)	GWh	3.1	3.5	3.9	4.3	4.8	5.4

7th yr. 1978	8th yr. 1979	9th yr. 1980	10th yr. 1981	11th yr. 1982	12th yr. 1983	13th yr. 1984	14th yr. 1985	19th yr. 1990	Growth rate per annum (%)
2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0
6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	0
10.4	10.5	10.7	10.8	11.1	11.3	11.6	11.9	13.6	2.0
15	15	15	15	15	15	15	15	15	-
12.1	12.3	12.5	12.8	13.0	13.3	13.6	13.9	15.9	2.0
55	55	55	55	55	55	55	55	55	-
2.5	2.6	2.6	2.7	2.7	2.8	2.8	2.9	3.3	2.0
2.5	3.0	3.6	4.3	5.0	5.8	6.7	7.7	14.9	20.5
3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0
5.5	6.0	6.6	7.3	8.0	8.8	9.7	10.7	17.9	9.5
25	25	25	25	25	25	25	25	25	-
7.4	8.0	8.8	9.7	10.6	11.7	13.0	14.3	23.9	9.5
1.8	2.0	2.3	2.5	2.8	3.1	3.4	3.8	6.0	11.7
3.6	4.3	5.1	6.1	7.1	8.3	9.6	11.0	21.3	20.5
2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	0
6.0	6.7	7.5	8.5	9.5	10.7	12.0	13.4	23.7	11.9

Table 5-4 Probable Load Forecast For Cebu Island (Cont'd)

	Unit	1st yr. 1972	2nd yr. 1973	3rd yr. 1974	4th yr. 1975	5th yr. 1976	6th yr. 1977
Transmission loss	%	25	25	25	25	25	25
Energy production	GWh	4.2	4.6	5.1	5.7	6.4	7.1
Maximum demand	MW	1.3	1.5	1.7	1.9	2.1	2.4
(VI) Sibonga area							
1) Utility & rural elect..	GWh	1.1	1.6	2.2	2.9	3.7	4.5
2) Non-utility	"	0	0	0	0	0	0
Total (1 + 2)	GWh	1.1	1.6	2.2	2.9	3.7	4.5
Transmission loss	%	25	25	25	25	25	25
Energy production	GWh	1.5	2.2	3.0	3.9	4.9	6.0
Maximum demand	MW	0.7	1.0	1.4	1.7	2.1	2.5
(VII) Toledo city area							
1) Utility & rural elect.	GWh	0.8	1.2	1.6	2.1	2.7	3.3
2) Non-utility		0	0	0	0	0	0
Total (1 + 2)		0.8	1.2	1.6	2.1	2.7	3.3
Transmission loss	%	25	25	25	25	25	25
Energy production	GWh	1.1	1.6	2.2	2.8	3.6	4.4
Maximum demand	MW	0.5	0.7	1.0	1.2	1.5	1.8
(VIII) Bol-Joon area							
1) Utility & rural elect.	GWh	0.5	0.7	1.0	1.4	1.7	2.1
2) Non-utility	"	0	0	0	0	0	0
Total (1 + 2)	GWh	0.5	0.7	1.0	1.4	1.7	2.1
Transmission loss	%	25	25	25	25	25	25
Energy production	GWh	0.7	1.0	1.4	1.8	2.3	2.8
Maximum demand	MW	0.3	0.5	0.6	0.8	1.0	1.2

7th yr. 1978	8th yr. 1979	9th yr. 1980	10th yr. 1981	11th yr. 1982	12th yr. 1983	13th yr. 1984	14th yr. 1985	19th yr. 1990	Growth rate per annum (%)
25	25	25	25	25	25	25	25	25	
8.0	9.0	10.1	11.3	12.7	14.2	16.0	17.9	31.5	11.9
2.7	3.0	3.3	3.7	4.1	4.5	5.0	5.5	8.7	11.4
5.5	6.6	7.8	9.3	10.9	12.7	14.7	16.9	32.5	20.5
0	0	0	0	0	0	0	0	0	0
5.5	6.6	7.8	9.3	10.9	12.7	14.7	16.9	32.5	20.5
25	25	25	25	25	25	25	25	25	-
7.3	8.8	10.5	12.4	14.5	16.9	19.5	22.5	43.4	20.5
2.9	3.4	3.9	4.4	5.0	5.7	6.4	7.1	12.1	17.2
4.0	4.8	5.8	7.0	8.0	9.3	10.7	12.4	23.8	20.5
0	0	0	0	0	0	0	0	0	-
4.0	4.8	5.8	7.0	8.0	9.3	10.7	12.4	23.8	20.5
25	25	25	25	25	25	25	25	25	-
5.4	6.5	7.7	9.1	10.6	12.3	14.3	16.5	31.7	20.5
2.1	2.5	2.8	3.2	3.7	4.1	4.7	5.2	8.8	17.2
2.6	3.1	3.7	4.4	5.1	5.9	6.9	7.9	15.3	20.5
0	0	0	0	0	0	0	0	0	-
2.6	3.1	3.7	4.4	5.1	5.9	6.9	7.9	15.3	20.5
25	25	25	25	25	25	25	25	25	-
3.4	4.1	4.9	5.8	6.8	7.9	9.2	10.6	20.4	20.5
1.4	1.6	1.8	2.1	2.4	2.7	3.0	3.4	5.7	17.2

Table 5-5 gives the operational services of Dancar Industries Inc.

Table 5-5 Energy Sold and Number of Customers in 1971

	Energy sold (thoudsand kWh)	No. of customers
Residential customers	883	1,473
Commercial customers	192	69
Flat-rate customers	7	24
Street lightings	36	1
Others	18	8
Total	1,136	1,575

The annual growth rate of energy sold was 18 percent on the average during the period of 1962 to 1971.

The power demand of this area consists of, with an overwhelming majority, industrial needs of the aforesaid mills and plant as shown in the table below. The generating facilities of these mills and plant are five 2,100 kW diesel driven units plus three steam turbine-generator units of 6,000 kW, 4,000 kW and 2,000 kW respectively and other small units.

Table 5-6 Energy Production in 1971

	Maximum demand (kW)	Annual energy production (thousand kWh)	Annual load factor (%)
Universal Cement Co.	7,800	54,600	80
Danao Sugar Mill	300	1,050	40
Danao Ice Plant	400	3,200	91
Dancar Industries Inc.	400	1,520	43

As stated in the foregoing, the probable load projection of this area was established based on the demand of Dancar Industries Inc. only, and the higher load projection on the total demand including those of industries. The annual growth rate of 18 percent recorded in the past by Dancar Industries Inc. was assumed to continue till 1980, and then to decrease to 15 percent with the result shown in Table 5-4.

(3) Mactan System

Mactan system is principally supplying energy to Lapu-Lapu City, on the opposite shore of Cebu across the strait. The generating capacity is 700 kW. The operational performance in 1971 is as shown below.

Table 5-7 Performance of Mactan System in 1971

Installed capacity (kW)	700
Maximum demand (kW)	330
Energy production (thousand kWh)	1, 184
Energy sold (thousand kWh)	970
Number of customers	1, 177

Other than the demand in the above, there are power demands at General Milling Corporation and Mactan Airport, both equipped with their own generating units.

The power plant at Mactan Airport has a total installed capacity of 3,405 kW with a maximum unit capacity of 400 kW, all diesel driven. The operation and maintenance of plant are carried out by Philippine Air Force. The maximum demand there is estimated at 1,200 kW. However, according to information gathered, the airport is planning to receive power supply from Mactan Electric Company. A feasibility report prepared in May 1971 on the expansion of Mactan Airport forecasts the peak power demand to increase to 2,240 kW at the first stage expansion program and to 7,760 kW at the second stage. However, since the timing of such expansions are unknown, the increase in power demand of the airport was not considered in the study.

The annual growth rate of power demand in the franchise area of Mactan Electric Company, which is 9 percent, was assumed to remain the same into the future, while the demand at the airport was supposed not to increase in the future. General Milling Corporation, located on the Cebu side of the island, is requiring 500 kW in peak demand, or 2,800 thousand kwh in annual consumption as indicated in Table 4-6. Therefore, the Corporation was included as a customer in projecting the probable future load. The forecast established on these bases is summed up in Table 5-4.

5-4-2 Rural Area

Electric Cooperative

In estimating the future demand in rural Cebu, due consideration was made, as stated in the foregoing, on the results of studies made on the proposed nine cooperatives in the Visayas and the achievements of VRESCO which is already operational on Negros. Table 5-8 gives the estimated electrification ratio and per customer consumptions on the date of operation (1974) and 10 years after the date of operation of the nine cooperatives. In general, although slight differences are observed among cooperatives, the electrification ratio on the date of operation are estimated in the vicinity of 50 percent with a target to electrify 80 percent within 10 years after the date of operation.

Electrification Ratio

Prior to estimating the future demand of rural Cebu, problematic is the electrification of the Cebu island as a whole. As described previously, rural Cebu was divided by PECT into four areas, namely, areas I to IV, and a cooperative was proposed to be built in Area I by 1974. However, the steps to be taken following Area I, that are to develop areas II to IV, are not scheduled for the time being. Therefore, the rural electrification was assumed to take place along the line of the state policy which aims at total electrification of the country on an area coverage basis by 1990. On this assumption, and taking into account the rise in electrification ratio of rural Cebu from 5 percent to 10 percent when the cooperative in Area I becomes operational in 1974, the annual increase in electrification ratio was obtainable as 2 percent in order to arrive at 42 percent in 1990. Capital investment requirement to attain such a rate would be as shown in Appendix 2. According to the estimate, the total capital investment requirement will be some 80 million pesos. In the years of 1972 to 1974, NEA is scheduled to disburse 200 million pesos annually to cooperatives for rural electrification. If such an amount of disbursement is to be continued by NEA, 4,000 million pesos will be sent for electrification program in the Philippines. Being 80 million pesos which is 2 percent of the 4,000 million pesos, Cebu's capital investment requirement is believed justifiable in respect of wht weight of Cebu in population, which is 4.45 percent against the total Philippines.

Population Growth

Based on the vital census reports in 1960 and 1970, the future annual growth rate of rural population was estimated to be 1.1 percent, and the one household structure to be 6 persons. (The rate of population growth in Cebu Province is 2 percent per annum, while it is 3.5 percent in urban Cebu.)

Number of Customers and Per Customer Consumption

Table 5-9 gives the estimated sectorial ratios with residential sector as 100 in the nine cooperatives. The ratio of commercial sector in rural Cebu was assumed to be 1.5 percent from the estimates in Table 5-8 and Table 5-9, in addition to the past record of VRESCO. Also, the per customer consumption in commercial sector was set at 4 times of a residential customer on the average. Prior to determining the energy consumption by large consumers as 10 percent of the total, the studies of the nine cooperatives and the situation of VRESCO were duly taken into consideration.

Table 5-8 Electrification and Energy Consumption by Sector (from Feasibility Report Prepared by NEA)

Electric Cooperative	Unit	Residential		Commercial		Irrigation		Public Buildings	
		1st year	10th year	1st year	10th year	1st year	10th year	1st year	10th year
1. Cebu									
Electrification	%	50	86	86	95	10	75	80	89
Consumption	kWh/mon.	38	91	40	114	2,000	2,000	25	70
2. Iloilo									
Electrification	%	50	86	86	95	10	75	80	89
Consumption	kWh/mon.	38	91	40	114	2,000	2,000	25	70
3. Antique									
Electrification	%	40	80	80	89	5	70	70	82
Consumption	kWh/mon.	30	75	32	90	2,000	2,000	25	70
4. Aklan									
Electrification	%	-	-	-	-	-	-	-	-
Consumption	kWh/mon.	-	-	-	-	-	-	-	-
5. Capiz									
Electrification	%	40	85	80	89	5	70	67	78
Consumption	kWh/mon.	30	75	35	105	2,000	2,000	25	70
6. Negros Occ.									
Electrification	%	50	86	86	95	10	75	80	89
Consumption	kWh/mon.	35	90	40	105	2,000	2,000	25	70
7. Negros Or.									
Electrification	%	38	75	40	85	10	75	70	88
Consumption	kWh/mon.	30	75	35	100	2,000	2,000	25	70
8. Southern Leyte									
Electrification	%	42	83	80	89	5	75	60	78
Consumption	kWh/mon.	30	75	30	100	2,000	2,000	25	70
9. Bohol									
Electrification	%	40	85	80	89	5	70	80	89
Consumption	kWh/mon.	30	75	35	105	2,000	2,000	25	70

Assuming the monthly energy consumption per residential customer to be 40 kWh in 1974 and the annual growth rate to be 7 percent thereafter, the following figures were obtained:

Year	1974	1980	1985	1990
kWh/month	40	60	84	118

With the above consumption of residential sector as a base, the total consumption of rural Cebu was obtained by referring the ratios of commercial sector and of large customer consumption both set against residential sector. The re-

Table 5-9 Percentage of Each Sector to Number of Residential Customers (From Feasibility Report prepared by NEA)

Electric cooperative	Number of Residential*	Commercial		Irrigation		Public building		Others	
		1st yr.	10th yr.	1st yr.	10th yr.	1st yr.	10th yr.	1st yr.	10th yr.
		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1. Cebu	11,064	3.4	4.0	0	0.4	2.3	2.2	1.7	1.0
2. Iloilo	9,590	4.1	9.1	0.3	1.4	3.8	3.0	1.8	1.1
3. Antique	12,045	2.5	2.8	-	0.3	2.4	2.1	2.1	1.1
4. Aklan	10,540	3.0	2.6	-	0.3	2.0	1.5	2.1	1.1
5. Capiz	7,684	5.3	5.7	0.1	1.5	6.5	5.8	2.4	1.2
6. Negros Occ.	14,162	2.3	9.0	-	0.2	1.1	0.9	1.7	1.1
7. Negros Or.	9,594	1.7	4.5	0.2	0.8	2.7	2.9	2.3	1.2
8. Southern Leyte	9,888	3.0	2.3	-	0.7	2.5	1.6	2.1	1.1
9. Bohol	10,034	3.0	3.1	-	0.4	3.0	2.0	2.1	1.0

Note: * number of residential customers to be supplied electricity in 1974

sults are shown in Table 5-10. The total consumption thus obtained were broken down into areas which, different from the areas established by PECT, were the zoning used in the feasibility study of NPC, by proportionating to the populations of areas with the results shown in Table 5-4. In rural Cebu, there are a few industrial power plants in operation. However, these are all small in size, and therefore, energy produced there is thought uneconomical. The future load of utilities was projected on the assumption that all these industries would be served by the utilities.

5-4-3 Load Forecast in Cebu Island

(1) Probable Forecast

The above sectorial and areal projections are recapitulated in Table 5-4. The annual load factor and transmission loss in the table were determined taking into consideration the present performance, as well as, the structure of system to be constituted in the future. As can be seen from the table, the energy production will reach 732 million kWh in 1980 and 2, 608 million kWh in 1990 with annual growth rates of 14.9 percent in the first period and 14.2 percent in the second period. These percentages of annual growth are in close proximity to what has been envisaged in macroscopic approach. The corresponding peak demands at generating end were estimated at 146 MW and 410 MW in 1980 and 1990 respectively. In terms of the annual growth rate, they are respectively 15.2 percent and 14.2 percent.

Table 5-10 Load Forecast in Rural Cebu Excluding Industries

	Year	Population (thousand)	Potential load (million kWh)	Electrification ratio (%)	Forecasted load (million kWh)
1	1972	785	63	6	3.8
2	73	795	67	8	5.4
3	74	804	74	10	7.4
4	75	814	80	12	9.6
5	76	823	86	14	12.1
6	77	833	93	16	15.0
7	78	843	101	18	18.2
8	79	852	109	20	21.9
9	80	861	118	22	26.0
10	81	871	128	24	30.7
11	82	880	138	26	36.0
12	83	889	150	28	41.9
13	84	898	162	30	48.5
14	85	907	175	32	56.0
15	86	916	189	34	64.2
16	87	924	204	36	73.4
17	88	933	220	38	83.7
18	89	941	238	40	95.1
19	90	949	257	42	107.8

(2) Higher Forecast

The higher forecast is the probable forecast plus (i) demands of industries that are more than 3,000 kW at peak hours, (ii) difference derived from different growth rates applied; an average over the years of 1962 to 1969 and the other over the years of 1962 to 1971 and (iii) separate forecast for the reclaimed land area. The higher forecast is shown in Table 5-11 in comparison with the probable forecast. If the higher forecast is the case, the capital investment scheduled in 1977 by the probable forecast should be advanced by one year and that of 1983 by one and a half years approximately.

5-4-4 Comparison with NPC Forecast

The probable forecast is comparatively shown in the following table together with the forecast established in the feasibility report of NPC.

Probable forecast of this report tends to be lower than that of NPC report by only a few MW till 1978. This is attributable to that NPC forecast is picking up industrial load from the initial stage including large industrial loads of over 3,000 kW. After 1979 this tendency is the reverse, the probable forecast exceeding NPC forecast. In the probable forecast, the annual growth rate of VECO was estimated from the past records to be 14 percent, while it was set at 12.5 percent by NPC. This difference has lifted the probable forecast over the NPC forecast.

Table 5-11 Higher and Probable Forecasts

Year		1972	1974	1980	1990
Higher forecast	Peak demand (MW)	58	78	189	740
	Energy demand (million kWh)	389	482	1,025	3,891
Probable forecast	Peak demand (MW)	47	63	146	510
	Energy demand (million kWh)	240	317	732	2,608

Table 5-12 Comparison with NPC Forecast

Year		1975	1980	1985
NPC forecast	Peak demand (MW)	75	133	220
	Energy demand (million kWh)	387	675	1,129
Probable forecast	Peak demand (MW)	73	146	273
	Energy demand (million kWh)	364	732	1,381

Chapter 6 Power Development Planning

6-1 Policy of Power Development Planning

Power development planning is a study to find the most economical way to develop and utilize available power resources for energy production to meet the load forecast established in Chapter 5. It includes the determination of the order of priorities of the projects proposed and their timing of implementation. The objective of the report is for the period from 1973 to 1987. However, the year of 1973 is too soon for any facilities or installations to be completed. Therefore, the coverage of the program is practically the years from 1974 to 1987.

Economy was primarily sought in the planning. According to the load forecast, the demand in the Cebu Grid will increase at an annual rate of 15 percent. To cope with such growth in demand, the present power supply capability should be multiplied by about 6 times including a reserve capacity, which means an addition of 250 MW in installed capacity. Largely dependent on foreign aid and capital, the Philippines should find its way to provide the largest power supply capability at the least cost by effectively utilizing its financial source. In the past, however, economization in this field does not seem to have been exercised to the fullest.

6-2 Process of Planning

No hydro power resources nor geothermal power resources that are conceivable in contemplating long-range power development program are available in Cebu. Therefore, the study was confined to a combination of diesel, steam and gas turbine units and their sizes. The power development program was planned according to the following steps:

(a) To estimate power supply requirement based on the estimated demand and reserve capacity.

(b) To study on the conditions of locations, unit sizes and timing of in-service of the conceivable thermal power plants.

(c) To prepare alternative plans that can secure the power supply requirement by arranging thermal power plants conceived in the above.

(d) To study alternative plans from the technical and economical points of view, and select the most optimum plan. The economic study includes the trend of energy cost of the system in the future in addition to the construction cost.

(e) To calculate the investment requirements of the selected plan, and prepare an investment program.

6-3 Power Supply Requirement

6-3-1 Reserve Capacity

The power supply requirement was assumed to be a sum of the probable load projected in Chapter 5 and the reserve capacity. A reserve capacity is a reserve for misforecasting of load and possible outage of facilities. In the report, the reserve was assumed to be 10 percent of the peak load. In NPC report, the reserve capacity is regarded as an equivalent of the maximum unit capacity of the system, which is not agreeable not only at the present stage, but in the foreseeable future.

The power systems in Cebu are still small, and their largest unit capacity is 5 MW of diesel driven generator. From a small unit capacity as this, the economy of scale cannot be expected. Power is costly there. Two large capacity units would be required at the same time if the reserve capacity should be equivalent to the maximum unit capacity. Consequently, a large amount of advanced investment would be required, uneconomically. As described into details in the comparative studies on the development plans, the reserve capacity equivalent to the maximum unit capacity would result in the installation of an excessive capacity of nearly 100 MW in 1977. According to NPC report, the total installed capacity in Cebu will amount to 243 MW in 1977, including a 75

MW reserve unit which will be the size of the maximum unit proposed, against the concurrent peak demand of 100 MW.

While, with the 10 percent reserve, the total installed capacity will be 157 MW against the same peak demand. Assuming the unit construction cost to be US$ 200 per kW, this difference in installed capacity is equivalent to US$ 17 million in monetary term. After 1977, which is the year of extreme, this difference will decrease as the system will grow. However, tentative calculation has revealed that the advanced capital investment involved in NPC report would amount to about US$ 10 million in the years of 1975 through 1987. The problem that NPC should solve now is how to supply less expensive power in abundance. Therefore, economy should not be sacrificed by taking countermeasures against supply failure which occurs seldom.

Outage of Maximum Capacity Unit

When a large capacity unit is to be introduced to a small system in which the reserve capacity is 10 percent only, it is necessary to prepare for outage of the large unit by analyzing the possible situations of the system to be incurred by the outage and establishing countermeasures in advance of the installation. There are scheduled outage and forced outage. The former is an outage for regular maintenance, such as boiler inspection which, lasting for about a month, is required once a year and maintenance of turbine which, lasting for a month or a month and half, is necessary once a year or two. Such outage can be scheduled beforehand taking into account the seasonal load fluctuation. However, the forced outage of a unit of which capacity is large in relation to the size of system may cause power supply failure to a large extent. But, the problems here are how often such an outage will occur and how fast the system can be recovered by what measures. No data are available in the Philippines in connection with such outages. In Japan, past record reveals that the annual outage ratio of a 50 to 125 MW class steam turbine unit is 1.4 percent (outage ratio = outage hours/calendar hours x 100), and the frequency is 4 times a year. It is considered that a fault entailing serious damages requiring emergency stoppage occurs in less than one out of the four times. In more than three cases, adequate measures are taken by limiting or cutting the load or by increasing the receipt of power from other sources before the unit in trouble is tripped, thereby saving the system from serious damages. The serious damage with once-a-year frequency may cause to fail entire system. However, such a failure is inevitable at the present stage. Precautions should be taken how to recover such a failure quickly. Diesel units or gas turbine units that are capable of black starting will help recover promptly. According to Plan GS-3 described later, the supply capability and reserve capacity will be as shown in Table 6-1.

As cen be seen from Table 6-1, the actual reserve capacity will exceed the 10 percent target providing a reserve capacity for outage of a unit. In 1977, it will be 33 MW while the maximum capacity unit will be 25 MW. In 1978, the maximum capacityunit will become 50 MW which can be put out of operation with with a reserve of 45 MW if the system operation is care fully examined and managed properly. In 1979, when the reserve decreases to 27 MW, outage of a 50 MW unit will result in supply shortage of 23 MW. However, compromise may be made either by hastening theinstallation of a 50 MW unit scheduled in 1980 by putting off the outage. Then, scheduled outage of the maximum capacity unit will be manageable with the development program formulated with the minimum 10 percent reserve.

Table 6-1 Peak Demand and Reserve Capacity

		1977	1978	(in MW) 1979
Required capacity	(A = B + C)	80	122	142
Reserve capacity	(B = 10% x C)	7	11	13
Peak demand	(C)	73*	111	129
Supply capability	(D)	106	156	156
Balance	(E = D - A)	26	32	14
Total reserve capacity	(F = B + E)	33	48	27

* VECO system only ...

Peak Supply Capability

A study was made on the portion of peak supply capability in the system in the future. The supply capability is various in character according to the prime mover of generator. The steam turbines of which output is hard to change are suited for continuous operation under a constant load, while the gas turbines are easily adjustable to follow a fluctuating load. The diesel engines are applicable for both constant and fluctuating loads. Therefore, the combination of generators of different type should be elaborated taking into consideration the requirement of system as a whole.

Table 6-2 Peak Load Forecast

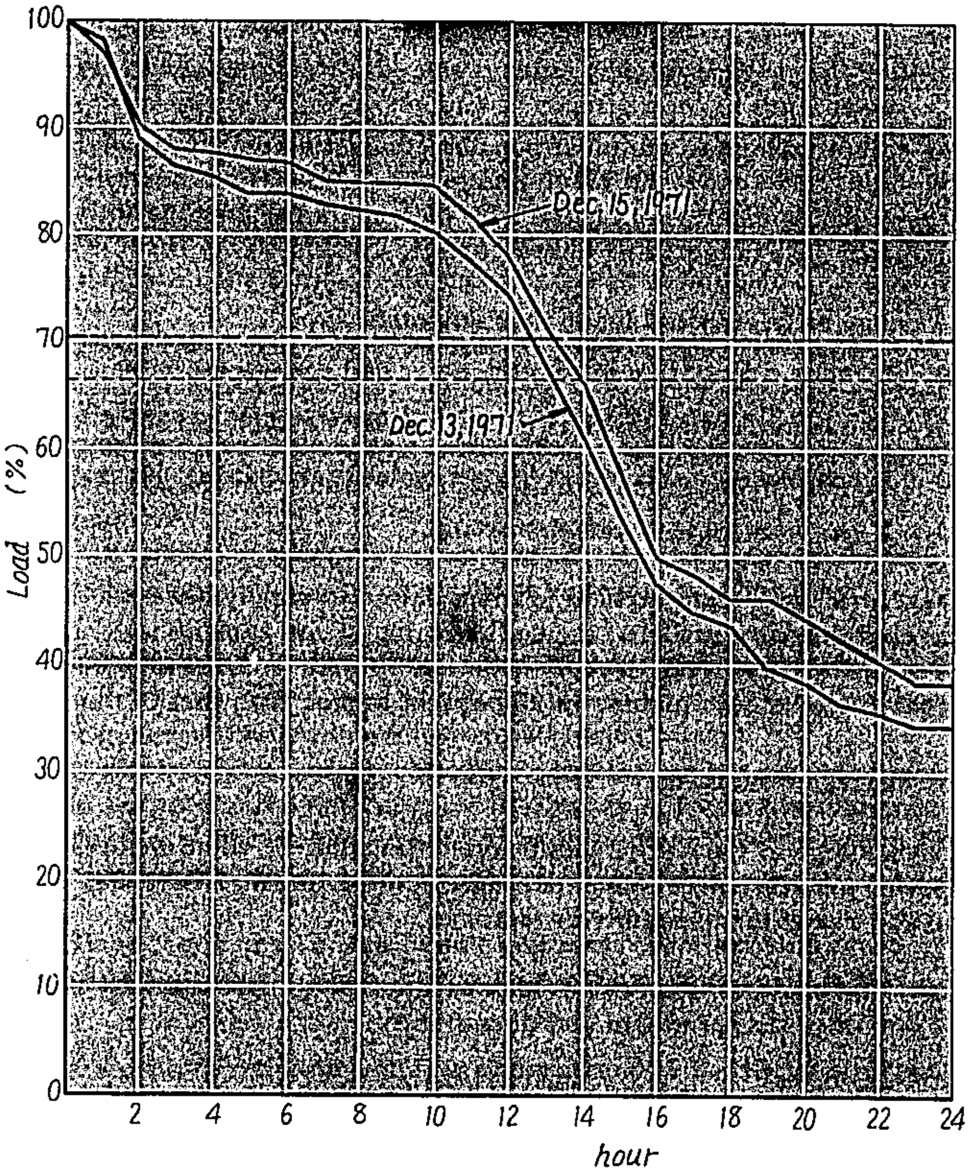
(in MW)

	1977*	1978	1980	1985
Total peak demand (including 10% reserve)	106	122	161	300
Average load	67	79	105	195
Peak portion	37	43	56	105
Short peak portion	16	18	24	45

*VECO system only

As stated in Chapter 4, the daily load factor is about 65 to 70 percent, 60 percent in annual load factor, in the present system of VECO. These figures were presumed to remain almost the same in the future. If a portion of load exceeding the daily average load is called peak load, the peak load of this system has a duration of about 12 hours with approximately 35 percent of the total power demand. Besides, it has a short peak with 2 to 3 duration hours; comprising as much as 15 percent of power demand. To meet such a pointed short peak, gas turbine generators and diesel driven generators are thought the most adequate in the Cebu Grid where hydro power potential is not available. The peak load was estimated to increase as shown in Table 6-2.

Fig. 6-1 Daily Load Duration Curve in VECO Grid



The installed capacity of VECO will be 33 MW by diesel units alone in 1973, not including that of steam units. If the diesel units are to meet the above peak portion, it will become short by 4 MW in 1978, and by 10 MW and 23 MW respectively in 1978 and 1980. Such peaking capacity requirement which should be added to that of diesel units will be about 70 MW in 1985 including short peaking capacity of 45 MW. In formulating the power development program, the peaking capacity requirement should be duly taken into account.

6-4 Generating Facilities

In Cebu are no hydro power resources nor geothermal energy. Therefore, the power development program should depend solely on fossil fuel to generate power by means of steam turbines, gas turbines or diesel engines. The characteristics of these generating units are as follows:

(1) Steam Turbine Generator

The steam turbine is the most popular generating unit today and its capacity is ranging from a few thousand kW to one million kW. The other type of units, namely, gas turbine and diesel engine may be considered as substitutes of the steam turbine. The outstanding characteristics of the steam turbine are as follows:

(a) The efficiency is higher than any other type.

(b) It takes a longer time to stop, start and change its output.

(c) The construction period requires approximately 3 years.

(d) It requires a considerably large quantity of cooling water.

(e) It is not capable of black starting.

Therefore, the steam turbine is most suited to supply base load. Although there are coal deposits in Cebu, the coal burning steam turbine was not considered due to unstability in coal supply quantity. Furthermore, the construction cost of coal-fueled steam turbine is 20 percent higher than that of the oil-fired.

(2) Gas Turbine Generator

A technological innovation has enabled the application of aeroplane gas turbine to power generation. Today, package units of 10MW, 25MW and 50MW are available and ready for assembly at factory.

(a) The construction cost is less expensive. Approximately one half of that of steam and diesel units.

(b) The fuel is normally distillate oil (heavy oil is also applicable). However, the efficiency being the lowest, fuel cost per kWh is the most expensive.

(c) Easy in operation, the gas turbine can perform instantaneous start and stop including black start.

(d) The term of delivery is very short. Operation can be started within one year after the placement of order.

(e) Cooling water can be circulated without a need of supplementing water.

(f) Output of a gas turbine depends largely upon ambient temperatures.

(g) It generates annoying noise. If it is to be installed near to residential area, measures should be taken, such as by installing silencers.

Upon these considerations, the gas turbine generator is thought adequate as peaking capacity, especially, when the power requirement is imminent.

(3) Diesel Engine Generator

Diesel engines have been used for power generation since a long time ago in a wide circle.

(a) With its high efficiency, the fuel cost is comparable with that of steam turbine although its unit capacity is small.

(b) The construction cost is almost equivalent to steam turbine generator.

(c) Being combustion type, frequent maintenance is required.

(d) Easy stop and start make it adjustable to load fluctuation.

(e) It generates noise in addition to vibration.

(f) In respect to the delivery, cooling water and other requirements, the diesel engine can be said to be in between the steam and gas turbines.

(g) Since there is a ceiling in unit capacity, the maximum plant capacity conceivable at utility power plant is up to 50 MW.

With this consideration in mind, it is construed to be the most proper way to have steam turbines met by base load and gas turbines and diesel engines by peak load.

Table 6-3 Basic Figures of Various Power Plants

	Gas turbine	Diesel engine	Steam turbine	Steam turbine
Plant capacity (MW)	50	50	100	150
Unit capacity no. of unit (MW x No.)	25 x 2	10 x 5	50 x 2	75 x 2
Plant factor (%)	50	60	70	70
Annual energy production (million kWh)	131	263	614	920
Station service use (%)	1.0	2.0	7	6
Annual available energy (million kWh)	130	257	592	864
Thermal efficiency at sending end (%)	24	35	32	34.5
(BTU/kWh)	(14,320)	(9,840)	(10,760)	(9,960)
Annual fuel consumption (10^3klit.)	51.7	64*	155	217
Unit construction cost (US$/kW)	95	190	195	185
Construction cost (thousand US$)	750	9,500	19,500	27,600
Foreign currency (%)	90	85	80	80
Domestic currency (%)	10	15	20	20
No. of persons for O & M	15	24	120	140
Service life	33	18	33	33

Note: * Lubricating oil of 525 tons is not included

Sizes of Generating Facilities

Assuming the unit capacity of steam turbine generators, to be in operation around 1975 to 1978, to be 50 to 75 MW, the basic figures of generators have been standardized to obtain the generating cost, and shown in Table 6-3. The gas turbine generators were assumed to have a unit capacity of 25 MW since it is the capacity adopted most widely. Although not conventional, diesel driven generators of 10 MW in unit capacity were assumed to be installed since it is readily imaginable that, within a couple of years, many of the diesel units will be designed to have a capacity of 10 MW and over. The number of units will be two for gas turbines and five for diesel engines. Two different capacity units, 50 MW and 75 MW, were considered for steam turbine generators. Generating costs were calculated based on these unit sizes. The conditions for calculation are as shown in Table 6-4.

The construction costs estimated in Table 6-3 were based on the prices bid in international tenders and taking duly into consideration the world wide tendency. Service lives of generators are the same as those in NPC report, except gas turbines which, not contemplated in NPC report, were considered to be the same as that of steam turbine generators following the practice in Japan.

Table 6-4 Conditions for Energy Cost and Annual Cost Calculation of Power Plant

Interest Rate	
Foreign currency	3.5% and 7.5%
Domestic currency	7%
Depreciation	
Steam turbine	3.03%
Gas turbine	3.03%
Diesel engine	5.5%
Annual salary	US $ 1,200/person
Repair and maintenance cost	2% of construction cost
Fixed cost	80%
Variable cost	20%
Miscellaneous cost	0.2% of construction cost
Administration cost	8% of total operation and maintenance (O & M) Cost
Fuel cost	
Bunker C	as shown in Table 6-5
I. D. O.	- ditto -
Lubrication oil	US $ 320/metric ton

Annual Cost of Power Plant

The annual cost of power plant was divided into the fixed cost and variable cost. The fixed cost including capital cost, payroll, a part of operation and maintenance cost, and a part of overhead cost, does not vary with the changes in operation or utilization of plant; capital cost comprising about 70 percent and operation and maintenance cost 25 percent. Fuel cost is a major single component comprising 97 percent of the variable cost and the remaining is a part of the maintenance and the overhead cost. Taxes and duties were not considered since NPC is exempted from them. The fixed cost was assumed to be disbursed in equal annual installment over the service life of power plant. The conditions upon which the annual cost was computed is shown in Table 6-4. Three cases of fuel cost were considered based on various prices informed as shown in Table 6-5.

NPC has concluded an agreement in September 1967 with ESSO Standard Eastern, Inc., in connection with fuel oil supply to Bataan Thermal Power Plant. According to the agreement, the basic price of fuel oil which is high viscocity Bunker-C is 1.1 pesos per million BTU. The agreement carries price es-

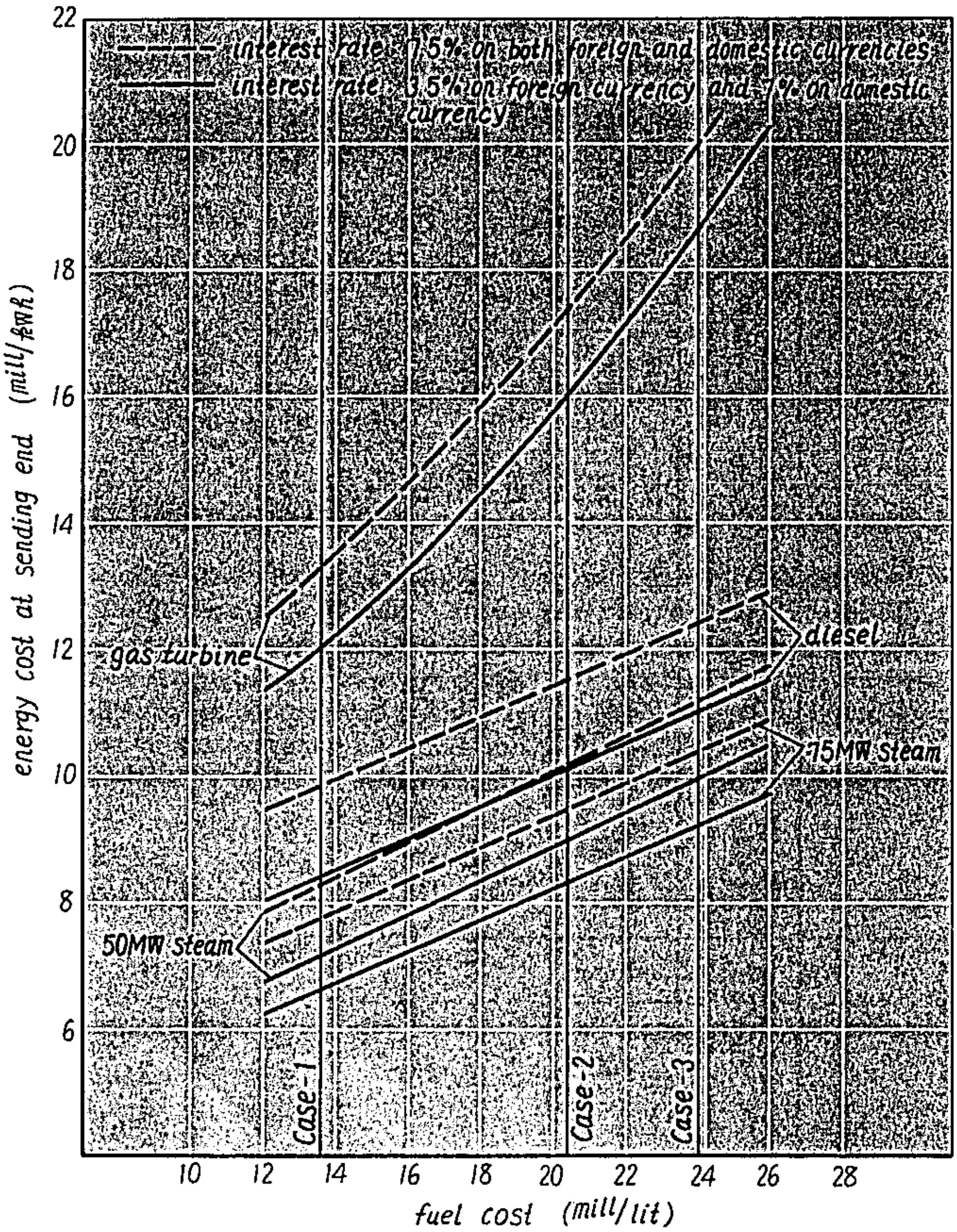
Table 6-5 Fuel Cost

	Bunker C			I.D.O. *			Remarks
	mill/lit.	centavos/lit.	Peso/mill BTU	mill/lit.	centavos/lit.	Peso/mill BTU	
Case 1	13.65	9.15	2.31	21.33	14.29	3.97	Cost of Bunker C based on contracted price in Bataan Thermal Power Plant as adjusted as of June 1972; cost of I.D.O. estimated from those of cases 2 and 3.
Case 2	20.45	13.70	3.46	31.72	21.25	5.90	Costs of Bunker C and I.D.O. based on bulk sale price to government organization, effective Dec. 1972 (in Cebu).
Case 3	24.25	16.25	4.10	38.43	25.75	7.14	Costs of Bunker C and I.D.O. based on the quotation of oil company on a bulk sale basis, Dec. 1972.

Note: * For gas turbine

calation clause according to which the price was hiked in June, 1972 up to 2.31 pesos per million BTU (9.25 centavos per liter), which is still lower by about 30 percent than the price fixed in September, 1972 for purchase by the government agencies in Cebu.

Fig. 6-2 Effect of Fuel Cost on Energy Cost



In view of the aggressive attitude of OPEC countries, the oil price is believed to keep rising in the future. However, the volume of purchase by NPC for power generation is thought much bulkier than the volume upon which the bulk sale price for the government agencies was fixed. Further, the oil consumption

Table 6-6 Energy Cost of Various Plants

Fuel cost: Case 2

Interest Rate: 3.5% on foreign currency
7.0% on domestic currency

	Gas turbine 25MW x 2		Total	Diesel 10MW x 5		Total	Steam turbine 50MW x 2		Total	Steam turbine 75MW x 2		Total
	Fixed cost:	Var. cost:		Fixed cost:	Var. cost:		Fixed cost:	Var. cost:		Fixed cost:	Var. cost:	
Interest	183	-	183	382	-	382	819	-	819	1,160	-	1,160
Depreciation	144	-	144	527	-	527	590	-	590	836	-	836
O & M cost	102	21	123	196	42	238	487	86	573	654	121	775
Wages	(18)	-	(18)	(29)	-	(29)	(144)	-	(144)	(168)	-	(168)
Repair	(76)	(19)	(95)	(152)	(38)	(190)	(312)	(78)	(390)	(442)	(110)	(552)
Others	(8)	(12)	(10)	(15)	(4)	(19)	(31)	(8)	(39)	(44)	(11)	(55)
Administration	8	2	10	16	3	19	39	7	46	52	10	62
Fuel cost	-	1,640	1,640	-	1,467	1,467	-	3,178	3,178	-	4,438	4,438
Total	437	1,663	2,100	1,121	1,512	2,633	1,935	3,271	5,206	2,702	4,569	7,271
Fixed cost/kW (US$)	8.74			22.42			19.35			18.01		
Variable cost/kWh (mill)		12.79			5.88			5.72			5.29	
Total			16.15			10.25			9.10			8.42

of NPC will increase progressively in the future. The consumption in 1978 is anticipated to be multiplied by 3.6 times in 1985. Also, attention should be brought to the fact that NPC has been purchasing oil at a relatively less expensive price. All these are believed to serve to brake the rise in oil purchasing price of NPC. If the present purchase price of NPC, that is for Bataan Thermal Plant, is supposed to increase at a rate of 6 percent annually, NPC will be able to purchase oil at 13.7 centavos per liter even in and around 1977.

Largely influential on power cost, the fuel cost will reflect directly on the power rate. Therefore, efforts should be made by NPC to restrain the rise in price of fuel oil in consideration of the large quantity and continuous purchase.

From the fuel cost estimated in the above, the energy cost was calculated with the results shown in Table 6-6 and graphically shown in Fig. 6-2.

Because of the low plant factor and expensive IDO, the variable cost per kwh of gas turbine is the most expensive while its fixed cost per kW is the least expensive as compared with other types of generators. Power generated by steam turbine is slightly less expensive than that of diesel engine.

6-5 Power Development Program

Policy of Program Formulation

In the studies described previously, the power supply requirements and the type of generators were determined. These generators were arranged in several chronological orders of implementation satisfying the future power supply requirements. In the arrangement, however, emphasis was put on economic requirements. In pursuing economy, due consideration should be given to the trend of electricity cost in the system as a whole in the future when the generators will have been installed, in addition to the construction cost of the generating units.

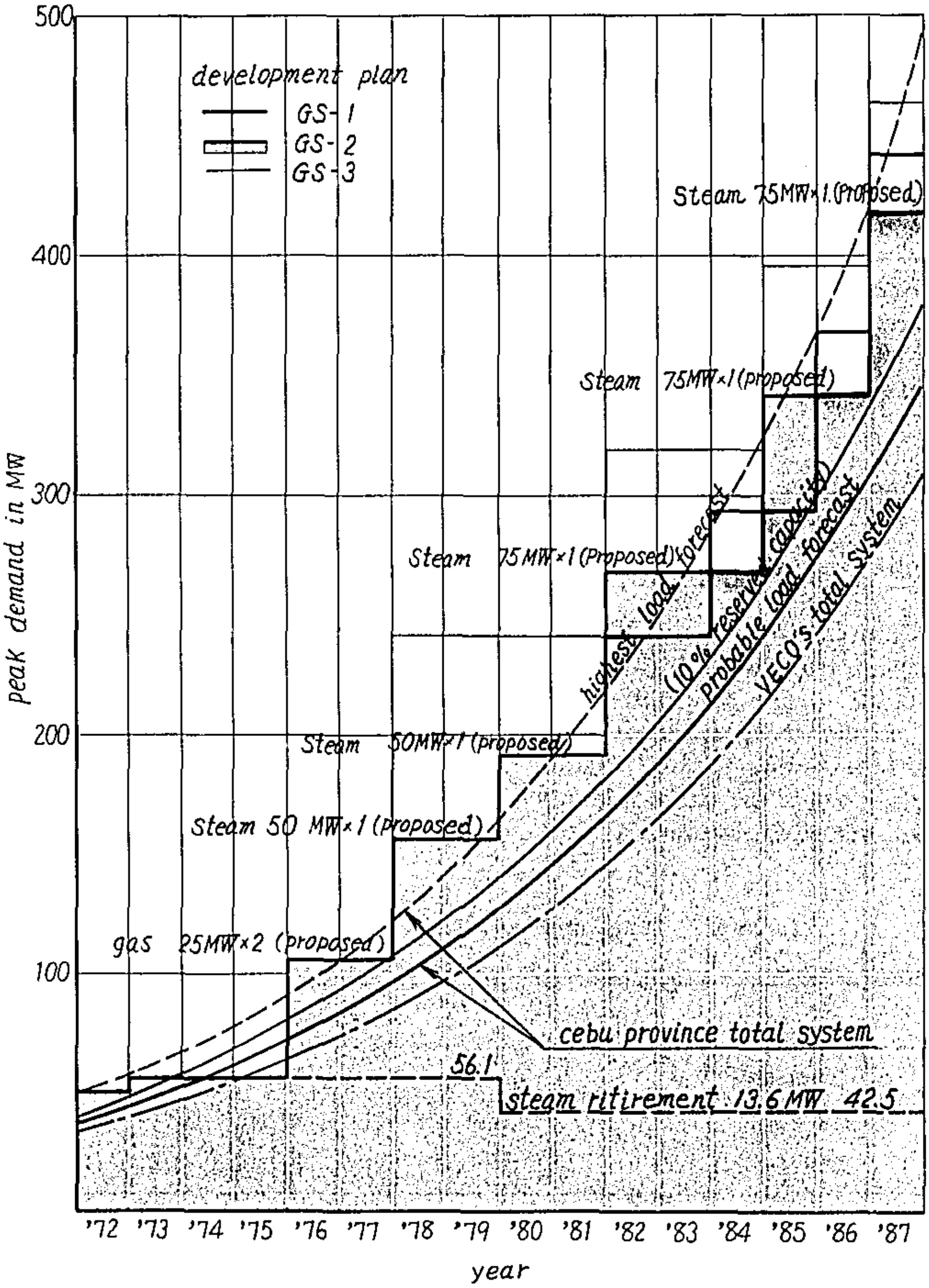
Table 6-7 Present Supply Capability as of December, 1972

	Installed Capacity (kW)
Thermal	13.600
Diesel	37.500
Total	51.100

Existing Power Supply Capability

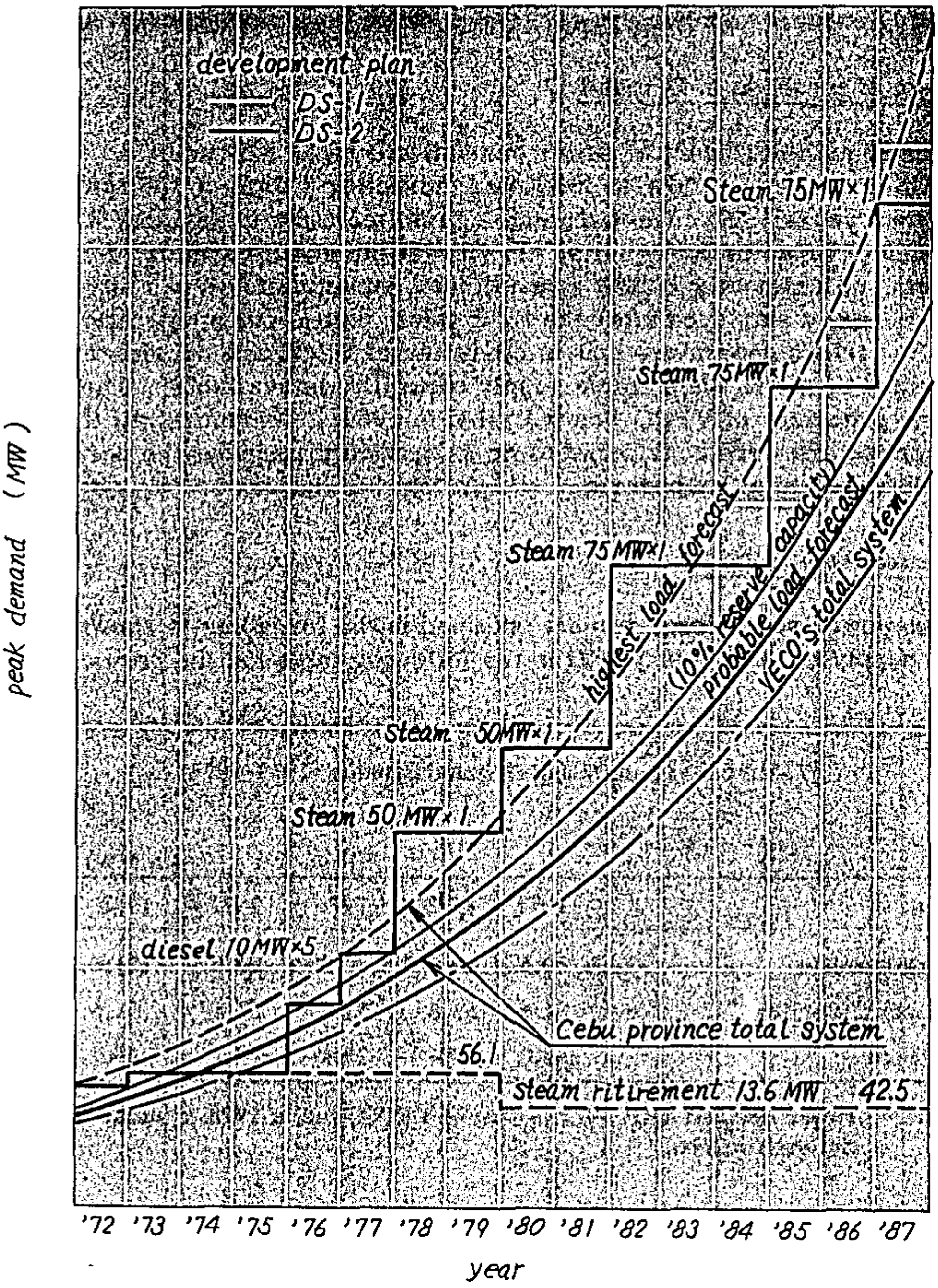
The estimated demand is shown in Table 5-4 and the power supply requirement is 110 percent of the estimated demand including the reserve capacity. The increases in demand and the supply hereinafter referred to are considered on yearly basis neglecting the monthly increases. Table 6-7 gives the power supply capability at the end of 1970, all of which is by VECO's installations.

Fig. 6-3 Development Program (Gas - Steam Turbine)



VECO plans to install and complete a 5,000 kW diesel unit in the first half of 1973 and the construction works are under way. There is no plan of unit addition in 1974 and thereafter. Since NPC has come to Cebu to undertake electrical power development, VECO, as a matter of course, will shift its capital investment from generating facilities to the expansion of distribution system. In fact, such is a picture envisaged in the state policy of the Philippines. Therefore, the power development program was formulated on the assumption that VECO would not increase its generating capacity after 1974. The construction period as well as the increasing rate of power demand were considered as follows:

Fig. 6-4 Development Program (Diesel Engine - Steam Turbine)



Construction Period

The construction period generally practiced of steam power plant is regarded as three years after placement of order. However, in consideration of the time requirement for financing and definite study, a steam power plant will not be in operation before 1978. On the other hand, diesel and gas turbine units can start operation within one to one and a half years after placement of order. This means that diesel and gas turbine units may be completed in 1975 and put in operation in the beginning of 1976. Therefore, it will be difficult to supplement the deficiency forecasted in 1974 and 1975. In 1976, a diesel unit or gas turbine unit will be able to start supplying power, and a steam power plant in 1978.

Rate of Increase in Demand

The annual increment of power demand will be 12 MW in 1975. This, however, will increase to 20 MW in 1980, and thereafter a total of 100 MW will be added within 4 to 5 years. To cope with such a rapid increase in demand, it is necessary to install large capacity units. In view of the small capacity of diesel driven generator, approximately 10 MW at maximum, steam units or gas turbine units will be primarily employed after the first steam unit is put in operation in 1978. The steam turbine generators now in operation of VECO are considerably aged, and expected to retire when ample supply capability is available. The oldest diesel engine generator of VECO was installed in 1964. Therefore, all the diesel engine generators were considered to be in service throughout the period which the development program covers.

Demand and Supply

The power supply requirement obtained in the foregoing is shown together with the supply capability of VECO in the following table for the period of 1974 to 1978:

Table 6-8 Supply and Demand Balance (1974-1978)

(in MW)

Year	1974	1975	1976	1977	1978
Peak Demand	59.6	69.0	80.0	92.3	121.0
Supply Capability	51.6	51.6	51.6	51.6	51.6
Balance	-8.0	-17.4	-28.4	-40.7	-69.4

Note: Power demand until 1977 is that of VECO, and in 1978 it includes the entire Cebu.

As indicated in the table, there will be a power shortage of 8 MW in late 1974. This will further increase to 17.4 MW, 41 MW and about 70 MW respectively in 1975, 1977 and 1978.

Table 6-9 kW and kWh Balance in Cebu System

Plan GS-2

	Unit	1969	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Max. demand	MW	84.1	96.6	110.8	128.7	145.8	165.0	184.7	213.0	241.3	272.9	309.0	350.0
Energy requirement	GWh	421	483	555	645	732	829	928	1,073	1,219	1,381	1,567	1,777
Installed capacity													
VECO	MW	56.1	56.1	56.1	56.1	42.5*	42.5	42.5	42.5	42.5	42.5	42.5	42.5
NPC	"	50	50	100	100	150	150	225	225	225	300	300	375
Total	"	106.1	106.1	156.1	156.1	192.5	192.5	267.5	267.5	267.5	342.5	342.5	417.5
Available energy production													
VECO	GWh	310	310	265	265	201	201	201	201	201	201	201	201
NPC	"	130	173**	416	416	702	702	1,134	1,134	1,134	1,566	1,566	1,998
Total	"	440	483	681	681	903	903	1,335	1,335	1,335	1.767	1,767	2,199
Reserve capacity	MW	22	9.5	45.3	27.4	46.7	27.5	82.8	54.5	26.2	69.6	33.5	67.5
"	%	26	10	41	21	32	17	45	26	11	26	11	19
Reserve energy	GWh	19	0	126	34	171	74	407	262	116	386	200	422
"	%	5	0	23	5	23	9	44	24	10	28	13	24

Note: * Steam turbines of 13.6 MW (5.0 MW steam x 2 units, 1.8 MW steam x 2 units) will be retired.
** Plant factor of gas turbines is 39%.

Power Development Program

In order to supplement such deficiencies in power supply capability, five power development plans were prepared for selection to be made later putting primary emphasis on the production of reasonably low-cost energy. They are five different combinations of steam generating units, gas turbine units and diesel driven units. The steam turbine generators of 75 MW were scheduled to be in operation only after 1982. After all, it will be by gas turbine units or diesel driven units that can supplement power deficit before 1978. After 1978, however, steam turbine generators will be the only generating facilities to be installed because an addition of diesel driven unit or gas turbine unit will not be practicable in respect of the power requirement in peak hours, as well as, the rate of increase in system capacity. Therefore, the combinations were confined to those of gas turbine generators and steam turbine generators, in addition to the combination of diesel driven generators and steam turbine generators. For the purpose of comparison with NPC report, a plan was prepared based on the concept that the reserve capacity should be equivalent to the maximum unit capacity after 1978. Plans designated by GS are the combination of gas turbine and steam turbine units, and DS indicates a combination of diesel driven unit and steam turbine unit. Each plan satisfies the power supply requirements of the system in each year by adding new generating facilities as illustrated by Table 6-9 and Fig 6-3 and 6-4.

(1) Plan GS-1

1976	25 MW x 2	gas turbine
1978	50 MW x 1	steam turbine
1980	50 MW x 1	ditto
1982	50 MW x 1	ditto
1984	50 MW x 1	ditto
1986	75 MW x 1	ditto
1987	75 MW x 1	ditto
Total	400 MW	

In this plan, 4 units of 50 MW steam turbine generators will be installed one by one following the addition of two gas turbine units.

(2) Plan GS-2

1976	25 MW x 2	gas turbine
1978	50 MW x 1	steam turbine
1980	50 MW x 1	ditto
1982	75 MW x 1	ditto

1985	75 MW x 1	ditto
1987	75 MW x 1	ditto
Total	375 MW	

In this plan, economy of scale is sought for by introducing 75 MW units after the installations of two 50 MW units.

(3) Plan GS-3

1976	25 MW x 2	gas turbine
1978	75 MW x 2	steam turbine
1982	75 MW x 1	ditto
1985	75 MW x 1	ditto
1987	75 MW x 1	ditto
Total	425 MW	

This plan has been prepared only for the purpose of comparison with NPC report. Following the installation of two 25 MW gas turbine, two 75 MW units are proposed to be completed as early as in 1978 with the purpose to obtain a reserve capacity equivalent to maximum unit capacity.

(4) Plan DS-1

1976	10 MW x 3	diesel engine
1977	10 MW x 2	ditto
1978	50 MW x 1	steam turbine
1980	50 MW x 1	ditto
1982	50 MW x 1	ditto
1984	50 MW x 1	ditto
1986	75 MW x 1	ditto
1987	75 MW x 1	ditto
Total	400 MW	

The gas turbines in Plan GS-1 are substituted by diesel engines which, due to the large number of units, will be installed in two years of 1976 and 1977.

(5) Plan DS-2

1976	10 MW x 3	diesel engine

1977	10 MW x 2	ditto
1978	50 MW x 1	steam turbine
1980	50 MW x 1	ditto
1982	75 MW x 1	ditto
1985	75 MW x 1	ditto
1987	75 MW x 1	ditto
Total	375 MW	

This plan is an alternative for Plan GS-2 employing diesel engines instead of gas turbines.

The above plans are summarized in Table 6-10

Table 6-10 Installation Schedule in Alternative Plans

(in MW)

Year	GS-1	GS-2	GS-3	DS-1	DS-2
1976	50	50	50	30	30
77	-	-	-	20	20
78	50	50	150	50	50
79	-	-	-	-	-
80	50	50	-	50	50
81	-	-	-	-	-
82	50	75	75	50	75
83	-	-	-	-	-
84	50	-	-	50	-
85	-	75	75	-	75
86	75	-	-	75	-
87	75	75	75	75	75
Total installed capacity	400	375	425	400	375

Evaluation of Five Plans

The five plans that are thought almost identical in their function, although slight differences are seen in the final scale, were evaluated in terms of the construction cost per kW and energy cost. The evaluation was solely based on generating facilities, and the transmission and the distribution facilities were thought to be common to all the five plans, and therefore not included in the evaluation.

(1) Construction Cost

The construction cost of steam turbine generator was assumed to be disbursed in the annual ratio of 25:50:20 in the three years period, while it was 20:80 in two years for diesel driven generator. The construction cost of gas turbine generator will be disbursed within one year. In strict terms, the construction cost of steam turbine generator is high for No. 1 unit and less expensive for No. 2 and No. 3 in the order. However, in order to obtain comparability, the construction costs of steam turbine generators were averaged. The total capital investment during the years of 1974 to 1986 was converted to the present worth as of 1974 by applying a discount rate which is shown in Table 6-11.

Table 6-11 Comparison of Alternative Plans in Construction Cost

Plan	Priority	Total construction cost		Present worth in 1974 (thousand US $) Discount rate		Total output
		Thousand US $	$/kW	7%	10%	(MW)
GS-1	2	71,350	179	43,290	35,890	400
GS-2	1	65,650	175	41,140	34,310	375
GS-3	5	73,750	174	49,870	42,850	425
DS-1	4	76,100	190	47,330	39,680	400
DS-2	3	70,400	188	44,860	38,110	375

Table 6-12 Comparison of Alternative Plans in Annual Cost

(Thousand US dollars)

Plan	Priority	**Case 1		***Case 2		****Case 3	
		Total	Present worth* in 1976	Total	Present worth* in 1976	Total	Present worth* in 1976
GS - 1	2	73, 260	42, 250	90, 870	52, 570	100, 960	58, 520
GS - 2	1	72, 320	41, 850	89, 600	51, 980	99, 440	57, 810
GS - 3	5	79, 360	46, 560	95, 400	55, 970	104, 420	61, 290
DS - 1	4	78, 240	45, 140	94, 160	54, 220	103, 310	59, 320
DS - 2	3	75, 830	44, 100	91, 530	53, 050	100, 260	58, 040

Note: *Discount rate is set at 7 percent

		Bunker C	I.D.O.
** Case 1 :	Fuel cost	13.65 mills/lit. (9.1 centavos/lit.)	21.33 mills/lit. (14.29 centavos/lit.)
*** Case 2:	"	20.45 mills/lit. (13.70 centavos/lit.)	31.72 mills/lit. (21.25 centavos/lit.)
**** Case 3:	"	24.25 mills/lit. (16.25 centavos/lit.)	38.43 mills/lit. (25.75 centavos/lit.)

Table 6-13 Power Development Program Annual Cost and Energy Cost (GS - 2)

	Unit	1 1976	2 1977	3 1978	4 1979	5 1980
Required capacity						
Gas turbines	MW	50	50	50	50	50
Steam tubines	"	-	-	50	50	100
Energy requirement	GWH	421	483	555	645	732
VECO plants	"	310	310	265	265	201
Gas turbine units	"	111	173	14	104	8
50 MW steam units	"	-	-	276	276	523
75 MW	"	-	-	-	-	-
(1) Fixed cost						
Gas turbines	10^3\$	437	437	437	437	437
50MW steam units	"	-	-	968	968	1,935
75 " "	"	-	-	-	-	-
Total	"	437	437	1,405	1,405	2,372
(2) Variable cost						
i) Case 1						
Gas turbines	10^3\$	961	1,498	121	900	69
50 MW steam	"	-	-	1,068	1,068	2,024
75 "	"	-	-	-	-	-
Total	"	961	1,498	1,189	1,968	2,093
ii) Case 2						
Gas turbines	"	1,419	2,212	179	1,330	102
50MW steam	"	-	-	1,578	1,578	2,991
Total	"	1,419	2,212	1,757	2,908	3,093
iii) Case 3						
Gas turbines	"	1,716	2,674	216	1,607	123
50MW steam	"	-	-	1,863	1,863	3,530
75 "	"	-	-	-	-	-
Total	"	1,716	2,674	2,079	3,470	3,653
(3) Annual cost (1 + 2)						
Case 1	"	1,398	1,935	2,594	3,373	4,465
Case 2	"	1,856	2,649	3,162	4,313	5,465
Case 3	"	2,153	3,111	3,484	4,875	6,025
(4) Unit energy cost						
Case 1	mill/kWh	12.60	11.18	8.94	8.88	8.41
Case 2	"	16.72	15.31	10.90	11.35	10.29
Case 3	"	19.40	17.98	12.01	12.83	11.35
(5) Present value in 1976						
Discount rate (7%)	-	0.935	0.873	0.816	9.763	0.713
Case 1	10^3\$	1,307	1,689	2,117	2,574	3,184
Case 2	"	1,735	2,313	2,580	3,291	3,896
Case 3	"	2,013	2,716	2,843	3,720	4,296

Note:

	Variable Cost (mill/kWh)		
	Case 1	Case 2	Case 3
Gas turbine	8.66	12.79	15.46
50MW steam	3.87	5.72	6.75
75 "	3.58	5.29	6.24

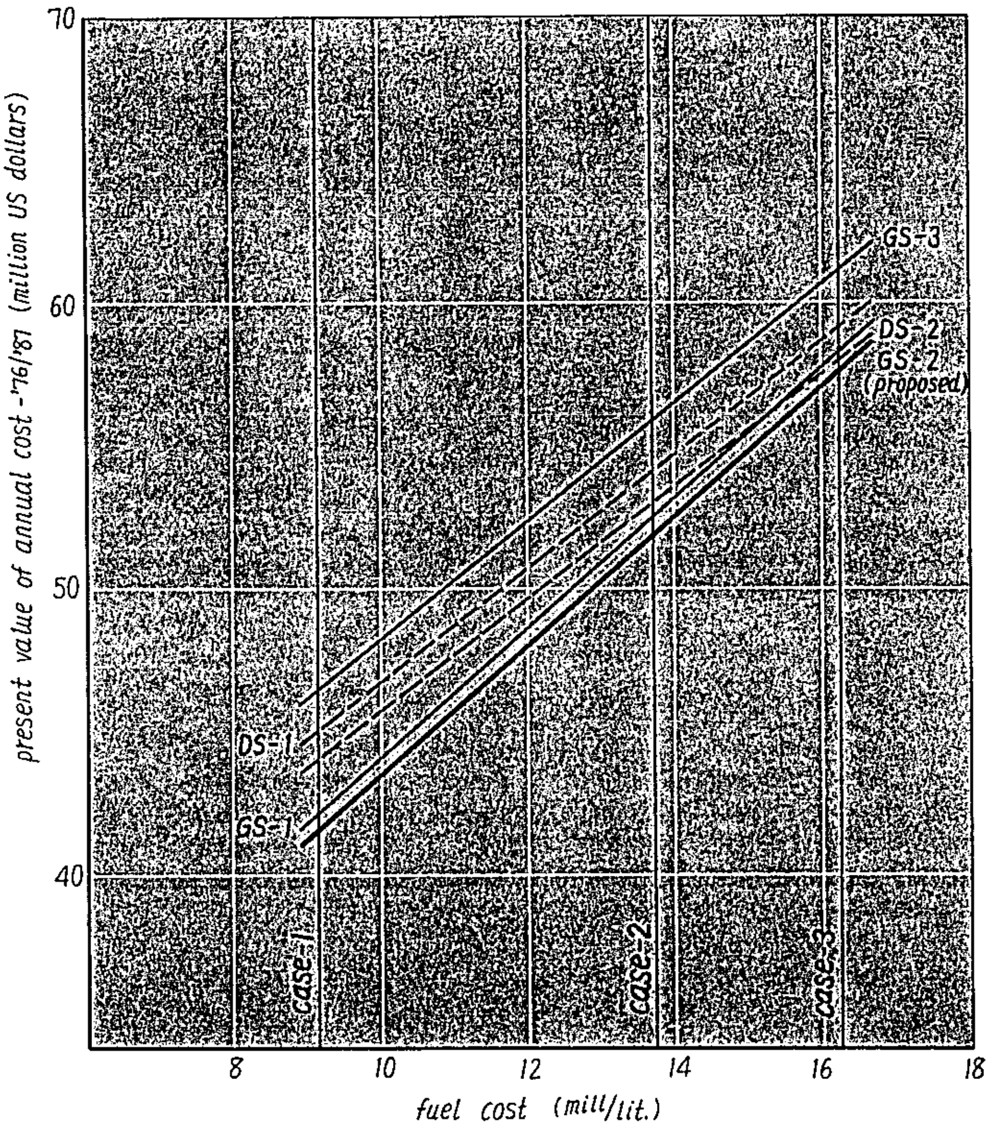
6 1981	7 1982	8 1983	9 1984	10 1985	11 1986	12 1987	Total
50	50	50	50	50	50	50	-
100	175	175	175	250	250	325	-
829	928	1,073	1,219	1,381	1,567	1,777	-
201	201	201	201	201	201	201	-
76	0	9	80	1	68	4	-
552	313	449	524	351	470	330	-
-	414	414	414	828	828	1,242	-
437	437	437	437	437	437	437	5,244
1,935	1,935	1,935	1,935	1,935	1,935	1,935	17,416
-	1,351	1,351	1,351	2,702	2,702	4,053	13,510
2,372	3,723	3,723	3,723	5,074	5,074	6,425	36,170
658	0	77	692	8	588	34	5,606
2,136	1,211	1,737	2,027	1,358	1,818	1,277	15,724
-	1,482	1,482	1,482	2,964	2,964	4,446	14,820
2,794	2,693	3,296	4,201	4,330	5,370	5,757	36,150
972	0	115	1,023	12	869	51	8,284
3,157	1,790	2,568	2,997	2,007	2,688	1,887	23,241
4,129	3,980	4,873	6,210	6,399	7,937	8,508	53,425
1,174	0	139	1,236	15	1,051	61	10,012
3,726	2,112	3,030	3,537	2,369	3,172	2,227	27,429
-	2,583	2,583	2,583	5,166	5,166	7,750	25,831
4,900	4,695	5,752	7,356	7,550	9,389	10,038	63,272
5,166	6,416	7,019	7,924	9,404	10,444	12,182	72,320
6,501	7,703	8,596	9,933	11,473	13,011	14,933	89,595
7,272	8,418	9,475	11,079	12,624	14,463	16,463	99,442
8.23	8.83	8.05	7.78	7.97	7.65	7.73	-
10.35	10.60	9.86	9.76	9.72	9.52	9.47	-
11.58	11.58	10.87	10.88	10.70	10.59	10.45	-
0.666	0.623	0.582	0.544	0.508	0.475	0.444	
3,441	3,997	4,085	4,311	4,777	4,962	5,409	41,853
4,330	4,799	5,003	5,404	5,828	6,180	6,630	51,981
4,843	5,244	5,514	6,027	6,413	6,870	7,310	57,809

(2) Energy Cost and Annual Cost

The energy costs were calculated for the respective plans and for the period of 1976 to 1987. Table 6-13 gives the result for Plan GS-2 as an example together with annual costs which were obtained from the annual fixed costs and the variable costs per kWh as described in the foregoing.

The power demand to be met by the generators proposed by the plans is the balance of the total power demand less power supply capability of VECO. It is a policy generally accepted in meeting the demand to first utilize the largest unit and then put the second largest in operation, and if the power supply by steam turbine generators alone is not sufficient, a diesel or gas turbine generator will be mobilized. As shown in Table 6-3, the annual energy production was obtained with a plant factor of 70 percent for steam turbine generator, and 60 percent and

Fig. 6-5 Present Value of Annual Cost



30 percent respectively for diesel driven and gas turbine units. Energy productions of respective units were obtained, which give the base to calculate the total variable cost. The total annual cost was obtained by adding the fixed cost to the total variable cost.

The summary of the total annual costs during the period of 1976 to 1987 for the respective plans are shown in Table 6-12 and graphically in Fig. 6-5.

Comparison of Plans

The plans are compared in Tables 6-11 and 6-12. The total installed capa-

Fig. 6-6 Trend of Energy Cost (Fuel Cost - Case 2)

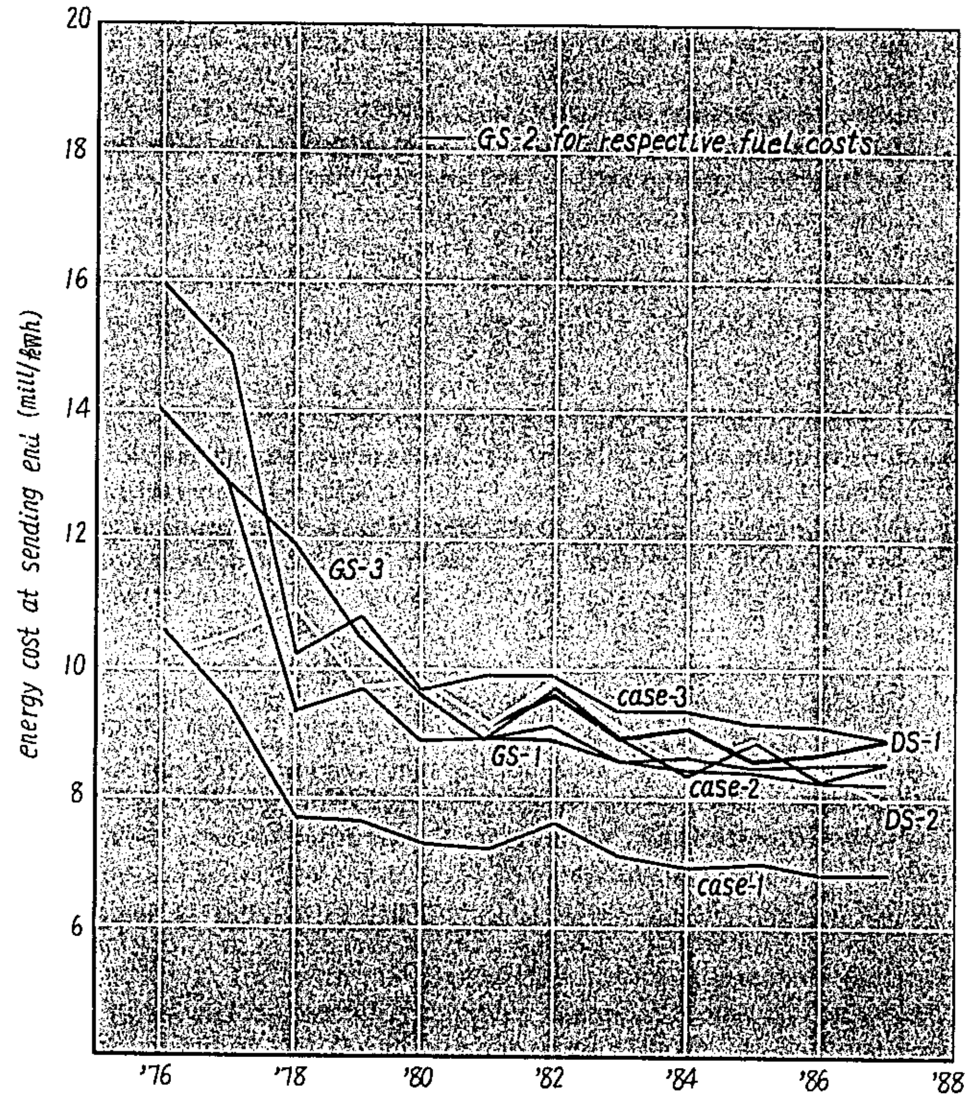


Table 6-14 Investment Schedule (Plan GS-2)

(in thousand US dollars)

Power Plant	Year of Completion		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Total
Gas turbine																
25MW No. 1 &	1975	Total	4,750													4,750
No. 2		FC	4,270													4,270
		DC	480													480
Steam turbine																
50MW No. 1	1977	Total	2,400	5,400	1,950											9,750
		FC	1,920	4,320	1,560											7,800
		DC	480	1,080	390											1,950
No. 2	1979	Total			2,400	5,400	1,950									9,750
		FC			1,920	4,320	1,560									7,800
		DC			480	1,080	390									1,950
75MW No. 1	1981	Total					3,500	7,600	2,700							13,800
		FC					2,800	6,080	2,160							11,040
		DC					700	1,520	540							2,760
No. 2	1984	Total								3,500	7,600	2,700				13,800
		FC								2,800	6,080	2,160				11,040
		DC								700	1,520	540				2,760
No. 3	1986	Total										3,500	7,600	2,700		13,800
		FC										2,800	6,080	2,160		11,040
		DC										700	1,520	540		2,760
Total		Total	7,150	5,400	4,350	5,400	5,450	7,600	2,700	3,500	7,600	7,600	7,600	2,700		65,650
		FC	6,190	4,320	3,480	4,320	4,360	6,080	2,160	2,800	6,080	4,960	6,080	2,160		52,990
		DC	960	1,080	870	1,080	1,090	1,520	540	700	1,520	1,240	1,520	540		12,660

FC : Foreign currency
DC : Domestic currency

city varies with the plans. The total construction cost is the least in Plan GS-2, followed by Plan DS-2 and Plan GS-1. However, Plan GS-3 is the lowest in per kW construction cost, followed by Plan GS-2 and Plan GS-1. In consideration of the difference in annual disbursement between the plans, the plans were compared in terms of the present worth as of 1974 with the result that Plan GS-2 comes to the lowest at a discount rate of 7 percent. Plan GS-1, Plan DS-2, Plan DS-1 and Plan GS-3 are following Plan GS-2 in the order which does not change as long as the discount rate stays within a range of 4 to 10 percent.

Assuming the interest rate to be 3.5 percent for foreign currency requirement and 7 percent for domestic currency requirement, the total annual cost during the period of 1976 to 1987 is the least in Plan GS-2, in both Case-2 and Case-1 of the fuel cost, followed by Plan GS-1, DS-2, DS-1 and GS-3. However, with fuel cost of Case 3, Plan DS-2 comes to the second and Plan GS-1 goes down to the third; the remainders staying the same in the order. This annual cost was divided by the annual energy production at sending end to obtain per kWh energy cost of which trend is graphically shown in Fig. 6-6.

In Plan GS-1 and Plan GS-2, the per kWh energy cost will stay high in 1975 and 1976 due to the operation of gas turbine generators. In 1978, attributable to the commencement of a steam turbine generator, the energy cost will start declining abruptly and will brake the level of 10 mills per kWh in around 1983. It will further go down to 9.5 mills per kWh in 1987. The energy cost in Plan GS-3 will stay relatively high stemming from the large fixed capital investment in 1978, and only after 1984 it will become on a par with Plan GS-1 and GS-2. In plans with diesel turbine generators, the energy cost will decline slowly, and it will be in 1985 or 1986 that the energy cost will brake the 10 mills per kWh level.

From the stand points of construction and annual costs described above, Plan GS-2 is believed to be the most superior, followed by Plan GS-1. Generally, the plans with diesel driven generators are inferior to the plans with gas turbine units due to the large initial capital investment. Plan GS-2 is a combination of two 25 MW gas turbine units, two 50 MW steam turbine units and 75 MW steam turbine units to be installed in the order. All these units including the gas turbine units are conventional type, therefore, no technical problems are involved. The power grid in Cebu is now recommended to have the generating facilities proposed by Plan GS-2.

Outline of the First Stage Construction

The first stage construction will include the installation of two 25 MW gas turbine units by 1975 and No. 1 unit of 50 MW steam turbine generator by the end of 1977. The gas turbine units are to supply power supplementing the deficiency in 1976 and in 1977, and the steam turbine generator to be operational from the beginning of 1978. In line with the development of the generating facilities, the transmission lines will be extended to cover the most towns on the island of Cebu, so that the power grid of VECO can be connected with the gas turbine generator in 1976. The electric service to rural areas will be extended by 1978.

The investment schedule for the proposed development program (Plan GS-2) is as shown in Table 6-14, but not including the cost for the transmission system.

6-6 Recommendations on Project Implementation

This project consists of the establishment of the Cebu Power Grid by constructing a central power plant and transmission lines, and the electrification of the entire island on an area coverage basis by extending electric power services with the energy produced at a cost reasonably low. The National Power Corporation established Visayas Regional Office, the first office in the Visayas, in Cebu in August 1972, and so far, it does not have any generating or transmission facilities in the Visayas except a couple of small hydro power plants. In view of such circumstances in Cebu, the followings are recommended in order to implement the project smoothly and efficiently.

(1) Cebu Power Grid Committee

The largest utility in Cebu, VECO is supplying over 90 percent of the total energy requirement in the island of Cebu with its own generating and transmitting facilities. Pursuant to the provisions of Presidential Decree No. 40 dated November 7, 1972, the National Power Corporation is now engaged in the construction and operation and maintenance of generating and transmitting facilities, and the distribution of electric power generated by NPC is to be undertaken by cooperatives, private utilities, local governments and other entities duly authorized subject to state regulation. In other words, NPC has been assigned by the state government to generate and wholesale power to VECO. However, without amicable cooperation between NPC and VECO, the largest to-be-customer of NPC, it will be virtually impossible to carry out the construction and operation of facilities. Therefore, a committee, herein tentatively called Cebu Power Grid Committee, is desired to be established with representatives including staff members of NPC and VECO in order to promote the implementation of the project in a cooperative manner. The agenda to be taken up by the committee are considered to be as follows:

Tendency of demand growth

Transmission and the distribution program

Determination of service extension and its method of service

Standardization of technical specifications

Problems involved in grid operation (power flow, voltage and reactive power control)

Date of retirement of old facilities

Other than VECO, there are power utilities of small scale only. However, it is also necessary to establish similar committees with same purport as in the case of VECO.

(2) Organization and Training Program of NPC Engineers

In NPC, technical specifications and other documents for a project are prepared in the Engineering and Construction Department in the Head Office, Manila. The construction supervision and the operation and maintenance will be performed by the Construction Division and System Generation Division of regional office. Although not organized in the Visayas Regional Office, these two divisions will have to be established and reinforced along with the progress of the project.

Having been engaged primarily in the development of hydro power resources, NPC has experienced staff in this field. However, Bataan Power Plant, 75 MW in installed capacity, is the first thermal power plant constructed by NPC in October, 1972. Although NPC is now successively engaged in the construction of No. 2 unit, 150 MW in installed capacity, in the premises of the same power plant, the engineering staff seems to be lacking in experienced engineers in the field of steam power plant construction. The steam turbine generator, 50 MW in capacity, to be connected to the Cebu Power Grid will be the third steam unit for NPC, and the gas turbine units will be installed in Cebu for the first time in the Philippines. In implementing the project, it will be necessary to train, in advance, electrical and mechanical engineers, in addition to technicians, to foster the middle class engineers who, lacking in NPC, will be actually engaged in the construction works. Upon these considerations, a training program has been prepared as shown in Table 6-15 and Fig. 6-9 as a proposal of the team.

Although automated to a remarkable extent, the operation of steam power plant still requires a large manpower. Fortunately, the construction work of No. 2 unit at Bataan will be able to provide a good many opportunities for on-the-job training. The training program proposed has been prepared in such a manner that one-fifth of the operators of steam power plant in Cebu will have experienced the operation at the time of commencement of the power plant. In the field of transmission and transformation of power, NPC has a powerful staff. Therefore, no program has been prepared in this field. In the realm of power development planning, including the review of load forecast which is described in the followings, some drills are thought necessary, and therefore, included in the program.

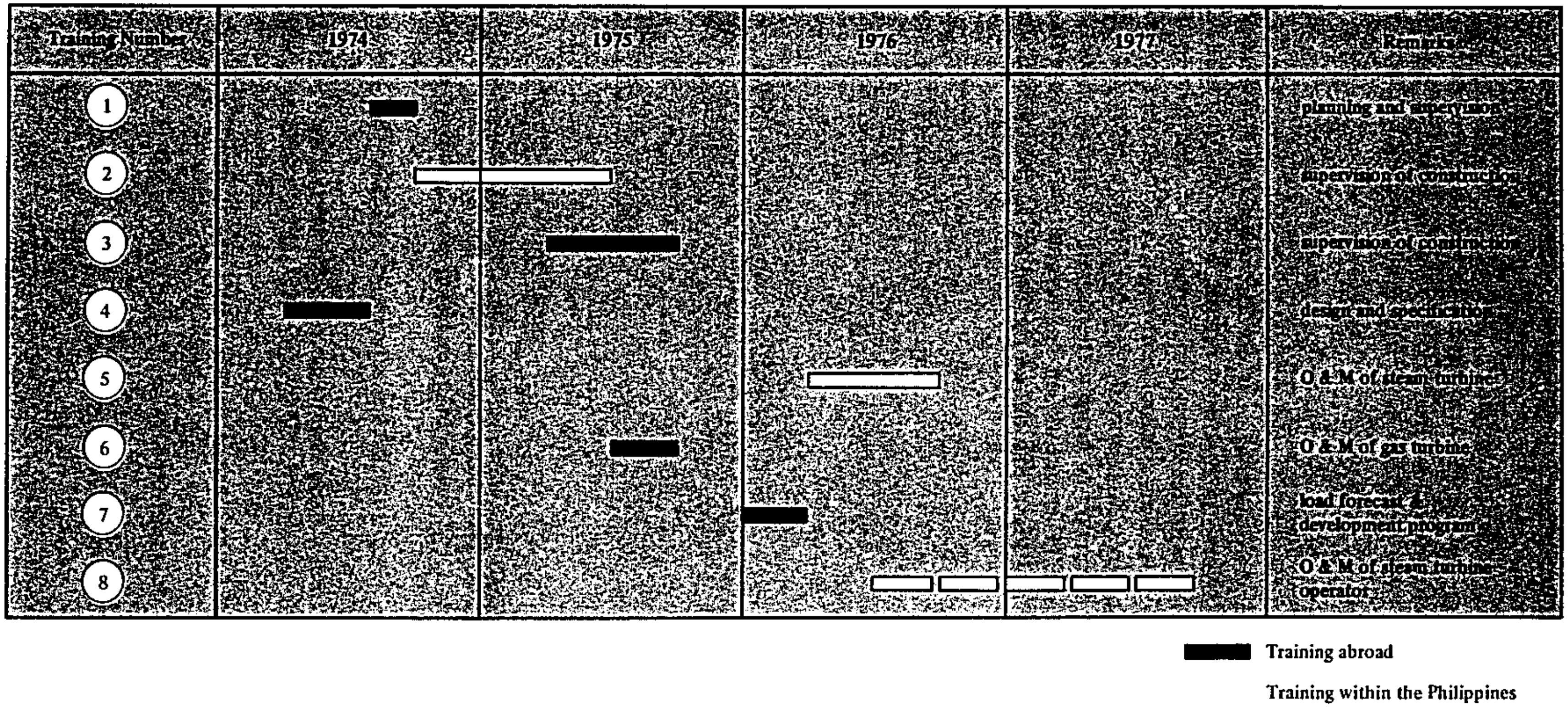
(3) Review of Load Forecast and the Development Plan

Prepared on the basis of latest data, as well as, of the reports on various projects proposed, the load forecast projected in this report is believed to be the most reliable and updated. However, a load forecast will be established on assumption and sometimes on hypothesis. Economic activities, too, involves many factors that will cause to bring about a change unpredictable beforehand, such as, depression caused by the floating exchange rate. Needless to say, the power demand is subject to the fluctuation in economic activities. Hence, the load forecast should be reviewed in relation to the contemporary economic en-

Table 6-15 Training Program

No.	Class	Engineer	Man-month	Objective	Place of training	
1	Senior engineer	Electrical	1 x 2	planning and supervision of steam power plant	electric power utility and manufacturer's shop	abroad
2	Middle class	Electrical Mechanical Architectural (or civil)	3 x 9	supervision of construction work of steam power plant	Bataan thermal power plant	Philippines
3	ditto	Electrical Mechanical	2 x 9	ditto	electric power utility	abroad
4	ditto	Electrical Mechanical	2 x 4	detailed design and preparation of specification	electric power utility	abroad
5	ditto	Electrical Mechanical	2 x 6	operation and maintenance of steam turbine	Batan thermal power plant	Philippines
6	ditto	Electrical Mechanical	2 x 3	operation and maintenance of gas turbine	manufacturer's shop and electric power utility	abroad
7	ditto	Electrical	1 x 3	load forecast and development program	electric power utility	abroad
8	Operator	Electrical Mechanical	15 x 3	operation and maintenance	Bataan thermal power plant	Philippines

Fig. 6-7 Training Schedule



vironment, thereby to be kept updated by adjusting the original forecast. The report describes, in addition to the results, the method and steps of forecast, as well as, the development planning into such details that engineering staff of NPC may review the forecast and the development program during the course of implementation. It is strongly recommended that the review be made at least once a year when power statistics of the previous year are made available.

(4) Fuel Price

As stated in chapters 6 and 8, the fuel cost comprises about 60 percent of generation cost; 10 percent increase in fuel cost means 6 percent increase in generation cost, which will eventually be borne by consumers. Subject to the numerous external factors, the determination of fuel cost is sometimes outside the command of NPC. Nevertheless, it is mandatory for NPC to strive for the purchase of less expensive oil in order to supply the power or better quality and lower cost. It is advisable that NPC conclude an agreement with oil supplier for the purchase at a stable price and for a prolonged period as in the case of Bataan Steam Power Plant.

Chapter 7 Description of Project

7-1 Generating Plant

7-1-1 Selection of Plant Site

The following conditions should generally be taken into account in selecting a site for a thermal power plant. They are:

(a) Proximity to the load center,

(b) Sufficient amount of supply with condenser cooling water and boiler feed water,

(c) Easy acquisition of necessary land area and less expensive land cost,

(d) Solid foundation for easy construction,

(e) Easy access to site for transportation of both meterials and fuel oil,

(f) Isolation from densely populated areas for prevention of harms to the public such as noises and pollution, and

(g) Safety from damages caused by floods, high tides, etc.

In the light of the above conditions, the Liloan site proposed in NPC report is considered appropriate. It is, however, recommended that the source of fresh water be confirmed by conducting field survey as soon as possible.

Another generating plant, expected to be required after 1985 to cope with the rapid growth of demand should desirably be located as near to Cebu City, the load center, as possible. For the next plant site, Naga or Carcar area, selected through reconnaissance by NPC, is considered suitable.

7-1-2 General Layout of Plant

Planning of general layout was made complying fundamentally to the layout prepared by NPC. The plant will accommodate two 25 MW gas turbine generators and one 50 MW steam turbine generator and have provisions for the successive additions of steam units of another 50 MW and two 75 MW. (See atached Preliminary Layout)

The plant site proposed by NPC has an area of approximately 10 hectares which is sufficient to accommodate the above installations, and therefore, adopted in this report.

The gas turbine units will be located at a place near to the south of the future steam powerhouse, two units arranged in parallel as one power block. In consideratin of the future construction work of the first steam unit, it is advisable not to place them too close to the proposed powerhouse site for that the construction work may generate disturbances to the operation of gas turbine generators. Thus for the time being, it might be necessary to consider a site for a temporary installation of the gas turbine units at a somewhat remote location. Being of the package type, the gas turbine unit is advantageous for such a case where relocation of the unit is probable. Furthermore, the gas turbine units will be utilized for construction and start-up power of the steam units.

The steam power plant was designed to be semi-outdoor type taking into account the climate in Cebu and the example of NPC's Bataan Thermal Power Plant in Luzon.

The steam powerhouse will be provided with one central control wing for every two units, and after completion of the first 50 MW unit, it will also be possible to remote-control from control wing the gas turbine units as well as the operation of the swithchyard, which, from the standpoint of the system operation, is obviously more expedient than to control them separately and individually.

Other auxiliary facilities such as utility building, workshop and warehouse, circulating water intake and discharge works, fuel storage facilities and so forth, were planned basically according to NPC's proposal.

For the connection of the switchyard bus circuits, one-and-half circuit breaker system was adopted for 115 kV switchyard in conformity with NPC's standard; on the other hand, 69 kV switchyard was arranged according to the transfer-bus system which renders considerably flexible operation and fair economy.

7-1 3 Outline of Main Equipment

(1) Gas Turbine Power Plant

a. Gas turbine generator (distillate oil burning)

Type	simple open cycle, single shaft, package type
Turbine output	25,000 kW (at ambient temperature 15 degrees Centigrade, atomospheric pressure 760 mmHg, peak rating)
Generator output	30,000 kVA
Voltage	13.8 kV
Frequency	60 Hz
Power factor	0.85 (lag)
No. of unit	2

b. Main transformer

Type	outdoor, 3 phase, 3 winding, forced-oil and forced-air-cooled type (FOA)
Capacity	60,000 kVA/60,000 kVA/25,000 kVA
Voltage	13.2 kV/115 kV/69 kV
No. of unit	1

(2) Steam Turbine Power Plant

a. Boiler (Bunker C oil burning)

Type	Outdoor, non-reheat type
Capacity	210 to 215 t/h
Steam pressure	106 to 96 kg/cm^2

Steam temperature	530 to 515 °C
No. of unit	1

b. Steam turbine

Output	50,000 kW
Steam pressure	102 to 92 kg/cm^2
Steam temperature	525 to 510°C
Condenser vacuum	700 to 690 mmHg
Running speed	3,600 rpm
No. of unit	1

c. Generator

Output	59,000 kVA
Voltage	13.8 kV
Running speed	3,600 rpm
Frequency	60 Hz
Power factor	0.85 (lag)
No. of unit	1

d. Main transformer

Type	Outdoor, 3 phase, 3 winding, forced-oil and forced-air-cooled type (FOA)
Capacity	60,000 kVA/60,000 kVA/25,000 kVA
Voltage	13.2 kV/115 kV/69 kV
No. of unit	1

(3) Switchyard and other Electrical Equipment

a. No. of outgoing transmission lines

115 kV	2 circuits

69 kV	3 circuits

b. Other electrical equipment

One general service transformer will be connected to the gas turbine generator circuit to supply start-up power to the steam units and to feed common station power requirements when the steam units are not operated. Consequently, this power plant as a whole can be black-started without receiving feed back power from the system.

For the connection system of main electrical equipment, see Drawing 7-2 Single Line Diagram.

7-2 Transmission Plants

7-2-1 Basic Considerations

(1) Reliability

High reliability in electric power supply is required in VECO's franchise area as a large portion of power demand in Cebu Island is concentrated in Metropolitan Cebu.

On the other hand, as for rural areas which occupy most part of Cebu Island, where electrification ratio still remains low, it is advisable to extend economical transmission plants, making a compromise in reliability to some extent, as long as low-cost and sufficient power can be supplied while promoting rural electrification.

From the above point of view, considerations were given to the transmission lines connected to VECO system to avoid stoppage even in case of one circuit failure; whereas one circuit of 69 kV transmission line was adopted for rural areas.

(2) Voltage

Transmission Voltage To VECO

The power plant at Liloan, initially operated with a capacity of 50 MW in 1976, will have an ultimate installed capacity of 300 MW in 1985, from which a greater part of generated power will be supplied to VECO.

Meanwhile, VECO has a plan of setting up one 115 kV/13.8 kV substation at Banilad, approximately 13 kilometers west of Liloan, for which they have already obtained some materials. Accordingly, 115 kV was selected for transmission voltage from the power plant to VECO system, taking into consideration the magnitude of power to be supplied.

For the further future development, the following estimations may be mentioned here. By the early 1990's another power plant is expected to be constructed at either Naga or Carcar with a capacity of around 300 MW to 400 MW. If this is the case, a transmission voltage higher than 115 kV, e.g., 230 kV, will have to be contemplated.

Transmission Voltage to Rural Areas

A rapid increase in power demand is expected owing to the expansion of electrification by estimated average rate of 2 percent per year. Nevertheless, total estimated demand in rural areas will be only about 25 MW in 1985 and about 42 MW in 1990. Therefore, 69 kV line was considered adequate to be set up by 1977 for rural electrification based on not only the present status but also the long-range forecast up to 1990.

Primary distribution lines from 69 kV substantions to the related delivery points were designed at 13.8 kV which is standardized in the Philippines.

(3) Transmission System Arrangement

A 69 kV line was adopted between Liloan and Sibonga despite that 115 kV line will take off Toledo at Naga instead of Sibonga, thus reducing power flow Naga to Sibonga. Moreover, power flow from Liloan to Naga will be improved by the interconnection of the future power plant at either Naga or Carcar with 230 kV system as well as with the 69 kV system sometime around 1987. In this way, the 69 kV line from Liloan to Naga is technically justified.

For the power transmission to Danao, too, a 69 kV line will be constructed. This voltage will be sufficient for the estimated demand up until 1990's.

Regarding the delivery point to VECO system, only Banilad susbtation was considered. It may be advantageous, however, to set up another delivery point at Naga for supplying municipalites of San Fernando, Naga, Minglanilla and Talisay in VECO's franchise area.

7-2-2 Outline of Transmission Plants

Transmission plants included in this projects are as shown in Table 7-1 and in attached General Plan and as summarized below.

Initially two circuits of 115 kV line will be constructed between the power plant at Liloan and VECO's proposed Benilad Substantion for a distance of approximately 13 kilometers. The 115 kV line will be on steel towers using 477 MCM, ACSR conductors.

Then 69 kV and 13.8 kV lines as well as seven step-down substations for 69 kV/13.8 kV will be constructed to cover the entire Province of Cebu to complete the Cebu Power Grid Project. (Refer to Drawing 7-3 Transmission Diagram)

The 69 kV lines totalling about 265 kilometers will be on wood poles which are nomally used by NPC and using 336 MCM, ACSR conductors. For Mactan, however, the conductor will be 267 MCM, ACSR. To span the strait, although overhead cable is conceivable, conductors were thought to be installed, in consideration of scenic effect, to the girders of Mandaue-Opon bridge, 860 meters in span, to be completed in 1973. Therefore, negotiations should be held with the constructor and controller of the bridge in connection with the installation method and safety. The 13.8 kV lines having a total length of about 250 kilometers will also be on wood poles using No. 2/0 AWG, ACSR conductors.

One 5 MVA, 69 kV/13.8 kV transformer will be installed at each seven step-down substation.

7-3 Construction Schedule

The proposed target dates of the project may roughly be splitted into two steps; namely, one for the completion of the gas turbine power plant and the steam power plant.

As regards the steam power plant which requires a longer construction period, financing procedure and definite study including preparation of specifications will be carried out after the final submission of this report at the end of March 1973; and provided that a contract for construction is awarded by the end of 1974, it will possibly be completed within the year 1977, taking into account 30 months for manufacturing and erection after placing an order.

In the meantime, the gas turbine power plant, including main transformer and switchyard equipment, will require approximately 16 months for manufacturing and erection, and it is likely to be completed within the year of 1975 on the assumption that the order is placed by the middle of 1974.

As for the transmission plants, pursuant to the above-mentioned target dates, it is necessary to complete the 115 kV transmission lines in 1975 and the other 69 kV and 13.8 kV transmission lines and substations in 1977.

Shown in Fig. 7-1 is the principal construction schedule of the project.

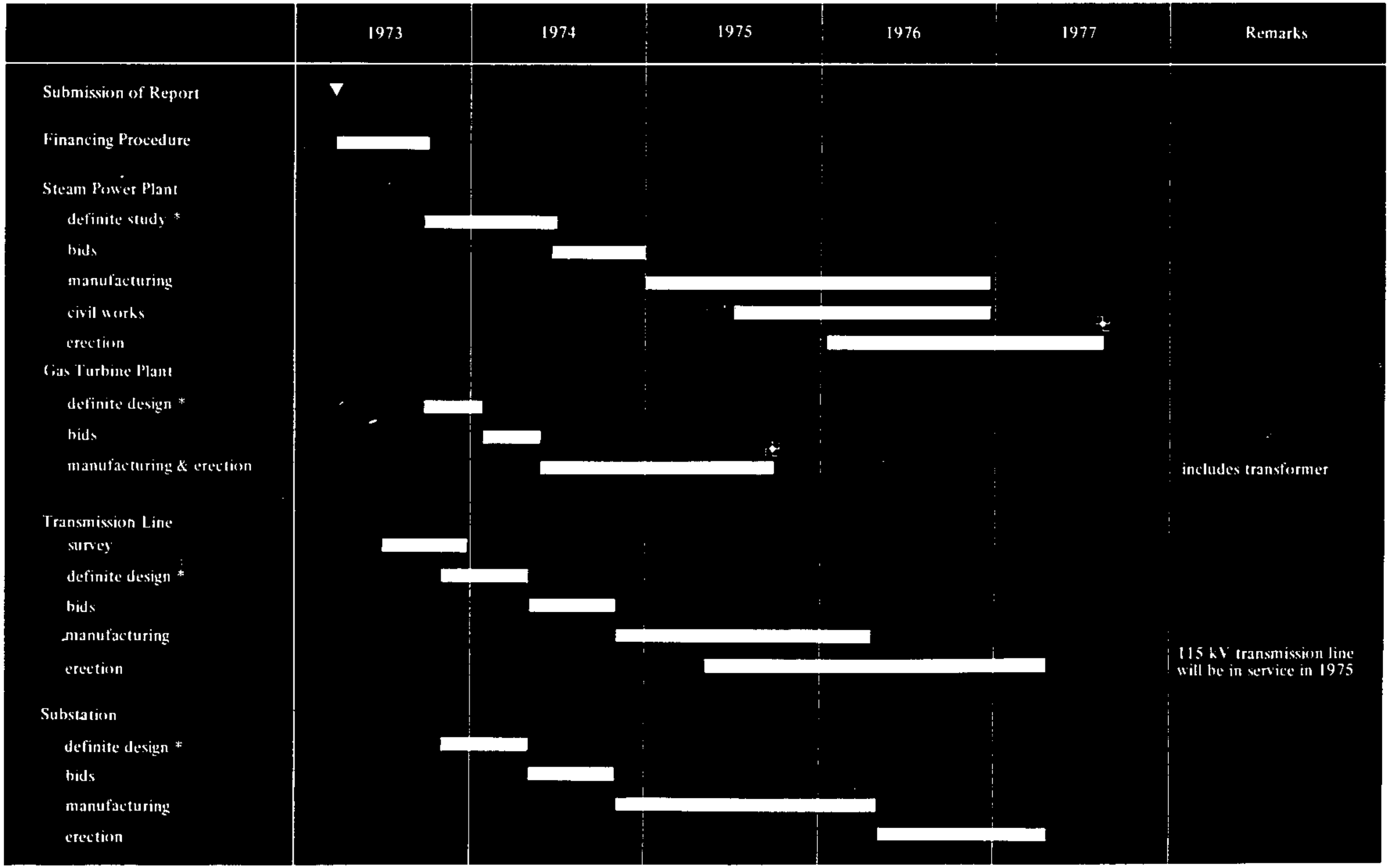
Table 7-1 Transmission Lines

Transmission Line	Voltage (kV)	No. of Circuit	Length (km)
Liloan - Banilad	115	2	13
Liloan - Mactan	69	1	15
Liloan - Danao	69	1	19
Lioan - Naga	69	1	39

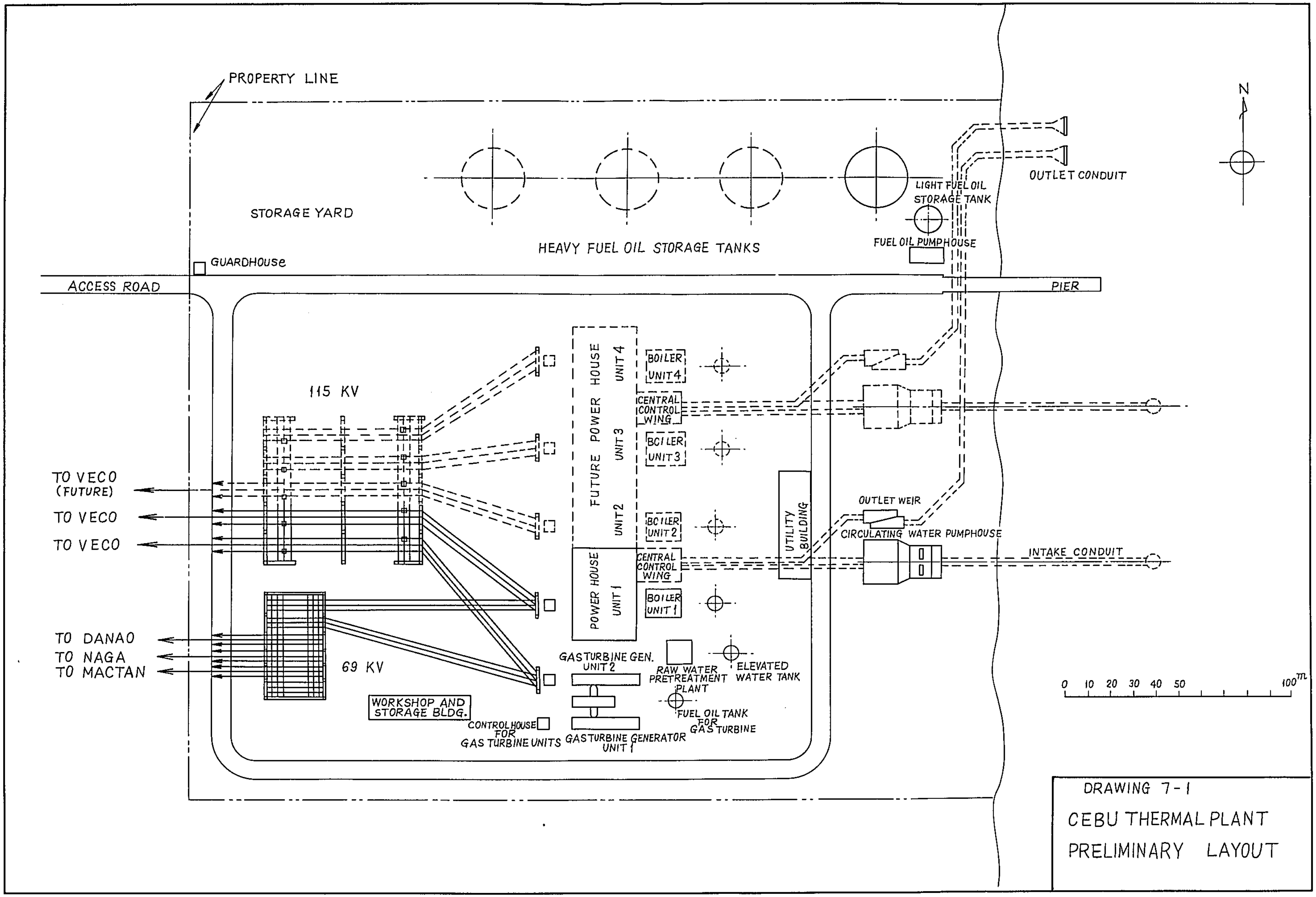
Table 7-1 Transmission Lines (cont'd)

Transmission Line	Voltage (kV)	No. of Circuit	Length (km)
Danao - Sogod	69	1	29
Sogod - Bogo	69	1	34
Naga - Toledo	69	1	25
Naga - Sibonga	69	1	28
Sibonga - Dumanjug	69	1	23
Sibonga - Boljoon	69	1	53
Bogo - Tabogon	13.8	1	14
Sogod - Borbon	13.8	1	10
Sogod - Catmon	13.8	1	5
Sogod - Tabuelan	13.8	1	18
Tabuelan - Tuburan	13.8	1	12
Toledo - Balamban	13.8	1	16
Balamban- Asturias	13.8	1	7
Toledo - Pinamungajan	13.8	1	16
Pinamugajan - Aloguinsan	13.8	1	7
Sibonga - Carcar	13.8	1	11
Sibonga - Argao	13.8	1	16
Boljoon - Alcoy	13.8	1	11
Alcoy - Dalaguete	13.8	1	7
Boljoon - Malabuyoc	13.8	1	19
Malabuyoc - Ginatilan	13.8	1	10
Ginatilan - Samboan	13.8	1	4
Boljoon - Oslob	13.8	1	14
Oslob - Santander	13.8	1	17
Bogo - Caputatan	13.8	1	4
Caputatan - San Remegio	13.8	1	5
Caputatan - Sugar Central	13.8	1	9
Sugar Central - Medellin	13.8	1	3
Sugar Central - Daan Bentayan	13.8	1	15
Total			528

Fig. 7-1 Construction Schedule of Cebu Power Grid Project



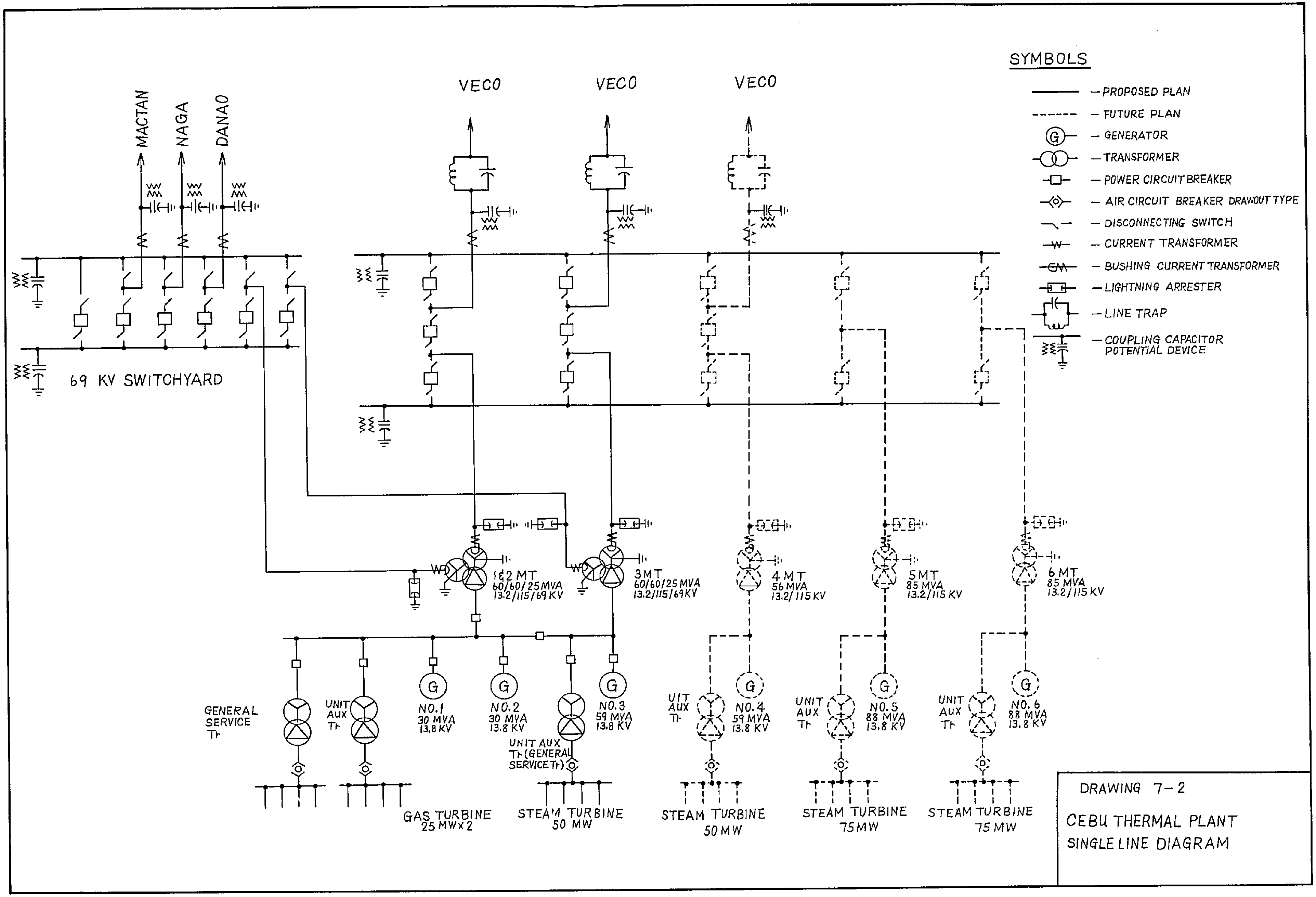
Note: * includes preparation of specifications.



DRAWING 7-1

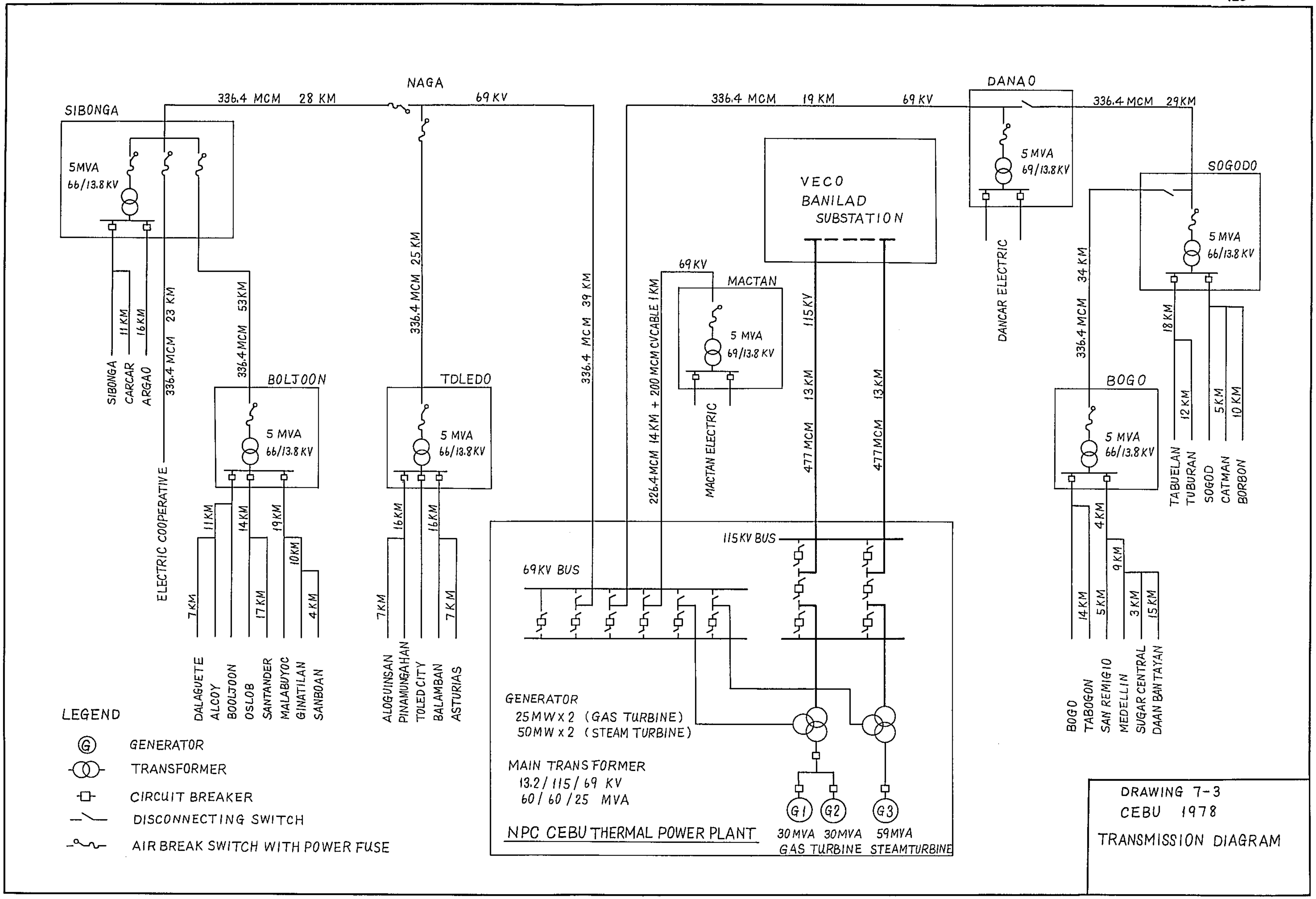
CEBU THERMAL PLANT

PRELIMINARY LAYOUT



DRAWING 7-2

CEBU THERMAL PLANT
SINGLE LINE DIAGRAM



DRAWING 7-3
CEBU 1978
TRANSMISSION DIAGRAM

Chapter 8 Cost Estimate and Economic Justification

8-1 Cost Estimate

8-1-1 Scope of Estimate

The estimate covers and includes the monetary requirement during the period of 1973 to 1978 for the construction of power plants, transmission lines and, substations which will constitute the Cebu Power Grid described in Chapter 7. The power plant will accommodate two 25 MW gas turbine generators and a 50 MW steam turbine generator. The transmission lines and substations are to wholesale energy to utilities and industries. The transmission lines to VECO will be a 115 kV line to conduct power to the step down substation that VECO will construct, and those to Dancar and Mactan utilities will be 69 kV transmission lines. Also, included are 69 kV transmission lines and 13.8 kV feeders to supply power to the substations of small utilities.

8-1-2 Conditions of Estimate

Supply of Materials

All the electrical and mechanical equipment and the materials of the power plant, substations, and the transmission lines were assumed to be imported from abroad. The supporting structures of 115 kV lines will be steel towers, while those for transmission lines of 69 kV and lower will be, following the practice of NPC, made of treated wooden poles available in the Philippines.

Prices of Equipment, Machinery and Materials

As stated in Chapter 1, the prices of equipment and machinery that are to be imported are the probable prices in the international tenders estimated taking into account the recent purchase prices in the Philippines, as well as, ECAFE region. The construction costs of substations and transmission lines were based on data made available by NPC that are indicated in terms of unit prices per kilometer length and per kVA capacity.

Foreign Currency Requirement

The foreign currency requirement was assumed to be a sum of the amount of CIF prices of equipment and machinery and a part of installation cost, but excluding inland transportation cost and a major part of installation cost that will have to be covered by domestic currency. The construction cost for civil works of the power plant was considered in the domestic currency portion.

Taxes and Duties

As amended in the New Charter, NPC is exempted from all the taxes and duties, and therefore, they were not considered.

Interest during Construction

The interest during construction was estimated for the period stipulated in Chapter 7 and with interest rates of 3.5 percent for foreign currency portion and 7.0 percent for domestic currency portion. The interest rate of foreign currency is discussed into details in Chapter 9 Financial Schedule, and that of domestic currency was determined on the assumption that a fund would be raised by issuing bonds of NPC.

Contingency

As compared with the construction cost of hydro power plant, there are less unknown factors in that of thermal power plant which is comprised of primarily the purchase of equipment and the machinery. In estimating the construction cost of thermal power plant, the contingency is normally considered as 5 percent. However, since the definite study of Cebu power plant has not been completed, the contingency was assumed to be 8 percent to be on the safe side, while that of gas turbines, transmission lines and substations to be 5 percent.

Engineering Fee

The engineering fee including definite design, preparation of specifications and construction supervisions, was assumed to be 5 percent.

Exchange Rate

All the costs are indicated in U.S. dollars with an exchange rate of 1 dollar to 6.7 pesos.

8-1-3 Capital Requirement

Table 8-1 gives the total capital requirement obtained based on the above conditions, and the annual disbursements are shown in Table 8-2.

Table 8-1 Capital Requirement of Project

(in thousand US dollars)

Plant	Foreign currency	Domestic currency	Total
Gas turbine power plant (25MW x 2)	4,300	470	4,770
Steam turbine power plant (50MW x 1)	8,420	2,400	10,820
Transmission plant	2,000	2,480	4,480
Total	14,720	5,350	20,070

Of the total capital investment of 20.1 million dollars by 1977, 4.8 million dollars (24 percent) is for gas turbine generators, and 10.8 million dollars (54 percent) and 4.5 million dollars (22 percent) are respectively for steam turbine generators and transmission and transformation facilities. The foreign currency requirement will be 14.7 million dollars (73 percent) and the domestic currency requirement 5.4 million dollars (17 percent). The large foreign currency requirement is attributable to the import of equipment, such as gas turbine generators and steam turbine generators which comprise the major part of the project. The breakdown of the investment is shown in Tables 8-3 through 8-6. The construction cost of both No. 1 and No. 2 gas turbine units is 95 dollars per kW, whereas that of steam

Table 8-2 Construction Cost by Year

(in thousand US dollars)

	1974	1975	1976	1977	Total
Steam power plant	320	2,600	6,000	1,900	10,820
Foreign currency	120	2,100	4,700	1,500	8,420
Domestic currency	200	500	1,300	400	2,400
Gas turbine plant	950	3,820			4,770
Foreign currency	950	3,345			4,295
Domestic currency		475			475
Transmission plant	200	200	2,040	2,040	4,480
Foreign currency	80	80	920	920	2,000
Domestic currency	120	120	1,120	1,120	2,480
Grand total	1,470	6,620	8,040	3,940	20,070
Foreign currency	1,150	5,525	5,620	2,420	14,715
Domestic currency	320	1,095	2,420	1,520	5,355

turbine generator, including advanced investment for land reclamation, cooling water intake structure and major structure of switchyard that are all for the future addition of steam turbine units, is as high as 216 dollars per kW. Consequently, the No. 2 unit which will be installed in the future is expected to go down to 175 dollars approximately in per kW construction cost.

Table 8-3 Cost Estimation
Gas Turbine Power Plant (25 MW x 2)

(in thousand US dollars)

	Total	Foreign currency	Domestic currency
Foundation	125	-	125
Gas turbine set	3,740	3,520	220
Miscellaneous plant equipment	190	140	50
Switchyard & transformer	355	325	30
Contingency	220	200	20
Interest during construction	50	40	10
Engineering	90	70	20
Total	4,770	4,295	475

Table 8-4 Cost Estimation
Steam Power Plant (50 MW x 1)

(in thousand US dollars)

	Total	Foreign currency	Domestic currency
Structural & improvement	1,460	290	1,170
Boiler plant equipment	2,730	2,340	390
Turbogenerator unit	3,300	3,020	280
Accessory electric equipment	390	330	60
Miscellaneous power plant equipment	130	90	40
Switchyard & transformer	880	880	80
Contingency	720	570	150
Interest during construction	620	510	110
Engineering	590	470	120
Total	10,820	8,420	2,400

Table 8-5 Construction Cost of Transmission Plant

(in thousand US dollars)

	Foreign currency	Domestic currency	Total
Direct cost			
Transmission line	1,142	1,988	3,130
Substation	610	115	725
Sub-total	1,752	2,103	3,855
Contingencies	88	105	193
Engineering	92	110	202
Interest during construction	68	162	230
Total	2,000	2,480	4,480

Table 8-6 Detailed Construction Cost of Transmission Plant

1. Transmission (in thousand US dollars)

Voltage (KV)	Length (km)	Unit construction cost Foreign currency	Unit construction cost Domestic currency	Construction cost Foreign currency	Construction cost Domestic currency	Total
115	13	10.6	15.0	138	195	333
69	265	2.9	4.65	791	1,300	2,094
13.8	250	0.85	1.97	213	493	706
Total	528			1,142	1,988	3,130

2. Substation (in thousand US dollars)

	Voltage (kV)	Transformer capacity (MVA)	Construction cost Foreign currency	Construction cost Domestic currency	Total
Mactan	69/13.8	5	80	15	95
Danao	69/13.8	5	85	15	100
Sogodo	69/13.8	5	85	15	100
Bogo	69/13.8	5	80	15	95
Toledo	69/13.8	5	85	15	100
Sibonga	69/13.8	5	95	20	115
Boljoon	69/13.8	5	85	15	100
Naga	69	-	15	5	20
Total			610	115	725

8-1-4 Comparison with NPC Estimate

For the comparative purpose, the construction cost estimated in the report is shown together with the estimate of NPC report in Table 8-7.

Table 8-7 Comparison of Construction Cost

(in thousand US dollars)

	Generation plant			Transmission plant			Total		
	Total	FC	DC	Total	FC	DC	Total	FC	DC
NPC report*	26,280	20,080	6,200	9,720	6,400	3,320	36,000	26,480	9,520
This report	15,590	12,870	2,870	4,480	2,000	2,480	20,070	14,720	5,350
Difference	10,690	7,360	3,330	5,240	4,400	840	15,930	11,760	4,170

Note: FC stands for foreign currency and DC domestic currency
* Indirect costs were distributed to each plant in proportion to its direct cost.

The construction cost of NPC report is for the installation of two 75 MW steam turbine units, while the estimate in this report is for a total of 100 MW in installed capacity with a combination of steam turbine and gas turbine units. Furthermore, the step-up substation, which is included in the generation plant in the present estimate, is included as a part of transmission plant in NPC report. Such differences in the estimate make unable simple comparison. However, the development program established in the report can meet the demand up to 1980, as in the case of the development program of NPC, but with less total capital investment by 15.9 million dollars, including 11.8 million dollars in foreign currency requirement. This difference is derived from, as stated in Chapter 6, the difference in policy of how the reserve capacity should be determined.

8-2 Economic Justification

8-2-1 Economic Evaluation

The power development program established in this report was evaluated in terms of the internal rate of return, as well as, the rate of return on a rate base. In both cases, the fuel cost, comprising about 60 percent of the energy cost, is a perplexing problem since the projection of fuel cost is very hard to make.

Three different fuel costs, as shown in Table 6-5 in Chapter 6, were prepared in order to make known the effect of the fuel cost to the evaluation of the project.

Fuel cost Case-1 represents the price at which NPC is purchasing for Bataan Thermal Power Plant (converted to the value as of June 1972), and Case-2 the wholesale price fixed in December 1972 for the govenment agencies in Cebu. The estimate of fuel cost forecasted in this report is the price fixed for the government agencies. Case-3, 20 percent higher than the price in Case-2, is based on the price quoted by an oil company in 1972.

The result of evaluation is very severe, and therefore, on the safe side because the project was evaluated independently and separately from the sequential power development in the future of which the present project is constituting a part. Included in the project, the transmission network, or the Cebu Grid, will be established covering almost entire area of the island, which, in the future development projects, will greatly contribute to lowering the energy cost. Therefore, in the long run, the present project would be much appreciated than what is shown by the present evaluation, which may be comprehensible if the evaluation made in this volume is compared with that described in Volume II, Chapter 7 Investment Program. The power rate and fuel cost adopted in Volume I are respectively Rate-2 and Case-2. In Volume I, Plan GS-2 is evaluated including the future development after 1978, and the rate of return is expected to exceed 10 percent in 1980, indicating the possibility of lowering the power rate. In this volume, however, the rate of return is predicted to go over the 10 percent level in 1986.

8-2-2 Internal Rate of Return

The internal rate of return of the project was obtained by the use of the following equation:

$$I = \sum_{t=1}^{33} \frac{(Rt - Ct)}{(1+i)^t}$$

In the equation, "I" represents the total capital investment not including interest during the construction, converted into present worth of 1977 end when this project will become operation. "Rt" is power sales revenue in t-th year and "Ct" is annual cost, including operation and maintenance cost and fuel cost but excluding interest and depreciation cost, in t-th year. The internal rate of return is represented by "i" which is largely variable with the fuel cost. The period represented by "t" is 33 years which is the service life of the thermal power plant.

The power sales revenue will be influenced by the power rate schedule. The New Charter of NPC has given NPC the authority to determine the power rate schedule in the respective regions, and with this power rate schedule, NPC should be on the paying basis. Having no existing facilities in Cebu, NPC will have to establish a new power rate schedule which should cover the energy cost and fair return. At the same time, it should be equivalent to or less than the energy costs of private utilities. Although it is desirable to have the power rate balanced with those in Luzon and Mindanao, the accounting system which is self supporting in each region hinders the establishment of such power rate.

(1) The energy cost at receiving end including transmission and transformation costs of Cebu Power Grid at its first stage will be as shown in Fig. 8-1 with the fuel cost of Case-2. From the figure, the wholesale price, including 10 percent return, was estimated to be approximately 14.5 mills per kWh and to be 12.3 mills per kWh and 15.5 mills per kWh respectively for the fuel costs of Case-1 and Case-3.

(2) Energy cost of a 10 MW diesel driven generator which a private utility would install in Cebu was estimated to be as shown in Table 8-8. The difference between the energy costs of NPC and private utility is derived from the difference in interest rate of fund to be raised and the exemption of NPC from taxes and duties. The interest rate applied for the private utility is 12 percent per annum, and the taxes are import tax and compensating tax which total to 20 percent of construction cost plus property tax and educational tax a total of which is 3 percent of construction cost.

Table 8-8 Estimated Energy Cost of Private Utility

Fuel cost	*Energy cost*
Case 1	13.9 mills/kWh (9.3 centavos/kWh)
Case 2	15.6 mills/kWh (10.4 centavos/kWh)
Case 3	16.6 mills/kWh (11.1 centavos/kWh)

In calculating the above figures, VECO was supposed to have a power plant which, 50 MW in installed capacity, would carry 60 percent of plant factor. Small in scale, energy to be produced by other private utilities will be considerably higher in cost than the above figures.

(3) According to Annual Report 1971/1972 of NPC, averaged power sales revenue of NPC in 1971/1972 was as shown in the following.

Table 8-9 NPC's Averaged Revenue per kWh

in mills/kWh (centavos/kWh)

	Luzon	Visayas	Mindanao	Average
Utilities	9.3 (6.2)	12.2 (8.2)	4.6 (3.1)	8.7 (5.8)
Non-utilities	8.4 (5.6)	12.2 (8.2)	3.9 (2.6)	7.3 (4.9)
Average	8.7 (5.8)	12.2 (8.2)	4.0 (2.7)	7.8 (5.2)

In the above, power sales to MERALCO were omitted since they were receipts from pooled energy of special rate. The revenue in the Visayas is from power generated at small hydro plants.

IBRD has requested NPC to maintain the rate of return over 8 percent to provide funds to finance construction of future plants. Further, it is contemplated by IBRD to fix the power rate of NPC as follows:

mills/kWh (centavos/kWh)

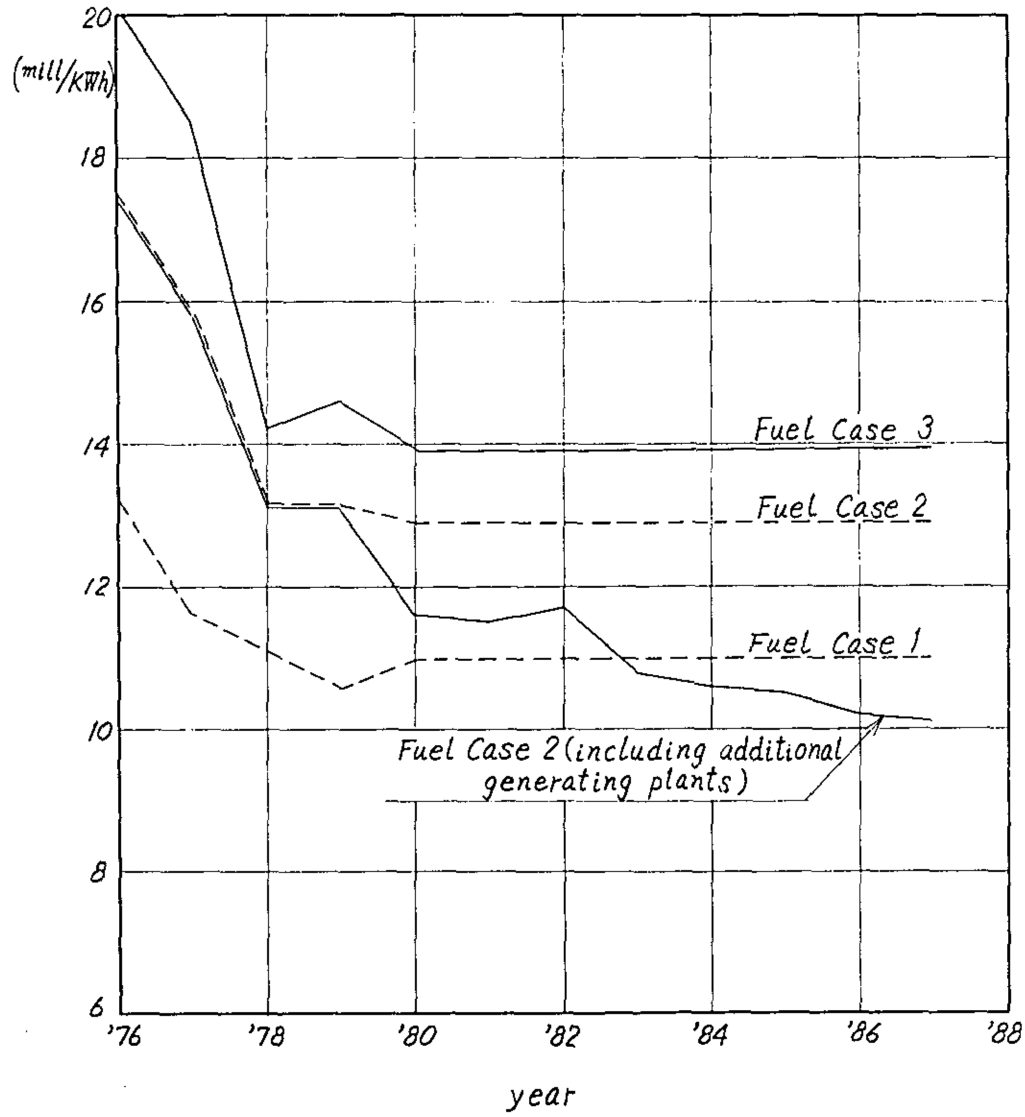
	1972	1973	1974	1975-76	1977
Luzon	8.85 (5.93)	9.6 (6.43)	10.9 (7.3)	10.9 (7.3)	10.9 (7.3)
Mindanao	4.0 (2.67)	4.0 (2.67)	4.0 (2.67)	5.0 (3.37)	5.5 (3.70)

Of the above rates, comparable with the Visayas are those of 1977 since Cebu grid will start operation after 1976. In Luzon the power rate will be 10.9 mills per kWh with hydro power plants and a thermal power plant at Bataan, and it will be 5.5 mills per kWh in Mindanao where all the plants will be hydraulic. Almost one half of Luzon, energy to be produced in Mindanao will be very cheap due to the favorable natural conditions of the power plant sites. In Cebu where power resources will be all fuel oil, energy cost will be high. Consequently, the power rates in the Visayas will not be in accord with that of Luzon or Mindanao. However, it should be fixed low insomuch as practicable since the energy cost of private utility estimated in (2) with the fuel cost of Case-2 will be higher than the power rate in Luzon by as much as 42 percent. Based on the cost estimate in the above, the power rate schedule of NPC was tentatively presumed as shown in the following. The unit sales price of 7 centavos per kWh set in NPC report is not practicable.

Table 8-10 Presumed Sales Price

	VECO		Others	
	mill/kWh	(centavos/kWh)	mill/kWh	(centavos/kWh)
Rate 1	13.4	(9)	16.4	(11)
Rate 2	14.9	(10)	17.9	(12)
Rate 3	16.4	(11)	19.4	(13)

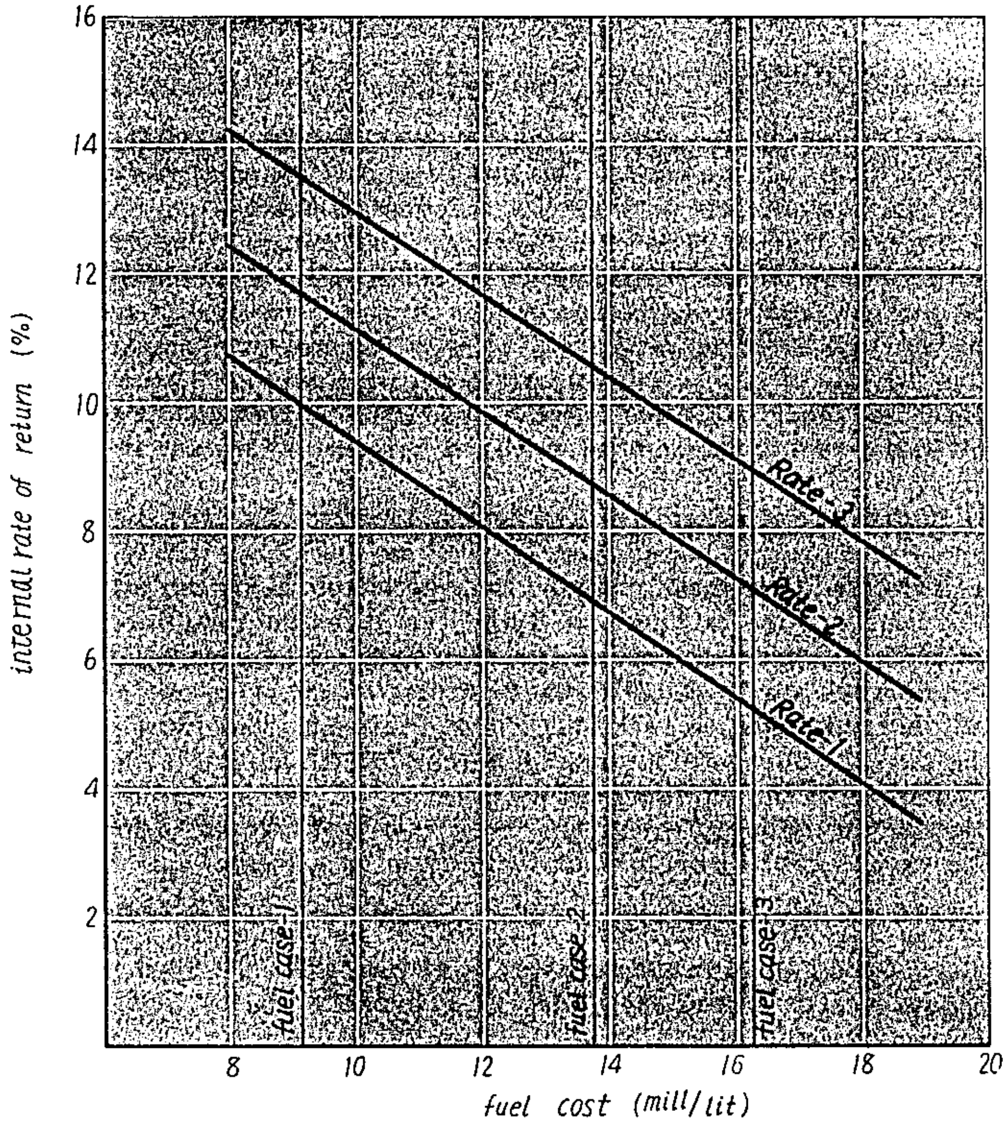
Fig. 8-1 Trend of Energy Cost at Receiving End (GS-2)



The rates set in Table 8-10 are competitive with the cost of VECO, and when compared with those of other utilities, they are far less expensive. People living in rural areas will be able to enjoy less expensive electricity which is not very much different in price from that in Cebu City.

With the results obtained from the above calculation, the internal rate of return was obtained as shown below.

Fig. 8-2 Internal Rate of Return



If the fuel cost is Case-1, the internal rate of return will be higher than 10 percent with any one of the three power rates. If the fuel cost is set at Case-2, the internal rate of return will be 8.9 percent with Rate-2 and 10.7 percent with Rate-3. If the highest fuel cost of Case-3 is applied, an internal rate of return of over 10 percent will not be obtainable.

Table 8-11 Internal Rate of Return

(%)

Fuel cost	Case 1	Case 2	Case 3
Rate 1	10.1	7.0	5.3
Rate 2	11.8	8.9	7.2
Rate 3	13.6	10.7	9.0

8-2-3 Rate of Return

In the Philippines, the power rates are determined based on the cost which is expressed in terms of rate base. The rate base is a sum of operating net assets, operating capital equivalent to two months' operating expense and non-cash items such as deferred assets. The rate of return is percentage of the operating income to the rate base, and is not acceptable to the Public Service Commission if it exceeds 12 percent. However, the maximum rate of return allowable for NPC is stipulated by its charter as 10 percent reflecting the non-profit nature of NPC. In computing the rate of return, capital cost is not considered. That is to say, interest on loans and other liabilities is not included in the expense. In the evaluation, a project with a rate of return of more than 8 percent is judged to be feasible.

As in the case of internal rate of return, the rate of return is largely influenced by the unit price of power sales, as well as, the fuel cost. With these variables, calculations were made to obtain the rate of return for the period of up to 1987. To illustrate the calculations, Table 8-11 gives the result obtained with the fuel cost of Case-2 and the wholesale price to VECO of 14.9 mills (10 centavos) per kWh which is Rate-2. In 1976, the first year of operation, the operating income will be in the red. In 1978 when the steam turbine generator is put in operation, the rate of return will become 7.0 percent, which will be further improved to over 8 percent in the following 1979.

The results of other calculations with different values of variables are shown in Table 8-12. If the 8 percent rate of return is considered as the critical level of justifications, fuel cost Case-1 makes the project justifiable with any rate; application of Rate-2 and Rate-3 raising the rate of return far up the level. With fuel cost Case-2, Rate-1 tends to deny the project, 7.8 percent in the 1987 rate of return, necessitating the application of Rate-2 or Rate-3.

With fuel cost Case-3, Rate-2 is hard to apply and only Rate-3 gives the rate of return over 8 percent. Such tendency of the rate of return is identical with that of the internal rate of return, which obviously denotes that, in order to secure a certain level of rate of return, the power rates should be hiked according to the rise in fuel cost.

Summary

As has been discussed in the foregoing, the project will generate electricity which can be wholesaled at a price lower than the energy cost of private utilities, besides, maintaining the rate of return above the required level. For the development of the national economy, efforts are being made by the Government to hold down the power rates. It is, therefore, demanded to fix the power rate as low as practicable. Funds to be raised for the project should be low in interest rate, and the fuel cost will have to be kept restrained as much as possible into the far future.

Table 8-12 Cebu Electric Power Grid

Calculation of Rate of Return

(fuel cost Case 2, Rate 2)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Energy sales (million kWh)												
VECO	109	170	225	317	219	219	219	219	219	219	219	219
Utilities	0	0	46	52	58	58	58	58	58	58	58	58
Sales price per kWh (mill/kWh) (centavos/kWh)												
VECO	14.93(10)											
Utilities	17.92(12)											
Gross revenue												
VECO @ 14. 93 mill/kWh	1,628	2,538	3,509	4,733	3,270	3,270	3,270	3,270	3,270	3,270	3,270	3,270
Utilities @ 17. 92 mill/kWh	0	0	824	932	1,039	1,039	1,039	1,039	1,039	1,039	1,039	1,039
Total	1,628	2,538	4,333	5,665	4,309	4,309	4,309	4,309	4,309	4,309	4,309	4,309
Operating cost												
Generation	110	110	373	373	373	373	373	373	373	373	373	373
Transmission	10	10	128	128	128	128	128	128	128	128	128	128
Fuel	1,420	2,313	1,758	2,909	1,636	1,636	1,636	1,636	1,636	1,636	1,636	1,636
Depreciation	157	157	588	588	588	588	588	588	588	588	588	588
Total	1,697	2,490	2,847	3,998	2,727	2,727	2,727	2,727	2,727	2,727	2,727	2,727
Operating income	-69	48	1,486	1,667	1,584	1,584	1,584	1,584	1,584	1,584	1,584	1,584
Rate base												
Net operating assets	5,170	5,013	19,756	19,168	18,580	17,992	17,404	16,816	16,228	15,640	15,052	14,464
Materials & supplies	10	10	20	20	20	20	20	20	20	20	20	20

(cont'd)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Re-payments	5	5	10	10	10	10	10	10	10	10	10	10
2 Months operating cost	283	416	475	668	455	455	455	455	455	455	455	455
Total	5,468	5,444	20,261	19,866	19,065	18,477	17,889	17,301	16,713	16,125	15,537	14,919
Rate of return		0.88	7.33	8.39	8.31	8.57	8.85	9.16	9.48	9.82	10.20	10.62

Table 8-13 Rate of Return on Various Conditions

	Fuel cost	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Rate 1													
	Case 1	4.19	9.54	8.10	10.42	8.94	9.23	9.53	9.86	10.21	10.58	10.97	11.42
	Case 2			5.25	5.60	6.13	6.32	6.53	6.75	6.99	7.24	7.52	7.83
	Case 3			3.66	2.74	4.57	4.71	4.87	5.03	5.21	5.60	5.60	5.82
Rate 2													
	Case 1	7.23	14.33	10.19	13.22	11.13	11.49	11.87	12.27	12.71	13.18	13.67	14.21
	Case 2		0.88	7.33	8.39	8.31	8.57	8.85	9.16	9.48	9.82	10.20	10.62
	Case 3			5.73	5.54	6.74	6.96	7.19	7.43	7.69	7.97	8.27	8.59
Rate 3													
	Case 2	1.70	5.53	9.40	11.15	10.47	10.81	11.16	11.54	11.95	12.38	12.85	13.36
	Case 3			7.80	8.29	8.91	9.20	9.49	9.81	10.15	10.52	10.92	11.35

Chapter 9 Financing Schedule

9-1 Funds to be Raised by Loans

As stated in Table 9-4, the total construction cost of the project, not including the interest during construction, is US $ 14,095 thousand in foreign currency and US $ 5,075 thousand in domestic currency totaling US $ 19,170 thousand. Assuming this requirement is to be financed by funds raised by loans, the loan condition was assumed to be as follows:

(a) Foreign currency

Annual interest rate:	3.5 percent and 7.5 percent
Repayment period:	25 years including 5 years grace period
Repayment method:	principal in equal annual amount (The interest during the grace period is payable from a fund to be raised in domestic currency. The interest rates are those of yen credit and prevailing rates in the Philippines of loans of international financing institutes.)

(b) Domestic currency

Annual interest rate:	7.0 percent
Repayment period:	14 years including 4 years grace period
Repayment method:	equal annual installments over capital and interest

(A fund in domestic currency will be raised by sale of bonds.)

9-2 Operating Income

The revenue from power sales was computed on the unit sales price of 14.9 mills per kWh (10 centavos per kWh) to VECO and 17.9 mills per kWh (12 centavos per kWh) to other utilities. This sales price is based on the power rate schedule fixed in a manner that the rate of return, kept above 8 percent, will not exceed 10 percent as stipulated in the New Charter of NPC. With this revenue, an operating income of US $ 4,309 thousand will be generated annually as shown in Table 9-1, even if the gas turbine generators, the reserve units, will stay idle after 1980. The fuel cost of steam turbine was assumed to be 20.45 mills per liter (13.70 centavos per liter) with the fuel cost of Case-2.

9-3 Financing Program

A cash flow was calculated as shown in Table 9-2 assuming the fuel cost at Case-2, power rate at Rate-2, annual interest rate of foreign currency borrowings to be 7.5 percent and that of domestic currency borrowing to be 7.0 percent. The cash flow will be in the black in 1976 and 1977. However, it will be in the red consecutively from 1978 till 1987 when the domestic currency borrowings will have been redeemed. The accumulated red figure in 1987 will amount to $5.3 million. Such a large red figure in spite of the internal rate of return of 8.9 percent is attributable to issuance of bonds which are repayable in ten years.

If the interest rate of 7.5 percent on foreign currency portion only is changed to 4.0 percent, many of the red figures will turn out to be black, and the accumulated black figure will amount to $761 thousand in 1978. In the years of 1979 to 1983, the cash flow will continue to be in the red, but it will turn out to be the black again in 1984. Therefore, the interest rate of 4 percent is thought to be the critical rate with regard to the yearly cash flow. In other words, for the betterment of cash flow, foreign capital should be borrowed at a rate lower than 4 percent annually. If the loan is to be laid by Japanese government, annual interest rate will be 3.5 percent. Table 9-3 shows the cash flow when the interest rate is 3.5 percent on foreign currency and 7 percent on domestic currency. Back data of the cash flow are shown in Tables 9-4 to 9-6. As can be seen from Table 9-3, a small amount of red figure will appear in 1980 and after 1988 when the bond will have been repaid, $1.2 million of cash will be generated annually. If Rate-1 is applied to the power rate, the cash flow will remain in the red from 1976 through 1987, which denies the adoption of power rate Rate-1.

With these considerations, it was concluded that a fund in foreign currency should be raised at an interest rate of 3.5 percent annually.

Table 9-1 Income Statement

		1974	1975	1976	1977	1978
	Sales of energy (GWh)	-	-	109	170	281
	VECO (GWh)	-	-	(109)	(170)	(235)
	Utilities (GWh)	-	-	-	-	(46)
	Sales price					
	VECO (mill/kWh)	-	-	14.93	14.93	14.93
	Utilities	-	-	-	-	17.92
(1)	Operating revenue	-	-	1,628	2,538	4,333
	VECO	-	-	(1,628)	(2,538)	(3,509)
	Utilities	-	-	-	-	(824)
(2)	Operating expenses	-	-	1,697	2,490	2,847
	Production	-	-	(110)	(110)	(373)
	Transmission	-	-	(10)	(10)	(128)
	Fuel	-	-	(1,420)	(2,213)	(1,758)
	Depreciation	-	-	(157)	(157)	(588)
(3)	Net income (1-2)			-69	48	1,486

Note: fuel cost: Case-2, power rate: Rate-2

Table 9-2 Cash Flow Statement

		1 1974	2 1975	3 1976	4 1977	5 1978
(1)	Sources					
	Internal cash generation					
	Net income (before interest)	-	-	-69	48	1,486
	Depreciation	-	-	157	157	588
	Total cash generation	-	-	88	205	2,074
	Borrowings					
	Foreign loan	1,125	5,370	5,290	2,310	-
	Domestic loan	384	1,532	3,184	2,487	-
	Total borrowings	1,509	6,902	8,474	4,797	-
	Total sources	1,509	6,902	8,562	5,002	2,074
(2)	Disbursement					
	Foreign currency	1,125	5,370	5,290	2,310	1,057
	Domestic currency	384	1,532	3,184	2,487	1,229
	Total disbursement	1,509	6,902	8,474	4,797	2,286
(3)	Cash flow	0	0	88	205	-212
(4)	Accumulated total	0	0	88	293	81

Note: fuel cost: Case 2, power rate: Rate-2; 7.5 % interest rate on foreign curreny and 7.0 % interest rate on domestic currency

(in thousand US dollars)

1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
369	277	277	277	277	277	277	277	277	277
(317)	(219)	(219)	(219)	(219)	(219)	(219)	(219)	(219)	(219)
(52)	(58)	(58)	(58)	(58)	(58)	(58)	(58)	(58)	(58)
14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93	14.93
17.92	17.92	17.92	17.92	17.92	17.92	17.92	17.92	17.92	17.92
5,665	4,309	4,309	4,309	4,309	4,309	4,309	4,309	4,309	4,309
(4,733)	(3,270)	(3,270)	(3,270)	(3,270)	(3,270)	(3,270)	(3,270)	(3,270)	(3,270)
(932)	(1,039)	(1,039)	(1,039)	(1,039)	(1,039)	(1,039)	(1,039)	(1,039)	(1,039)
3,998	2,725	2,725	2,725	2,725	2,725	2,725	2,725	2,725	2,725
(373)	(373)	(373)	(373)	(373)	(373)	(373)	(373)	(373)	(373)
(128)	(128)	(128)	(128)	(128)	(128)	(128)	(128)	(128)	(128)
(2,909)	(1,636)	(1,636)	(1,636)	(1,636)	(1,636)	(1,636)	(1,636)	(1,636)	1,636)
(588)	(588)	(588)	(588)	(588)	(588)	(588)	(588)	(588)	(588)
1,667	1,584	1,584	1,584	1,584	1,584	1,584	1,584	1,584	1,584

(in thousand US dollars)

6 1979	7 1980	8 1981	9 1982	10 1983	11 1984	12 1985	13 1986	14 1987	15 1988
1,667	1,584	1,584	1,584	1,584	1,584	1,584	1,584	1,584	1,584
588	588	588	588	588	588	588	588	588	588
2,255	2,172	2, 172	2, 172	2, 172	2, 172	2, 172	2, 172	2, 172	2, 172
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
2,255	2,172	2,172	2,172	2,172	2,172	2,172	2,172	2,172	2,172
1,762	1,709	1,656	1,603	1,550	1,498	1,445	1,392	1,339	1,286
1,229	1,229	1,229	1,229	1,229	1,229	1,229	1,229	1,229	0
2,991	2,938	2,885	2,832	2,779	2,727	2,674	2,621	2,568	1,286
-736	-766	-713	-660	-607	-555	-502	-449	-296	+886
-655	-1,421	-2,134	-2,794	-3,401	-3,956	-4,458	-4,907	-5,303	-4,417

Table 9-3 Cash Flow Statement

		1 1974	2 1975	3 1976	4 1977	5 1978
(1)	Sources					
	Internal cash generation					
	Net income (before interest)	-	-	-69	48	1,486
	Depreciation	-	-	157	157	588
	Total cash generation	-	-	88	205	2,074
	Borrowings					
	Foreign loan	1,125	5,370	5,290	2,310	-
	Domestic loan	339	1,272	2,712	1,923	-
	Total borrowings	1,464	6,642	8,002	4,233	-
	Total sources	1,464	6,642	8.090	4,437	-
(2)	Disbursement					
	Foreign loan	1,125	5,370	5,290	2,310	493
	Domestic loan	339	1,272	2,712	1,923	1,013
	Total disbursement	1,464	6,642	8,002	4,233	1,506
(3)	Cash flow	0	0	88	204	568
(4)	Accumulated total	0	0	88	292	860

Note: fuel cost: Case 2, power rate: Rate-2; 3.5 % interest rate on foreign currency and 7.0 % interest rate on domestic currency

Table 9-4 Estimated Borrowing & Disbursement Schedule

(in thousand US dollars)

Year	Net requirement		Interest		Borrowing		Interest on borrowings		Disbursement	
	FC	DC	FC	DC	FC	DC	FC	DC		
1974	1,125	300	39	21	1,125	339	39	24	1,125	339
1975	5,370	1,045	227	94	5,370	1,272	227	113	5,370	1,272
1976	5,290	2,300	412	255	5,290	2,712	412	301	5,290	2,712
1977	2,310	1,430	493	355	2,310	1,923	493	436	2,310	1,923
1978	0	0	493	0	0	0	0	0	493	0
Total	14,095	5,075		725	14,095	6,246	1,171	874		

Note: 1. FC : Foreign currency (Anual interest rate 3.5%)
DC : Domestic currency (" 7.0%)

2. Interest on FC loan is capitalized and included in the DC borrowings but in 1978 it is payable from power sales earning.

(in thousand US dollars)

6 1979	7 1980	8 1981	9 1982	10 1983	11 1984	12 1985	13 1986	14 1987	15 1988
1,667	1,584	1,584	1,584	1,584	1,584	1,584	1,584	1,584	1,584
588	588	588	588	588	588	588	588	588	588
2,255	2,172	2,172	2,172	2,172	2,172	2,172	2,172	2,172	2,172
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
1,198	1,173	1,149	1,124	1,099	1,075	1,050	1,025	1,001	976
1,013	1,013	1,013	1,013	1,013	1,013	1,013	1,013	1,013	0
2,211	2,186	2,162	2,137	2,112	2,088	2,063	2,038	2,014	976
44	-14	10	35	60	84	109	134	158	1,196
904	890	900	935	995	1,079	1,188	1,322	1,480	2,676

Table 9-5 Amortization Schedule for Foreign Currency

(in thousand US dollars)

	Year	Principal	Interest	Total	Outstanding
					14,095
1	1979	705	493	1,198	13,390
2	80	"	469	1,173	12,685
3	81	"	444	1,149	11,981
4	82	"	419	1,124	11,276
5	83	"	395	1,099	10,571
6	84	"	370	1,075	9,867
7	85	"	345	1,050	9,162
8	86	"	321	1,025	8,457
9	87	"	296	1,001	7,752
10	88	"	271	976	7,048
11	89	"	247	951	6,343
12	90	"	222	927	5,638
13	91	"	197	902	4,932
14	92	"	173	877	4,229
15	93	"	148	853	3,524
16	94	"	123	828	2,819
17	95	"	99	803	2,114
18	96	"	74	779	1,410
19	97	"	49	754	705
20	98	"	25	729	0

Annual interest rate : 3.5 %

Table 9-6 Amortization Schedule for Domestic Currency

(in thousand US dollars)

	Year	Principal	Interest	Total	Outstanding
					7,120
1	1978	514.6	498.4	1,013.0	6,605.4
2	79	550.6	462.4	"	6,054.8
3	80	589.2	423.8	"	5,465.6
4	81	630.4	382.6	"	4,835.2
5	82	674.5	338.5	"	4,160.7
6	83	721.8	291.2	"	3,438.9
7	84	772.3	240.7	"	2,666.6
8	85	826.3	186.7	"	1,840.3
9	86	884.2	128.8	"	956.1
10	87	946.1	66.9	"	10.0

Interest rate : 3.5%

Chapter 10 Consideration on Socio-Economic Effects of Power Development

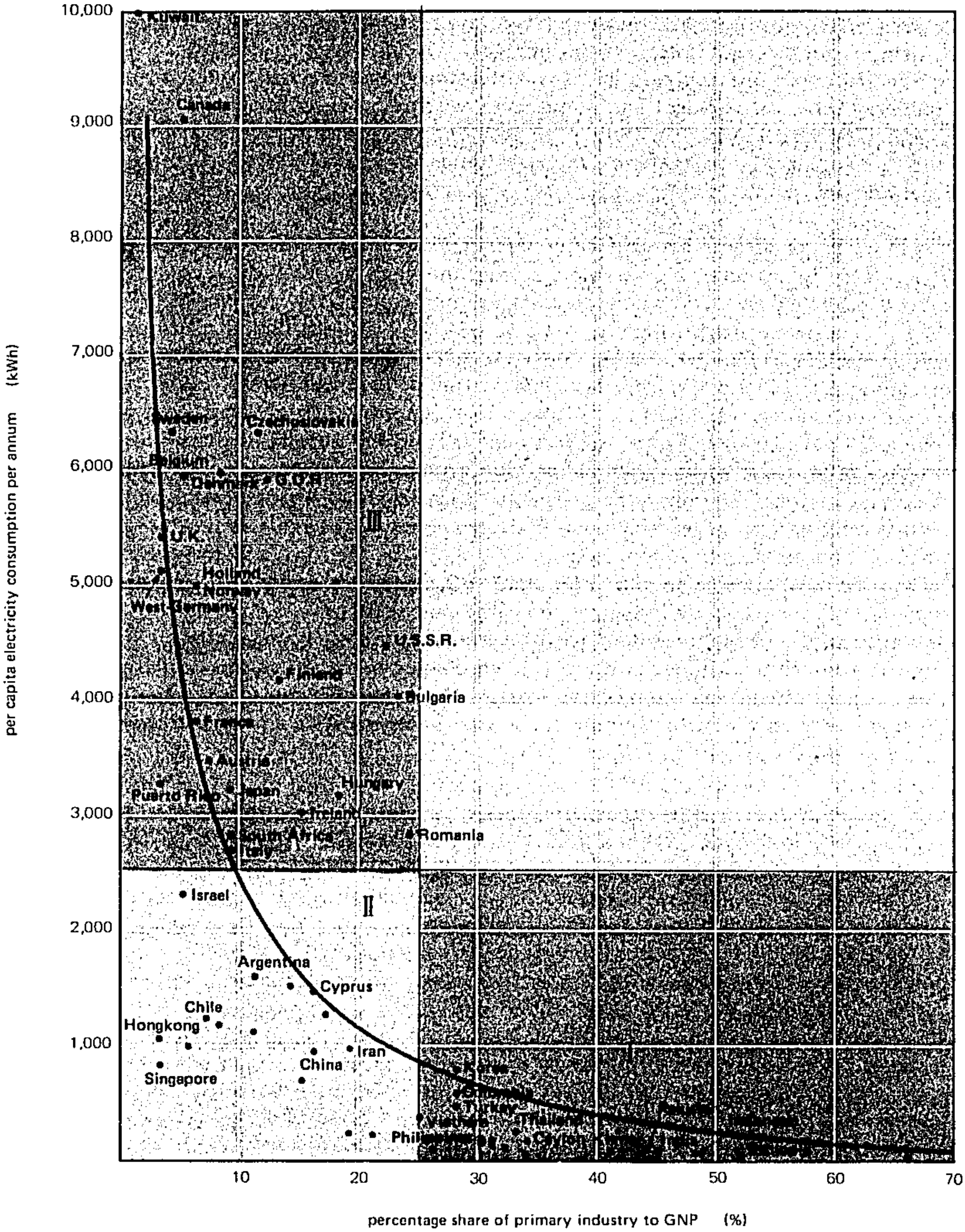
10-1 Economic Growth and Power Development

No such words are necessary as to describe the utility of electric power which is sustaining the modern life of the people as well as contributing to the economy as an important energy source. The demand for this electric power is very closely correlated with the economic growth. The fact that the demand for power increases at a higher rate than the economic growth rate when the economy is in a boom and that the demand does not decrease when in a recession elucidates the significant role played by power. The correlation between power-consumption and economic structure of a country has an interesting one which can be stated as follows: "the lower is the share of primary industry's value-added to the GNP of a country, the more the country consumer the power". On the figure 10-1, most of the South-east Asian countries are located in the region-I and the so-called developed countries are in the region III. The economic development studies show that the high share of the primary industry to GNP is, except some special cases, a trait of developing economy whose economic stage in a sense of development is still expecting the take-off. The share will decrease when industry dispersal and rural industrialization get under way. The countries in the region-I are generally characterized by the dominant traditional agricultural society, where the power consumption is quite small. The take-off of these economies requires not only the power development but the development of various infrastructures as well as many other social conditions and environments. Among many conditions, the power development which is needed both for the consumption and production activity is very conducive to the improvement and stability of the people's life and for the completion of the infrastructures.

From the standpoint of Visayas in the Philippines, where industrialization and development are rather retarded compared with Luzon —— especially greater Manila area —— and Mindanao, the equity of the people which is one of the main objectives of economic policy will not be attained if these regional unblance is kept untouched or enlarged further. The unbalance may also cause the problem of over-density or excessive sparsity of population and economy. Economic development may accompany regional or sectoral unbalance in development or be the result of full utilization of the merit brought by the leading sector or region. However, there are many demerits of over-concentration and, in some examples, what is counted merits turns out to be demerits. Therefore, balanced growth and development is the desirable one. In this sense, Visayas development is very significant for the entire Philippines. The region is, as stated earlier, known as agricultural society and the main economic activity is the production and export of primary products. Therefore the economic connection and industrial linkage with other regions are weak. In other words, the region is relatively noninfluential and passive in economic activity. The population growth of the region will explain the state, which is 1.56 percent while the national average is 3 percent. Moreover, sugar and mining products, which are the staples of the region, are directly exported to the overseas demander as raw materials without being processed by domestic transactors. (They play, of course, an important role as dollar earners.) For the purpose of stepping out of the present situations for the region to the vigorous and influential regional economy as well as levelling the regional unbalance from national point of view requires investment in infrastructure.

Above all, power supply in the region depending on small private utilities is retarded in comparison with the other region and has to be improved. As for entire Philippines in 1961, electric charge shared 0.60 percent, 0.93 percent and 0.70 percent of the activity levels of household, commercial sector and industiral sector respectively. These ratios are thought to have increased during these ten years by the active power development by NPC, thus indicating the tendency of power consuming. Whereas in the Visayas the ratios at present are estimated to be a little less than, or almost equivalent to, the 1961 level of the whole Philippines. (The estimate is made from the sales data obtained from the utilities in Visayas.) In consideration of that power development and generation were executed by NPC through 1960's and that the industrialization in Mindanao is remarkably promoted by the full use of cheap and dependable power generated from Maria Cristina dam, Visayas industrialization as well as its social and economic activities may, to some extent, be stimulated and encouraged by exploring the power resources. The BOI's industry dispersal policy together with the above-mentioned power development are indispensable for the development of the region and therefore be materialized as soon as possible.

Fig. 10-1 Correlation between Percentage Share of Primary Industry to GNP and Per Capita Electricity Consumption per Annum



10-2 Socio-economic Effects of Power Development

If the recommendations given by the survey team are put into practice, the proposed socio-economic effects will be followings, which are divided into (1) direct effects brought by construction of the project and (2) indirect effects resulting from the completion of the project. Various data or conditions are required to make full analysis and quantification of these effects such as inter-industry table on regional basis and shadow price system prepared for all inputs necessary for the project. Since the data and materials obtained are not available for these quantitative analysis, the consideration is confined to qualitative evaluation and analysis.

(1) Direct effects brought by construction of the project

The direct effects will emerge from the year 1974 when, according to the proposed schedule, the construction of the project starts. As shown in Table 7-2 Vol. I, the investment schedule totals to US$ 37.7 million (252.2 million pesos) by 1987 which is to be spent on purchase, transportation and installation of equipments and on civil works for the construction of thermal plants. This will flow into the economic circulation. Whereas foreign currency expenditures which share 77 percent of the total project cost will be for purchasing the overseas-made equipments, whose socio-economic effects on Philippine economy as well as Visayas regional economy are not known without above-mentioned economic model. However, this expenditures of domestic currency will result in the increase of income and employment opportunity. In addition, the increase in income will be absorbed by the lower income class since it is generated by the expenditures on construction work, thus bringing about the better income distribution. The wage-earners in the Visayas, whose wage rates in terms of the opportunity cost are very low or sometimes almost zero, will have chance to increase the consumption if the they are employed in construction work. Consequently their participation in Visayas economy will further increase the income and from the national or

Table 10-1 Estimated Employment Creative

(man-month)

Year	Cebu	Visayas
1975	2, 100	3, 100
76	4, 900	9, 900
77	2, 700	4, 600
78	2, 400	7, 300
79	1, 700	8, 800
80	2, 400	14, 400
81	1, 000	8, 200
82	600	6, 200
83	2, 400	6, 700
84	1, 800	5, 400
85	3, 400	5, 200
86	2, 900	5, 900
87	-	1, 000
Total	28, 300	86, 700

regional point of view, may mitigate the critical income inequity issue. NEC announces that GNP of the Philippines in 1970 was 26,053 million pesos, of which the Visayas seemingly shared 16 percent or 4,060 million pesos. The domestic currency planned in the project cost is 250 million pesos. Since there is no remarkable public investment in the Visayas, this project will expectedly generate the income creation effects as well as employment creation effects.

(2) Indirect effects resulting from the completion of the project

The indirect effects can be summarized into two categories, namely (i) promotion of electrification and (ii) long-run stability or decrease of electric rate. The rural electrification, as described in the earlier chapter, is one of the main national objectives and is to be promoted through NPC coupled with NEA policy. The project aims at increasing the present electrified ratio to as high as 40 percent or approximately 4.6 million of 11.93 million Visayas inhabitants. This will result in enhancement of people's living standard and rural modernization. As for the second category, although there included a big unknown factor of the price of petroleum, the electric rate is considered to be lowered in the long-run, judged from the financial analysis of the project. This may also bring about the industrial development and the tilt of power consumption.

The example of MORESCO, an electric cooperative which uses power generated in Maria Cristina dam illustrates that the investment of 1 peso in electricity resulted in 5 pesos increase of electric appliance sales, 0.05 pesos increase of petroleum products sales and 5 pesos increase of manufactured products sales respectively. Moreover, if the project is executed, those existing private utilities will be relieved of power generation and will afford to promote the distribution of electricity. Eventually the rural electrification will conceivably be promoted by private utilities.

(i) Effects of electrification

Annual electrification ratio is scheduled as Table 10-3, which enables the present 7 percent to go high up. The example of MORESCO also shows that electrification will serve to mechanization of agriculture (use of irrigation pump, electric tiller etc.), popularization of electric appliances, improvement of sanitary conditions, building of new residences and creation of employment opportunity. (The milling plants, wood product manufacturing, welding shops and radio-TVrepair shops are reported to have newly set up in MORESCO's case). Those new equipments and facilities necessary for the modern life are not popular in the Visayas and are only seen in cities and its vicinities where electric power is supplied.

Moreover, as rural electrification gets under way, cultural and educational effects can be expected. Illiteracy in rural area will decrease and modern culture will be introduced to the area through popularization of radio and TV, thus serving to the one of the national objectives, decrease of population growth. The introduction of modern culture will also be beneficial in facilitating the inhabitants to understand the value system of modern society. The agricultural society of the Philippines are said to be very conservative and traditional, but those traditional ways of living and thinking are expected to be modernized in some respects by virtue of agricultural land reform now under way and of electrification. As one of the criteria for the economic development, the gap between the rich and the poor is sometimes used. Interpretation of this gap is whether or not the middle class of the society exists. In the Philippines, the growth of the new middle class which has political, economic and cultural power is awaited not only for solving the gap problem but for its active role played to be the step for country's take-off. For this purpose, as well as many policies, the increase of agricultural productivity and modernization of agricultural society through electrification are necessarily promoted.

In these senses, the completion of power projects in rural area will give rise to the social and economic development.

(ii) Effects of long-run stability or decrease of electric rate

As far as the financial analysis of the project is concerned, the electric rate will be stabilized or decreased in the long-run. What is here referred is, of course, the whole sale price which will emerge between NPC and utilities and the retail price to the final demanders, which should be treated as an internal politic problem, is not known clearly. However long-run stability of rate will have the effects of stimulating enterprises, industries and industrial complexes which are operating under full employment of their capacities due to the bottle-neck caused by power supply. The economic activities of these industries especially labor-intensive and export-oriented industries will be activated. Moreover those industries which are using the costly power generated by their own facilities — most of the industries in the region including Atlas mining are those type — will be able to push their cost down by obtaining the cheap and dependable power supplied by NPC. The price of 15.5 mills/kWh (10.2 centavos/kWh) under which the a-

Table 10-3 Population Projection and Proposed Served Population

Year	Cebue			Panay			Negros			
	Pop.	Served	%	Pop.	Served	%	Pop.	Served	%	Pop.
1976	1,852	564	30.4	2,367			2,412			743
1977	1,890	611	32.4	2,412	481	19.9	2,446	467	19.1	753
1978	1,930	661	34.2	2,458	542	22.1	2,480	563	22.7	764
1979	1,970	716	36.4	2,505	602	24.0	2,515	613	24.4	774
1980	2,012	773	38.4	2,552	670	26.3	2,550	714	28.0	785
1981	2,054	833	40.6	2,601	738	28.4	2,586	770	29.8	796
1982	2,097	896	42.7	2,650	820	30.9	2,622	829	31.6	807
1983	2,141	963	45.0	2,701	904	33.5	2,659	882	33.2	819
1984	2,186	1,032	47.3	2,752	964	35.0	2,696	944	35.1	830
1985	2,231	1,105	49.5	2,804	1,033	36.8	2,734	1,010	37.0	842
1986	2,279	1,178	51.7	2,858	1,099	38.5	2,772	1,062	38.3	854
1987	2,327	1,253	53.9	2,912	1,166	40.0	2,811	1,117	39.7	865

nalysis is made in the report is the average value of all whole prices from NPC to utilities in the Visayas and can possibly be decreased by 1987 to the value to about 75% of the above price, provided the conditions remain as they are.
In the other regions of the Visayas, the same can be expected because economy of scale will arise, which will be followed by the long-run stability and decrease of electric rate. This will clearly stimulate the activities of the enterprises in the Visayas.

Table 10-2 Expected Electric Rate*

(centavos/kWh)

	Cebu	Visayas Average
1976	11.66	11.46
77	10.59	10.45
78	8.78	9.85
79	8.78	9.38
80	7.77	8.31
81	7.70	8.58
82	7.84	9.18
83	7.24	8.38
84	7.10	8.24
85	7.04	8.04
86	6.83	7.84
87	6.77	7.57

* genrating cost of NPC at receiving end

(in thousand unit)

Bohol		Leyte			Samar			Total		
Served	%	Pop.	Served	%	Pop.	Served	%	Pop.	Served	%
		1,489			1,122			8,863	1,434	16.7
		1,512	281	19.6	1,139			10,152	1,840	18.1
		1,534	339	22.1	1,157			10,323	2,105	20.4
143	18.5	1,557	386	24.6	1,176			10,497	2,460	23.4
166	21.1	1,581	429	27.1	1,195			10,675	2,752	25.8
197	24.7	1,604	478	29.8	1,214			10,855	3,016	27.8
207	25.6	1,628	529	32.5	1,233			11,037	3,281	29.7
214	26.1	1,653	562	34.0	1,253	163	13.0	11.226	3,688	32.8
222	26.7	1,678	594	35.4	1,273	171	13.4	11,415	3,927	34.4
232	275.	1,703	625	36.7	1,293	179	13.8	11,607	4,184	36.0
243	28.4	1,728	656	38.0	1,314	189	14.4	11,805	4,427	37.5
256	29.5	1,754	688	39.2	1,335	199	14.9	12,004	4,679	39.0

The proposed electric charge share to the 1987 activity levels of household, commercial sector and industrial sector is safely said to be low in consideration of high electrification ratio and mass-power consuming tendency. If the retail price of electricity to the final demanders are kept at present level.

Table 10-4 Electric Charge Share

	1970			1987		
	Activity level (million pesos)	Electric charge (million pesos)	%	Activity level (million pesos)	Electric charge (million pesos)	%
Household expenditure	6, 100	15. 5	0. 25	15,700	247	1. 57
Commercial sector	1,740	9, 0	0. 51	3,850	132	3. 42
Industrial sector	2, 330	13. 4	0. 57	6,830	187	2. 73

Table 10-4 explains the relative low share of the electric charge, in view of the example of Japan where the charge shares 2 percent of household expenditures in 1970

In addition, this rate decrease will enable the final demanders to have savings resulting from resorting their energy to NPC. The value of this savings are not measurable from the data now available. Qualitative examples of such savings are such that will be brought by abandoning the cattle forces employed in agricultural sector and the generation by their own facilities now used in commercial and industrial sectors in cities. The quantitative measurement is as difficult as that of consumers' surplus between NPC and utilities in view of the data scarcity but there definitely exists, which should be counted as social economic benefits.

These effects are supposed to emerge from, according to the proposed schedule of the project, 1975. The promotion and fostering of export-oriented light industries, one of the main national objectives of the Philippines, are to be facilitated through electrification and power development as well as many policies concerning infrastructures. The completion of the project would be highly contributing to give rise to the social benefit exceeding the project cost.

APPENDIX

Appendix 1

PRESIDENTIAL DECREE NO. 40

ESTABLISHING BASIC POLICIES FOR THE ELECTRIC POWER INDUSTRY

WHEREAS, one of the primary concerns of the government in promoting the economic welfare of the people is to hasten the electrification of the entire country, more particularly the rural areas; and

WHEREAS, it is necessary to establish certain basic policies for the attainment of said objective;

NOW, THEREFORE, I, FERDINAND E. MARCOS, President of the Philippines, by virtue of the powers vested in me by the Constitution as Commander-in-Chief of all the Armed Forces of the Philippines, and pursuant to Proclamation No. 1081 dated September 21, 1972, and General Order No. 1 dated September 22, 1972, do hereby order and decree, as part of the law of the land, the following basic policies for the electric power industry.

1. The attainment of total electrification on an area coverage basis, which is a declared policy of the State, shall be effected primarily through:

a) The setting up of island grids with central/linked-up generation facilities.

b) The setting up of cooperatives for distribution of power.

2. The setting up of transmission line grids and the construction of associated generation facilities in Luzon, Mindanao and major islands of the country, including the Visayas, shall be the responsibility of the National Power Corporation (NPC) as the authorized implementing agency of the State.

a) Plant additions necessary to meet the increase in power demand of the area embraced by any grid set up by the NPC shall be constructed and owned by the NPC.

b) In areas not embraced by the NPC grid, the State shall permit cooperatives, private utilities and local governments to own and operate isolated grids and generation facilities, subject to State regulation.

3. The distribution of electric power generated by the NPC shall be undertaken by:

a) Cooperatives
b) Private utilities
c) Local governments
d) Other entities duly authorized subject to State regulation.

4. Within the area embraced by a grid set up by the NPC, the State shall determine privately-owned generating facilities which should be permitted to remain in operation.

5. It is the ultimate objective of the State for the NPC to own and operate as a single integrated system all generating facilities supplying electric power to the entire area embraced by any grid set up by the NPC.

6. The Power Development Council shall be expanded and strengthened to make it more effective in the planning and implementation of power and electrification projects and in the re-direction and re-orientation of the various sectors of the industry towards national development goals.

Done in the City of Manila, this 7th day of November, in the year of Our Lord, nineteen hundred and seventy-two.

(SGD) FERDINAND E. MARCOS
President

By the President:
(SGD) ALEJANDRO MELCHOR
Executive Secretary

Appendix 2 Estimation of Capital Investment Required for Rural Electrification in Cebu Island

A2-1 Summary

Estimation was made on the amount of fixed capital investment to be put out mainly in distribution plants through electric cooperatives and electric utilities in order that forecasted rural load of 107,770 MWh may be attained by 1990. As a result of an approximate estimate, a total amount of some 80.5 million pesos was considered necessary.

A2-2 Analyses on Fixed Capital Investment in Distribution Plants by Cebu Electric Cooperative

According to the Feasibility Report for Cebu Electric Cooperative, load forecast and corresponding fixed capital investment in distribution plants are as tabulated in Table A2-1.

For the purpose of analysis, load growth is classified into the following categories for the convenience's sake.

Table A2-1 Load and Investment in Cebu Electric Cooperative

Year of Operation		Load (MWh)	Investment (thousand pesos)	Load increase investment for expansion (MWh)
Construction		—	8,055	—
1	1974	5,676	1,299	—
2	1975	7,440	597	1,196
3	1976	9,960	762	1,775
4	1977	12,096	652	1,140
5	1978	14,352	838	1,045
6	1979	17,244	705	1,457
7	1980	20,424	745	1,456
8	1981	23,712	745	1,246
9	1982	27,518	791	1,435
10	1983	31,524	745	1,254
	Total	—	15,934	12,004

(a) Initial load

To be picked up by initial fixed capital investment. (An abrupt uprise in electrification ratio is expected.)

(b) Load increase by new customers owing to fixed capital invested every year. (A gradual increase in electrification ratio is achieved.)

(c) Growth in consumption per customer

Based on the figures shown in Table A2-1, the correlation between load and fixed capital investment is quantatively studied below.

(1) Initial Fixed Capital Investment and Initial Load

Assuming that initial fixed capital investment is the sum of investment during construction and a half of investment in the first year of operation, then

Initial fixed capital investment

$$= 8{,}055{,}000 + (\frac{1}{2} \times 1{,}299{,}000)$$

$$= 8{,}705{,}000 \text{ (pesos)}$$

Initial fixed capital investment per initial load

$$= 8{,}705{,}000 \; / \; 5{,}676$$

= 1,530 (pesos/MWh)

(2) Load Increase Owing to Fixed Capital Investment for Expansion

It is assumed equivalent to gross load less growing load of the previous year's customers. According to the said Feasibility Report, rate of growth in consumption per customer is expected to be ranging from 13 to 8 percent each year, that is, an average of 10 percent per year. Therefore,

Total of load increase owing to fixed capital investment

= 12,004 (MWh)

Total of fixed capital investment for expansion

= 15,934,000 - 8,705,000

= 7,229,000 (pesos)

Averaged fixed capital investment per MWh load increase

= 7,229,000 / 12,004

= 600 (pesos/MWh)

Incidentally, initial fixed capital investment is put out principally in constructing main facilities such as primary distribution lines, and fixed capital investment for expansion is used for extending consumer-end facilities such as secondary distribution lines.

A2-3 Cost Estimation for Rural Electrification

In accordance with the result of analyses stated in the preceding paragraph, cost estimation was made for rural electrification of the entire island of Cebu based upon the following assumptions.

(a) Disregarding difference in the geographical conditions in various parts of the island, the correlation between load and capital investment, as observed in the case of Cebu Electric Cooperative, is assumed uniformly applicable to the whole area.

(b) Fixed capital investment per MWh load increase is equivalent to the mean value of the initial fixed capital investment per initial load and the fixed capital investment for expansion per MWh load increase, as derived in the preceding paragraph, that is, approximately 1,100 pesos per MWh increase.

(c) Only new distribution plants are considered, not depending on existing distribution lines in rural areas as they are to become obsolete sooner or later.

It will be noted from Table A2-2 that the annual gross load less load of customers of the previous year increasing at 7 percent annually will leave 55,600 MWh in the accumulated total during 1974 to 1990. Such accumulated total may be considered as an increment derived from the fixed capital investment for expansion.

Consequently, based on the above assumption (b), estimated capital investment sums up to 1,100 x 55,600 = 61,200,000 (pesos). This estimated capital investment only includes the investment in distribution plants after 1974 when Cebu Electric Cooperative goes into operation, and does not include the capital investment during construction of the said cooperative.

According to the Feasibility Report, it will install its own generating plants to meet demand within the area. After 1977, however, when the Cebu Power Grid is completed by NPC, there will be no necessity for the Cooperative to install generating plants. Therefore, the fixed capital investment by Cebu Electric Cooperative is for the following facilities in addition to fixed capital investments for expansion included in the foregoing.

Distribution plant (during construction)	8,055,000	pesos
Transmission plant (during construction)	681,000	pesos
Substation plant (during construction, 5MVA 1978 2x 5MVA)	8,039,000	pesos
Generation plant (during construction 3x1.5MVA) 1975 1.5MVA)	6,180,000	pesos
General plant (during construction, 1978 & 1983)	1,290,000	pesos
Total (not including contingencies)	19,245,000	pesos
Adopt	19,300,000	pesos

The sum of these cost estimations, that is, 61,200,000 + 19,300,000 = 80,500,000 (pesos) is the total fixed capital investment to be made by electric cooperatives and electric utilities including Cebu Electric Cooperative, for rural electrification of Cebu island.

Table A2-2 Load Forecast for Rural Area

n	Year	Load: Ln (MWh)	Load increase owing to investment:
0	1974	7,360	—
1	1975	9,580	1,710
2	1976	12,080	1,830
3	1977	14,950	2,020
4	1978	18,210	2,210
5	1979	21,890	2,410
6	1980	26,050	2,630
7	1981	30,740	2,870

Table A2-2 Load Forecast for Rural Area (cont'd)

n	Year	Load: Ln (MWh)	Load increase owing to investment:
8	1982	36,000	3,110
9	1983	41,920	3,400
10	1984	48,540	3,690
11	1985	55,950	4,010
12	1986	64,220	4,350
13	1987	73,440	4,720
14	1988	83,700	5,120
15	1989	95,110	5,550
16	1990	107,770	6,000
			Total - - 55, 630*

* Let Ln = load in n th year (MWh)

r = rate of increase for consumption per customer (7% per year)

dLn = load increase due to investment (MWh)

Then,

$dLn = Ln - (1 + r)L_{(n-1)}$ (n = 1, 2, . . . , 16)

$$\sum_{n=1}^{16} dLn = \sum_{n=1}^{16} Ln - (1+r)\sum_{n=1}^{16} L_{(n-1)}$$
$$= L_{16} - L_0 - r\sum_{n=1}^{16} Ln$$
$$= 55,630 \text{ (MWh)}$$

Appendix 3 System Analyses

(1) Power Flow Analyses

After power and reactive power of the system were made known by power flow calulation, transformer tap settings were selected in a manner to maintain suitable operating voltage of the system.

(a) In Cebu Grid, power source will be centralized at one place, and the 69 kV transmission lines will be extended over a long distance to connect to 13.8 kV distribution lines which will cover the entire island. Voltages at places far from the power plant would fluctuate largely with the variation of load. Therefore, tap changers will be installed at the step-up substation to regulate 69 kV and at 69 kV/13.8 kV substations 13.8 kV to minimize the voltage fluctuation of the grid.

(b) On-load tap changers to be installed on the 69 kV side of step-up transformers will have a tap width of $\pm$ 5 percent so that the voltage of 69 kV grid can be maintained within a fluctuation range of a few percent.

(c) To regulate the 13.8 kV distribution voltage, on-load tap changers with a tap width of 102.5 to 92.5 percent will be installed on 69 kV/13.8 kV transformers.

(d) When the 13.8 kV distribution capacity becomes short due to increase in demand, or when the voltage drop or distribution loss becomes large, 69 kV lines should be constructed at such places like from Bago to Medellin, Bogo from Sogod to Tabuelan and from Toledo to Asturias. Such extension of transmission line is expected to be made by 1990.

(e) Power plants were supposed to be built near Naga to the south of Cebu City in 1987 and 1990, and connected with VECO system by a 230 kV transmission line. Power flow on this line would be about 220 MW in 1990.

(2) Short Circuit Capacity

Since the short circuit capacity of 115 kV system is estimated to be about 2,000 MVA in 1990, capacity of a circuit breaker should be more than 3,500 MVA. The short circuit capacity of 69 kV system will be 110 MVA to 1,100 MVA at the maximum in 1990 and 89 MVA to 350 MVA at the minimum during off peak hours in 1978. The short circuit capacity of 13.8 kV distribution line near to 69 kV substation will be 40 MVA to 100 MVA at the maximum in 1990 and 30 MVA to 50 MVA at the minimum during off peak hours in 1978.

One line grounding current of 69 kV system, if occurred near the power plants, will be larger than three phase short circuit current, and it will be 60 to 70 percent of three phase short circuit at a place remote from the power plant.

(3) *Transient Stability*

The system, after the power plants are constructed to the south of Cebu City, is confirmed through transient stability studies to be stable. Generators will not step out by single circuit failure of transmission.

Fig. A-1 Power Flow at Peak Time in 1978

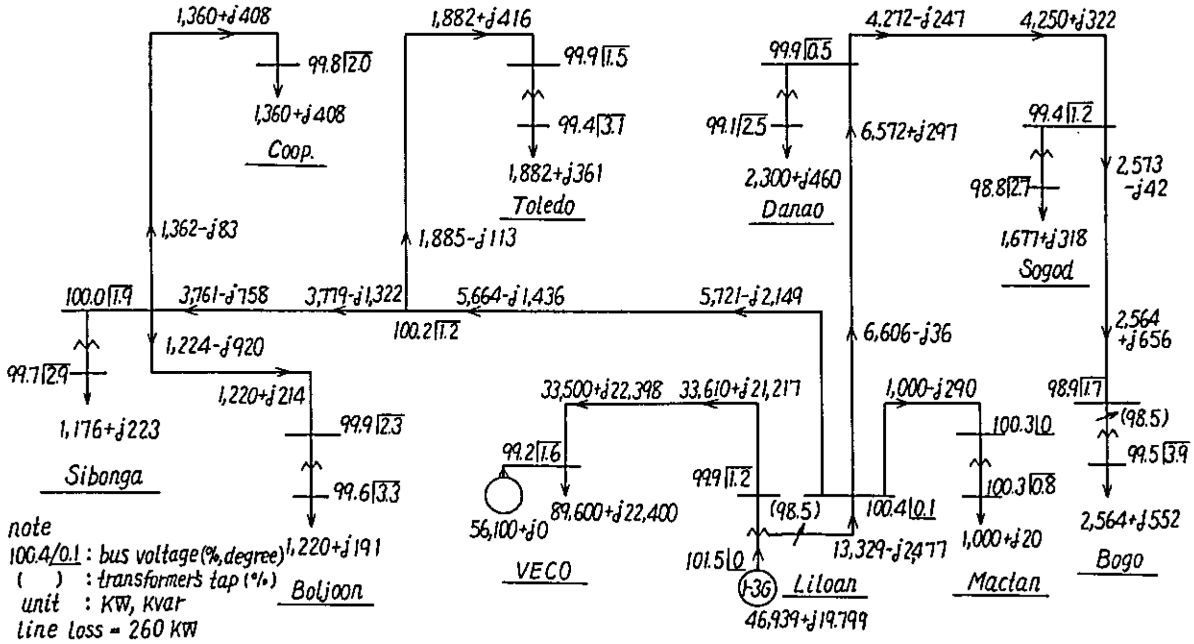


Fig. A-2 Power Flow at Off Peak Time in 1978

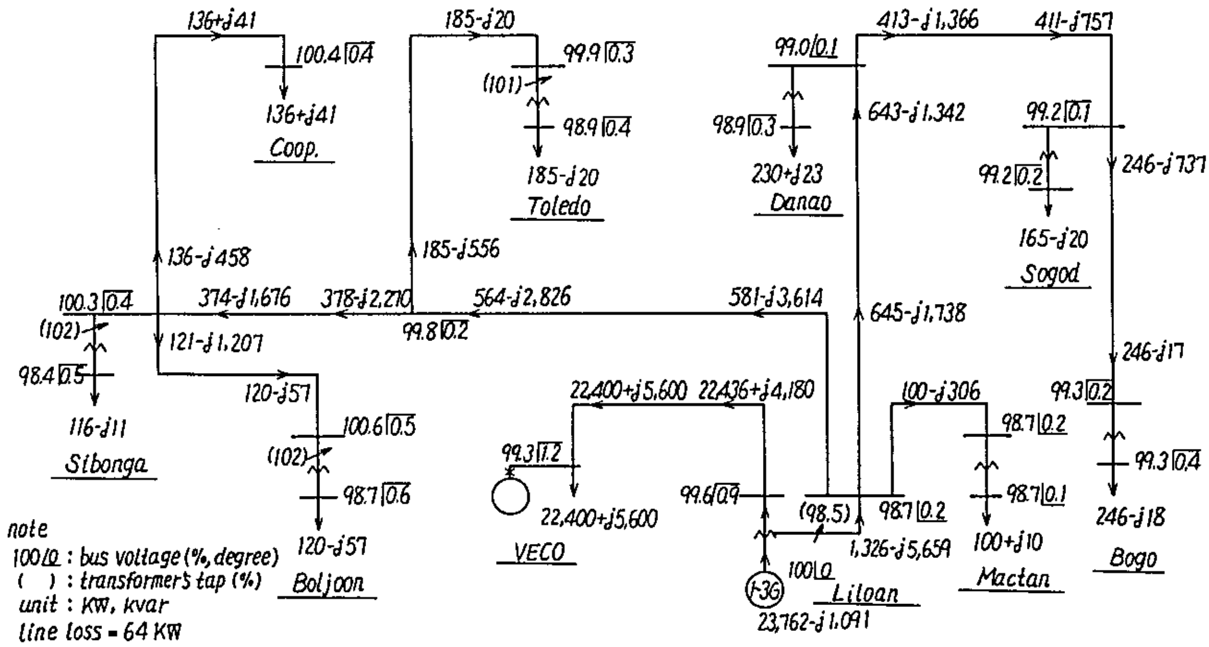


Fig. A-3 Power Flow at Peak Time in 1985

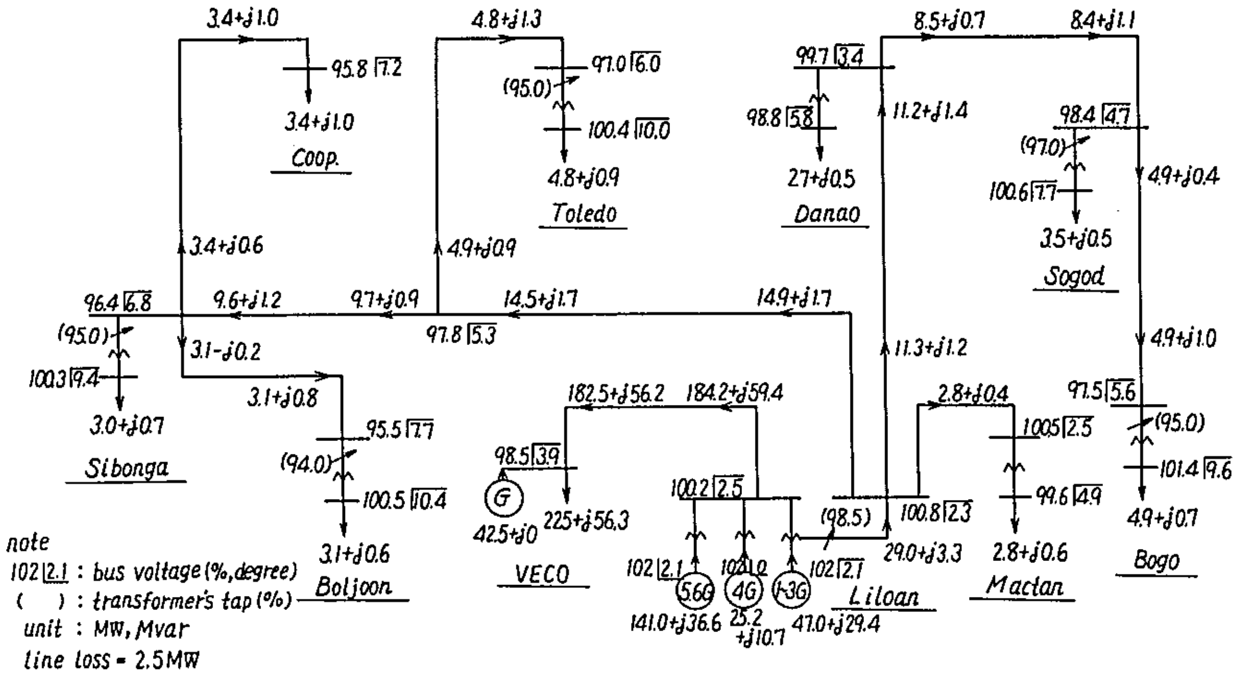


Fig. A-4 Power Flow at Peak Time in 1987

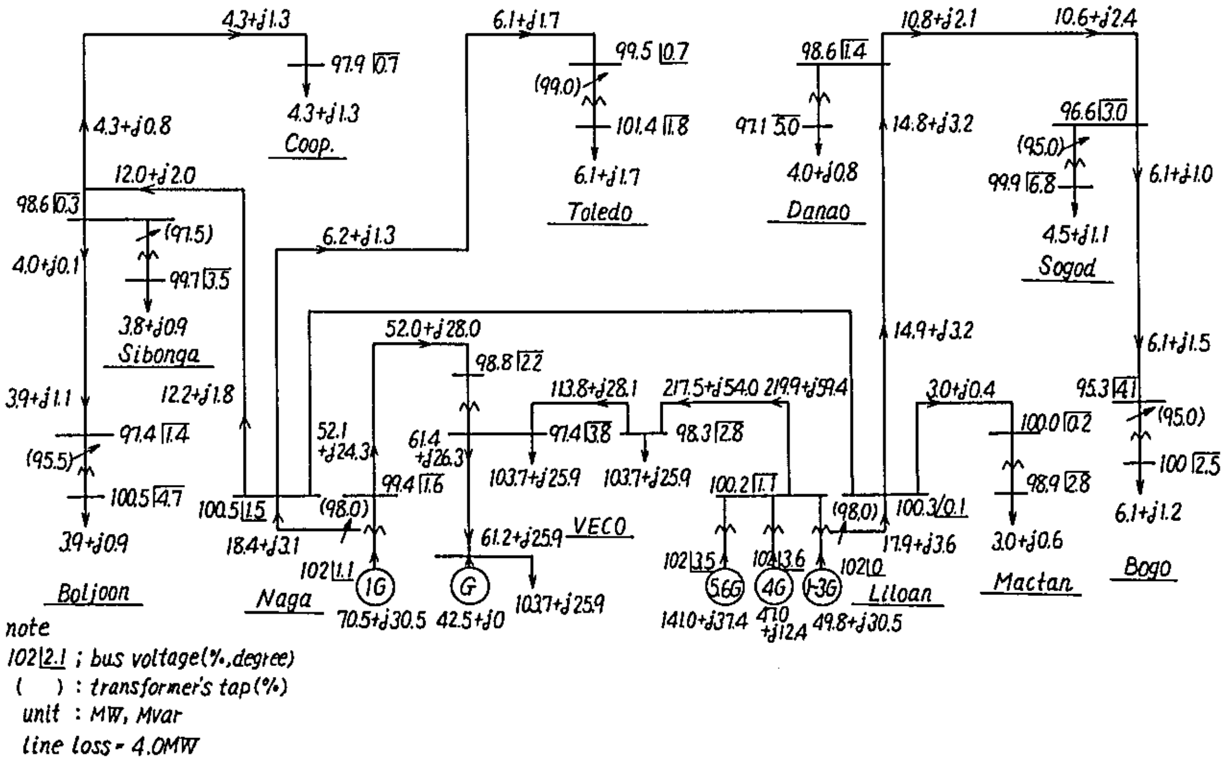
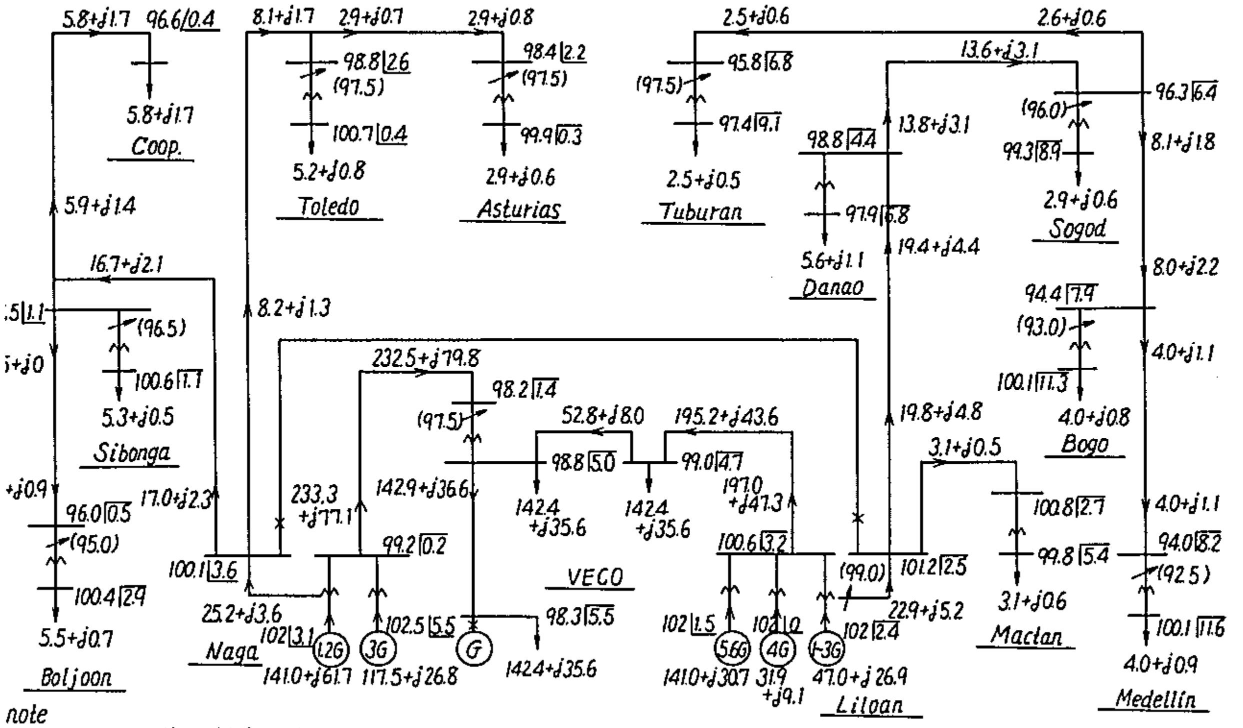
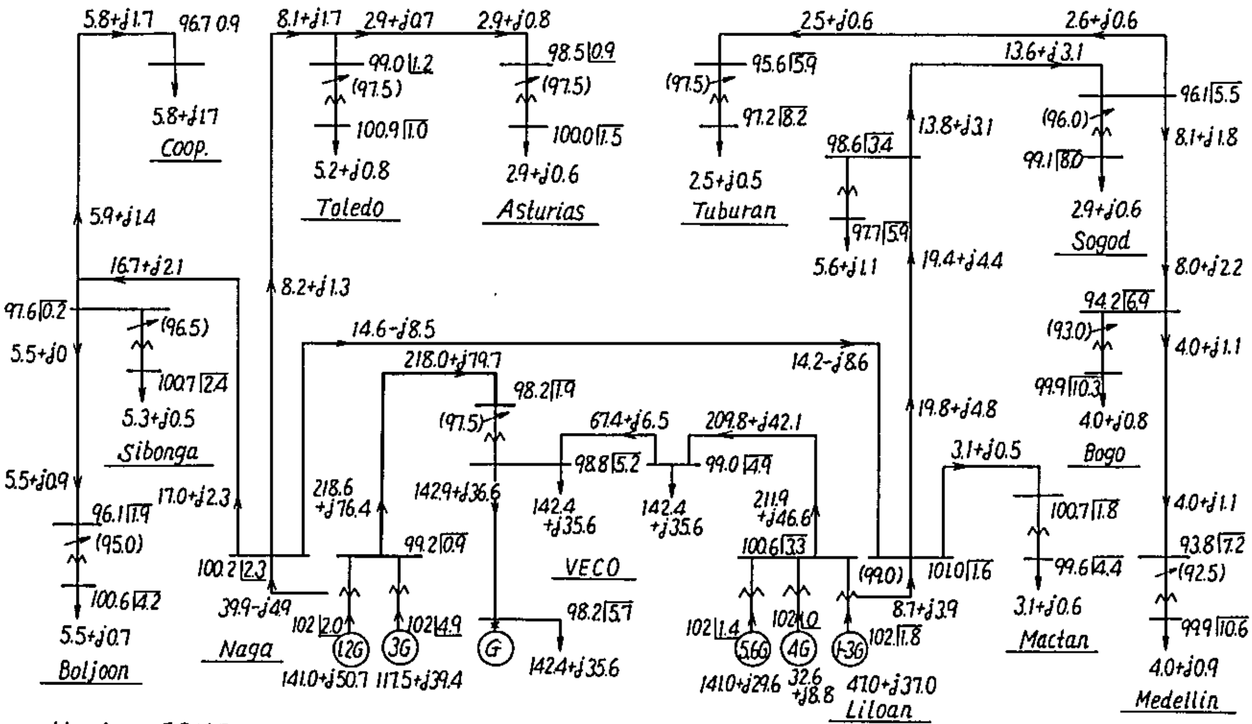


Fig. A-5 Power Flow at Peak Time in 1990



note
102∠1.5 : bus voltage (%,degree)
( ) : transformer's tap (%)
unit : MW,Mvar
line loss = 4.4 MW

Fig. A-6 Power Flow at Peak Time in 1990 (Loop Operation)



Line loss = 5.0 MW

Fig. A-7 Three Phase Short Circuit Capacity at Peak Time in 1978

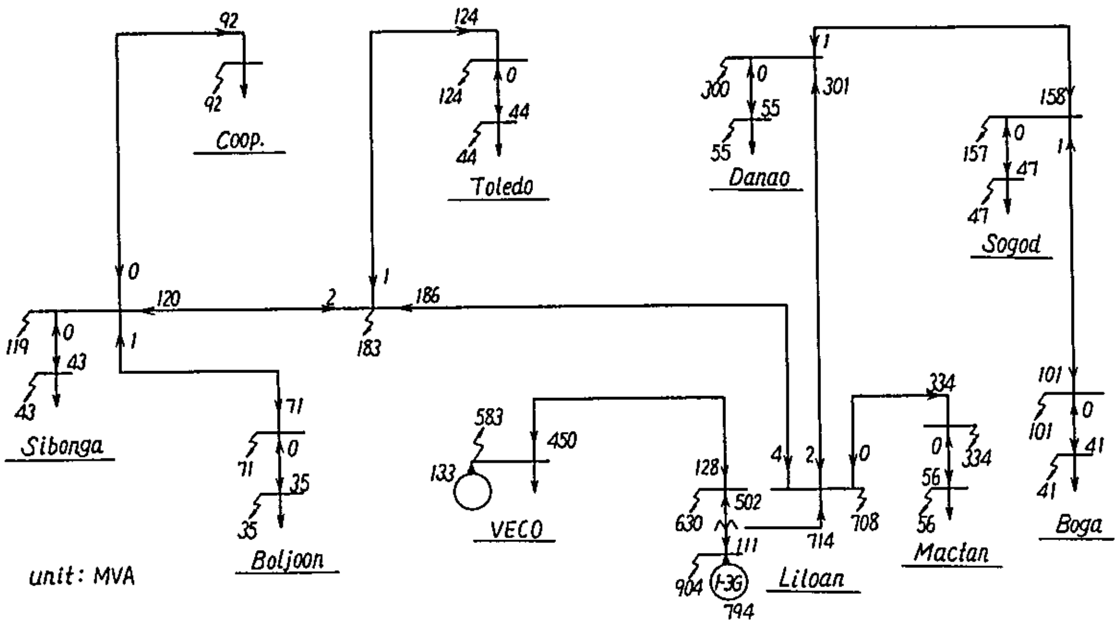


Fig. A-8 Three Phase Short Circuit Capacity at Off Peak Time in 1978

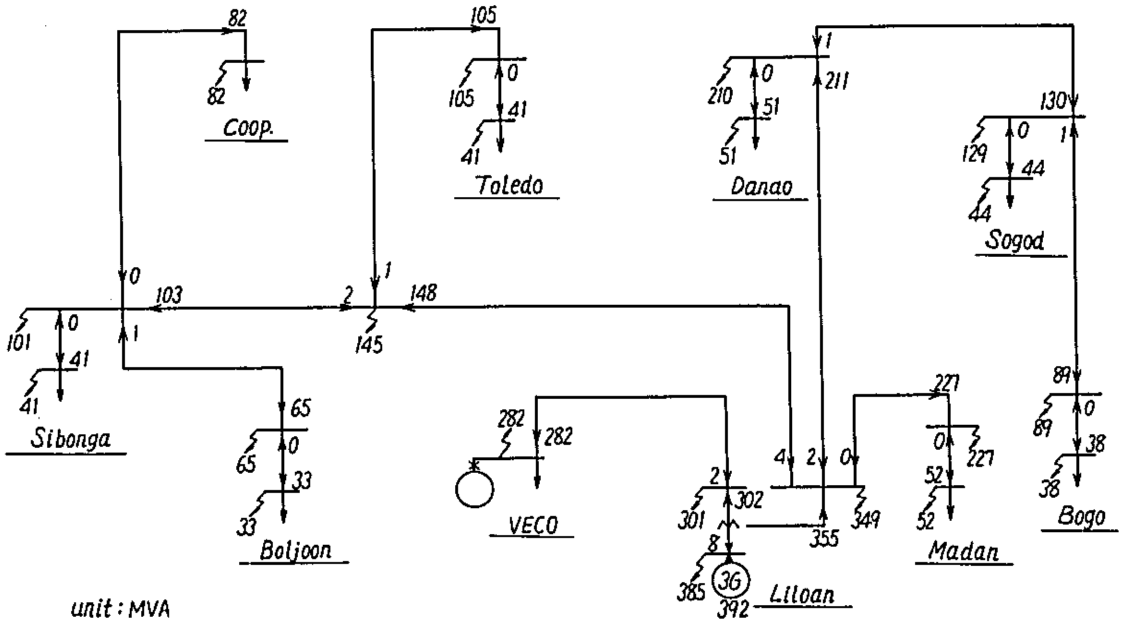


Fig. A-9 Three Phase Short Circuit Capacity in 1985

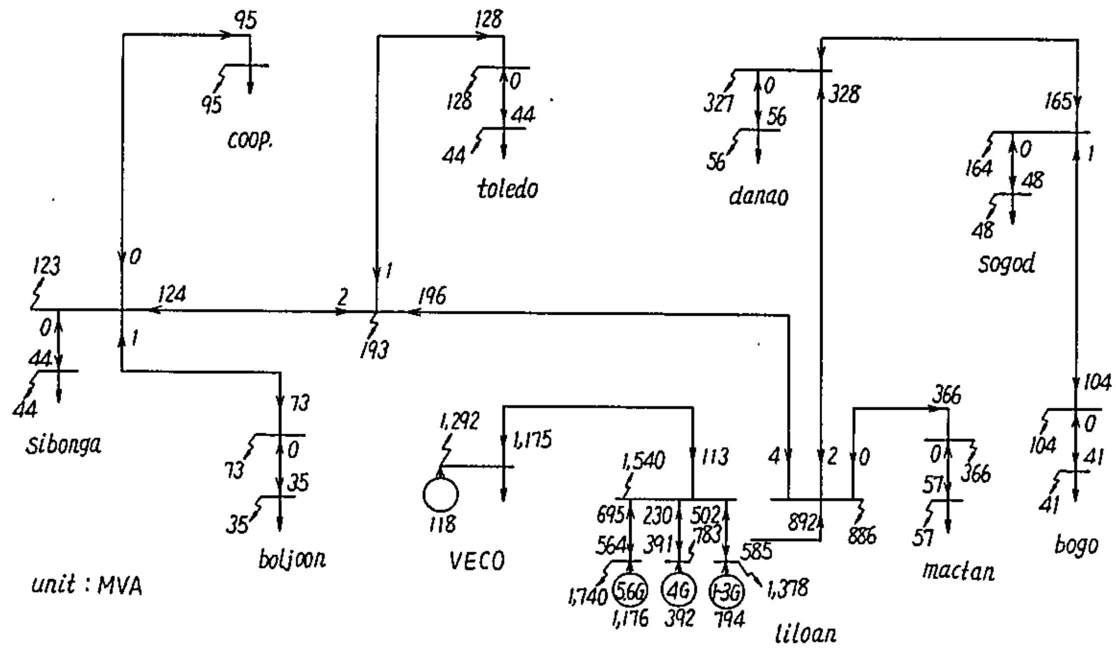


Fig. A-10 Three Phase Short Circuit Capacity in 1987

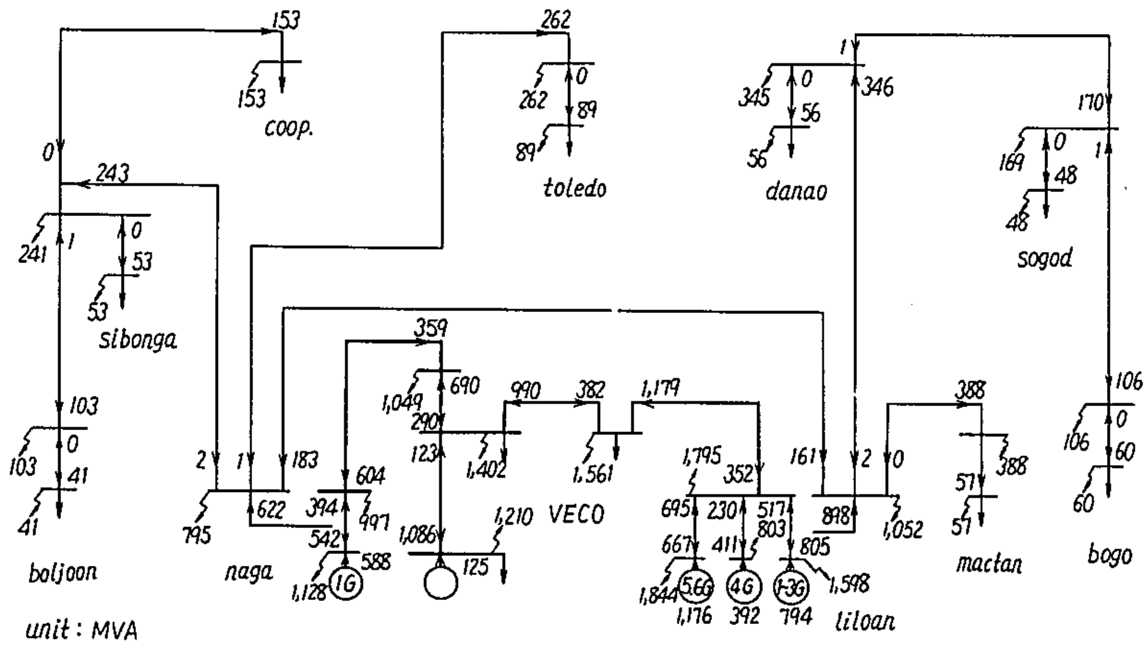


Fig. A-11 Three Phase Short Circuit Capacity in 1990

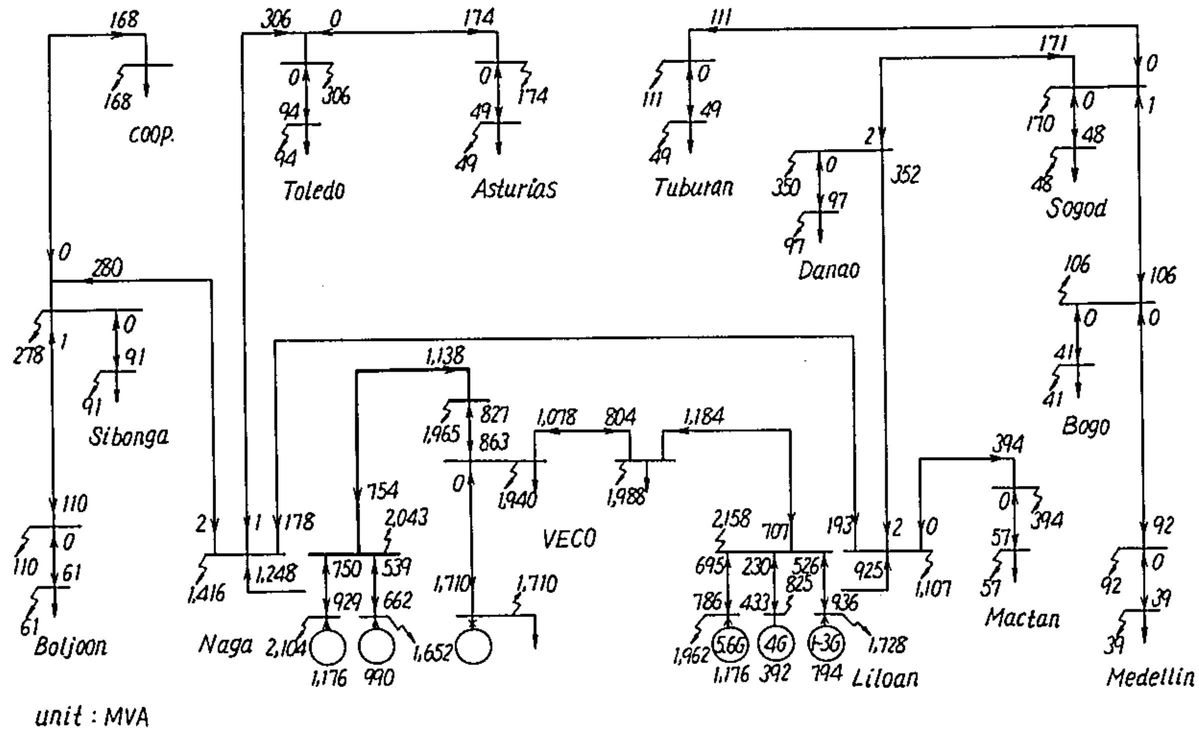


Fig. A-12 Percent Impedance Map for Positive Phases Sequence in 1990

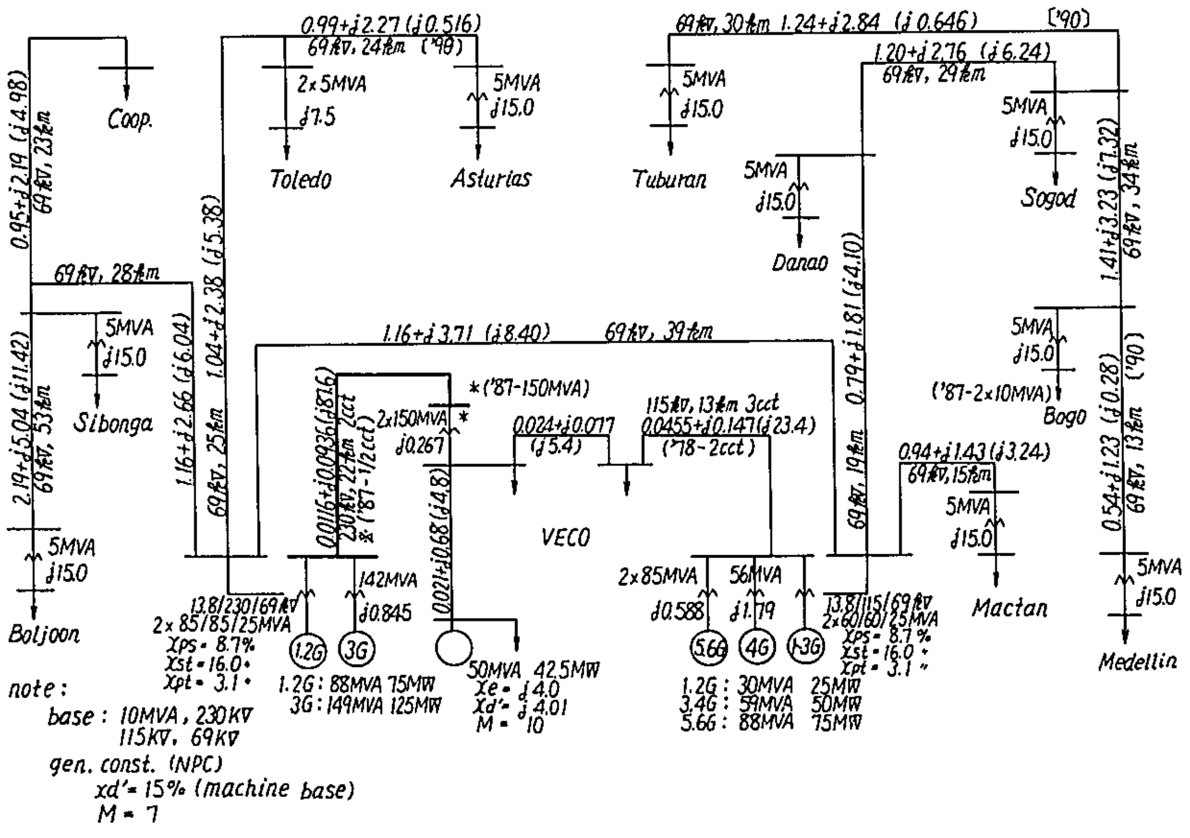


Fig. A-13 Swing Curve of Transient Stability in 1987 Peak
LILOAN-BANILAD Line 1 cct 3 lg, C. B. Open (0. 14 Sec)

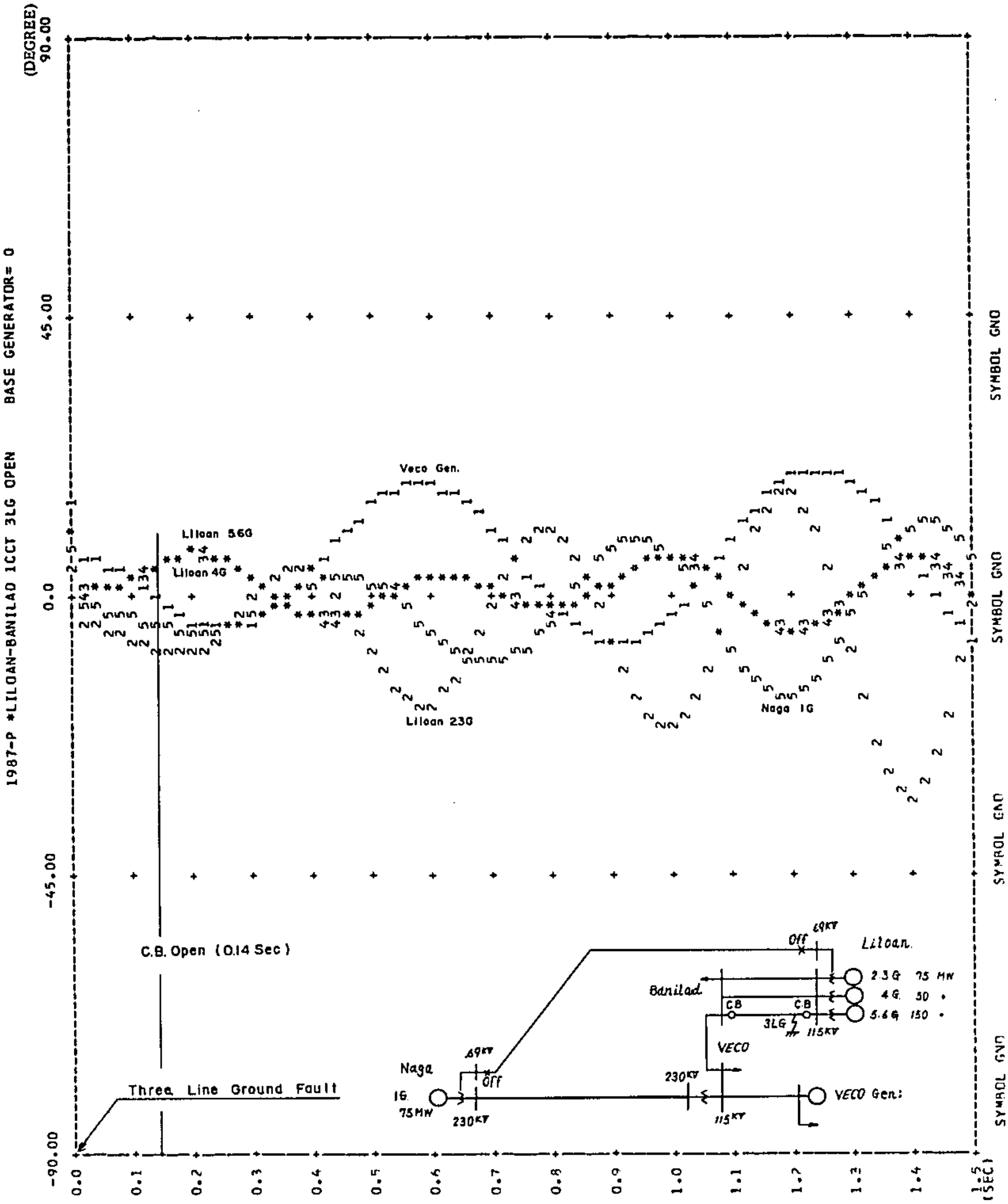


Fig. A-14 Swing Curve of Transient Stability in 1987 (Loop Operation)
NAGA-VECO Line (230 kV) 3 lg, C.B. Open (0.1 Sec)

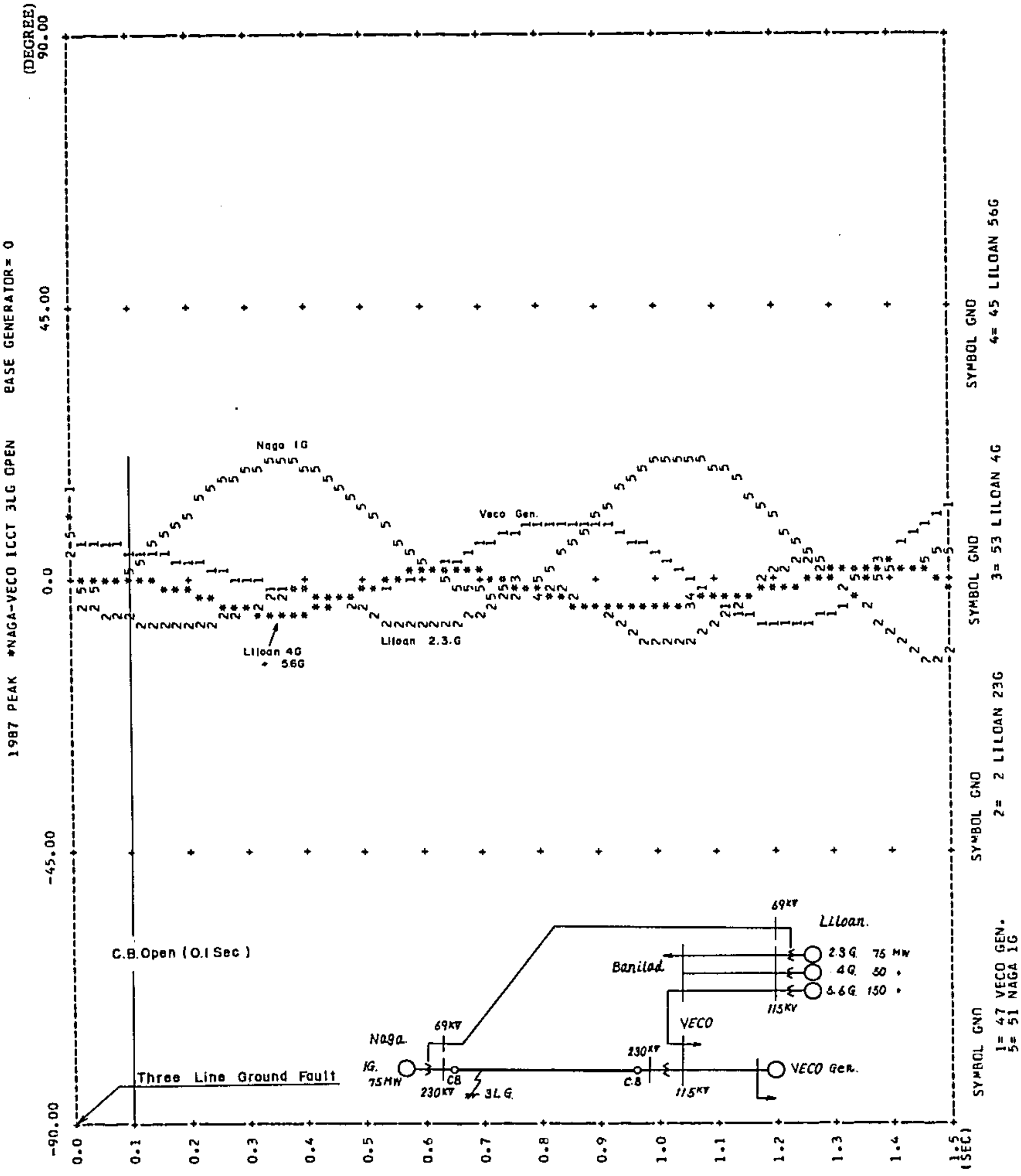


Fig. A-15 Swing Curve of Transient Stability in 1990
LILOAN-BANILAD Line 1 cct 3 lg, C. B. Open (0. 14 Sec)

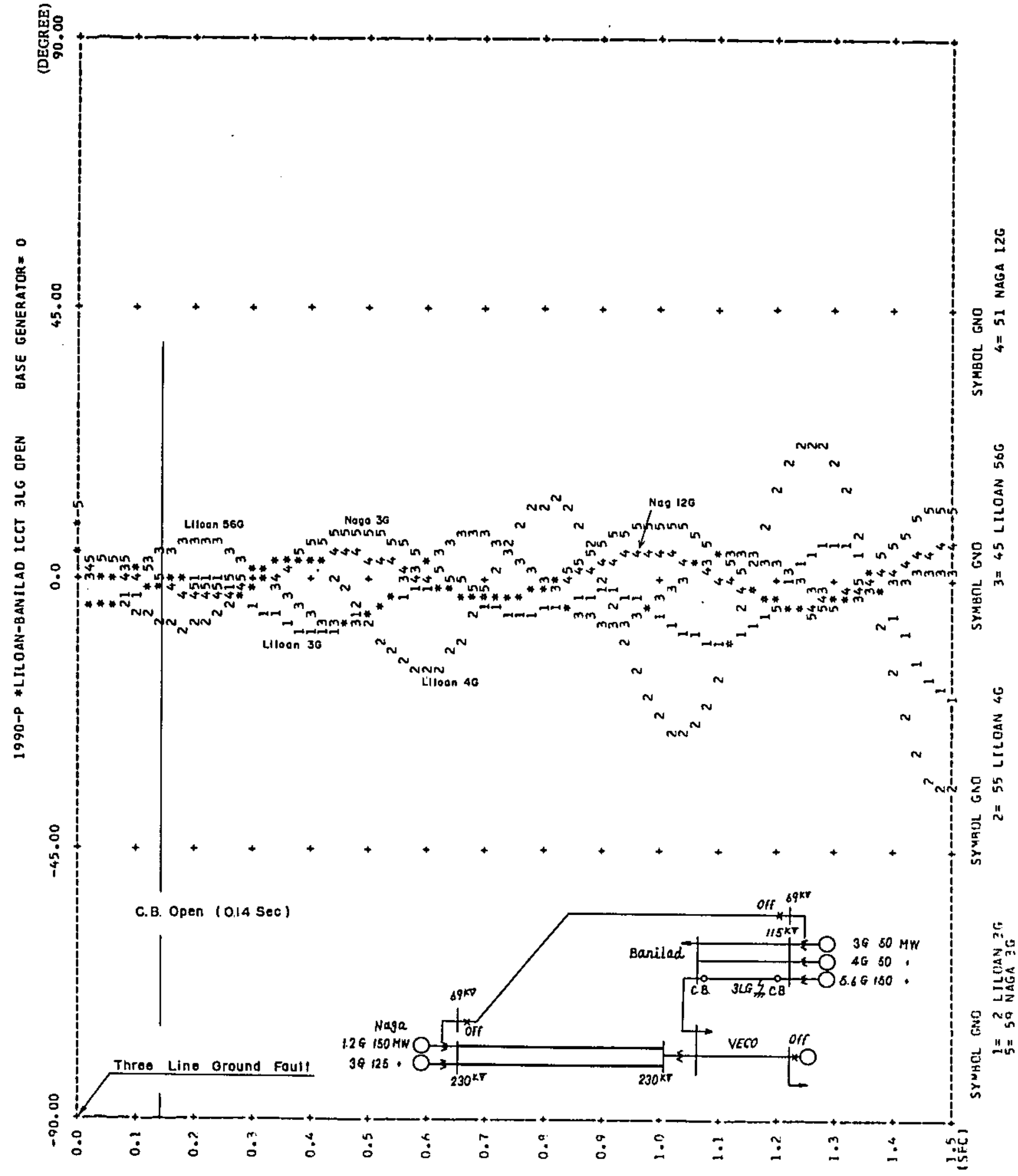


Fig. A-16 Swing Curve of Transient Stability in 1990
NAGA-VECO Line (230 kV) 1 cct 3 lg, C. B. Open (0. 1 Sec)