BASIC DESIGN STUDY REPORT

ON

DIESEL POWER GENERATOR SUPPLY PROJECT

IN

THE CO-OPERATIVE REPUBLIC OF GUYANA

NOVEMBER 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

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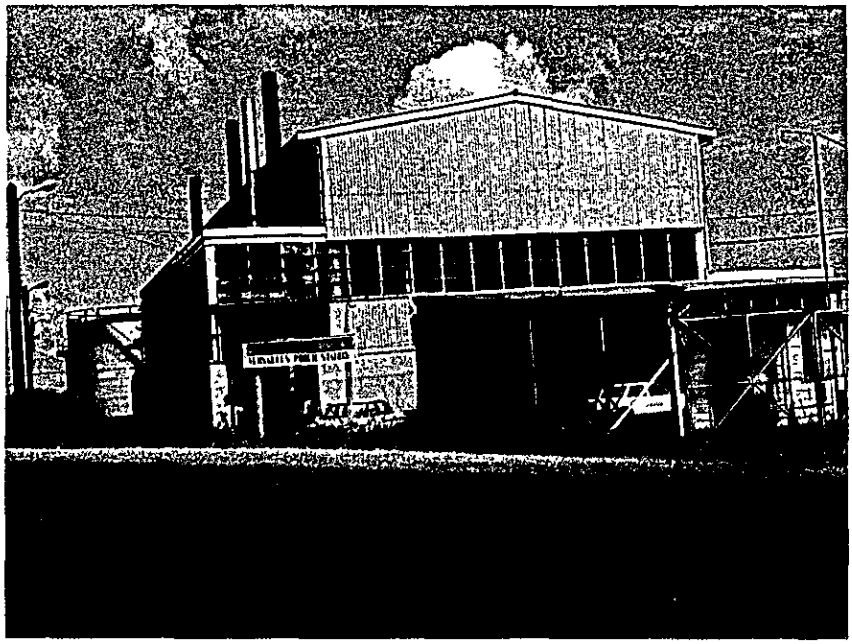
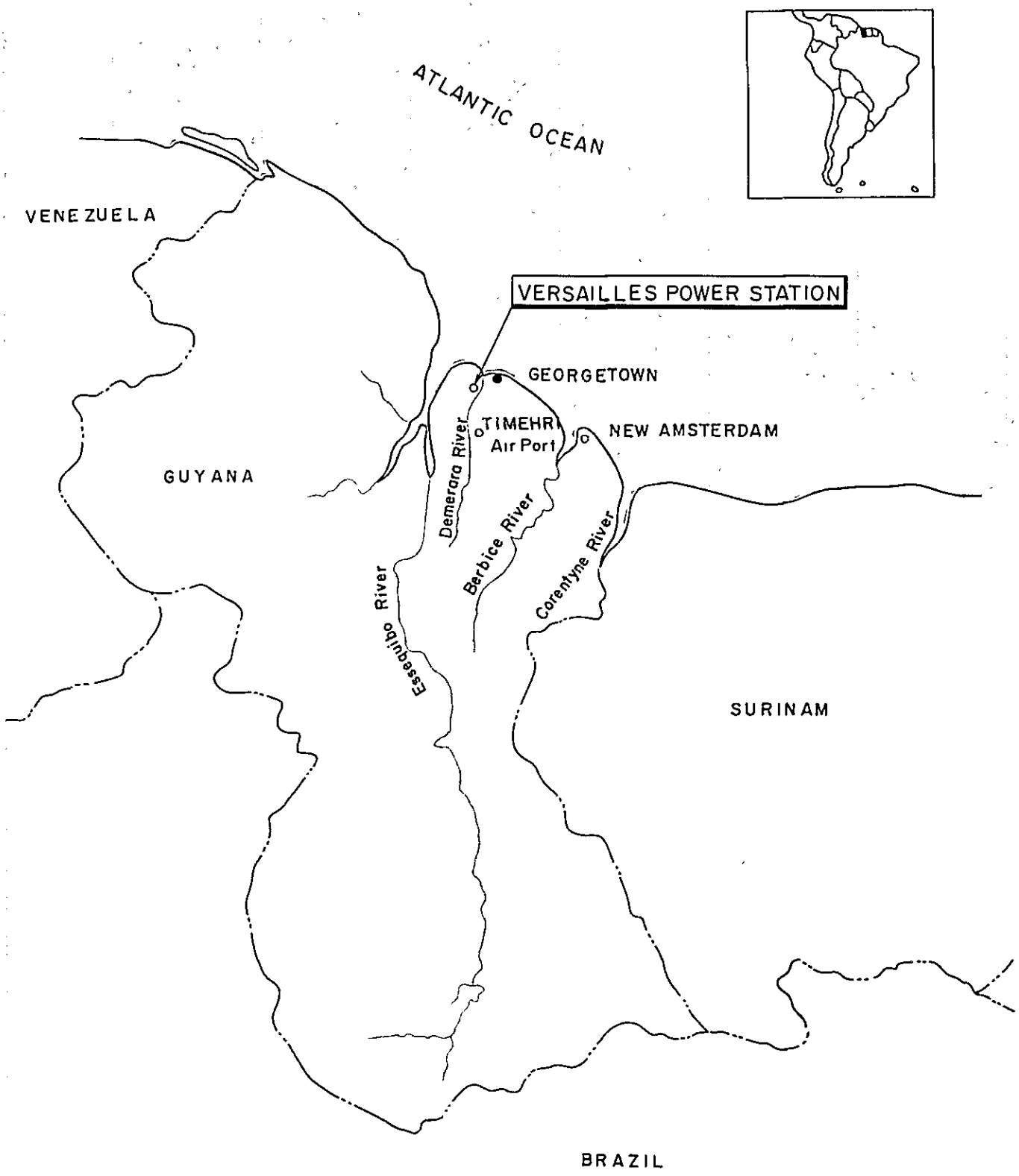
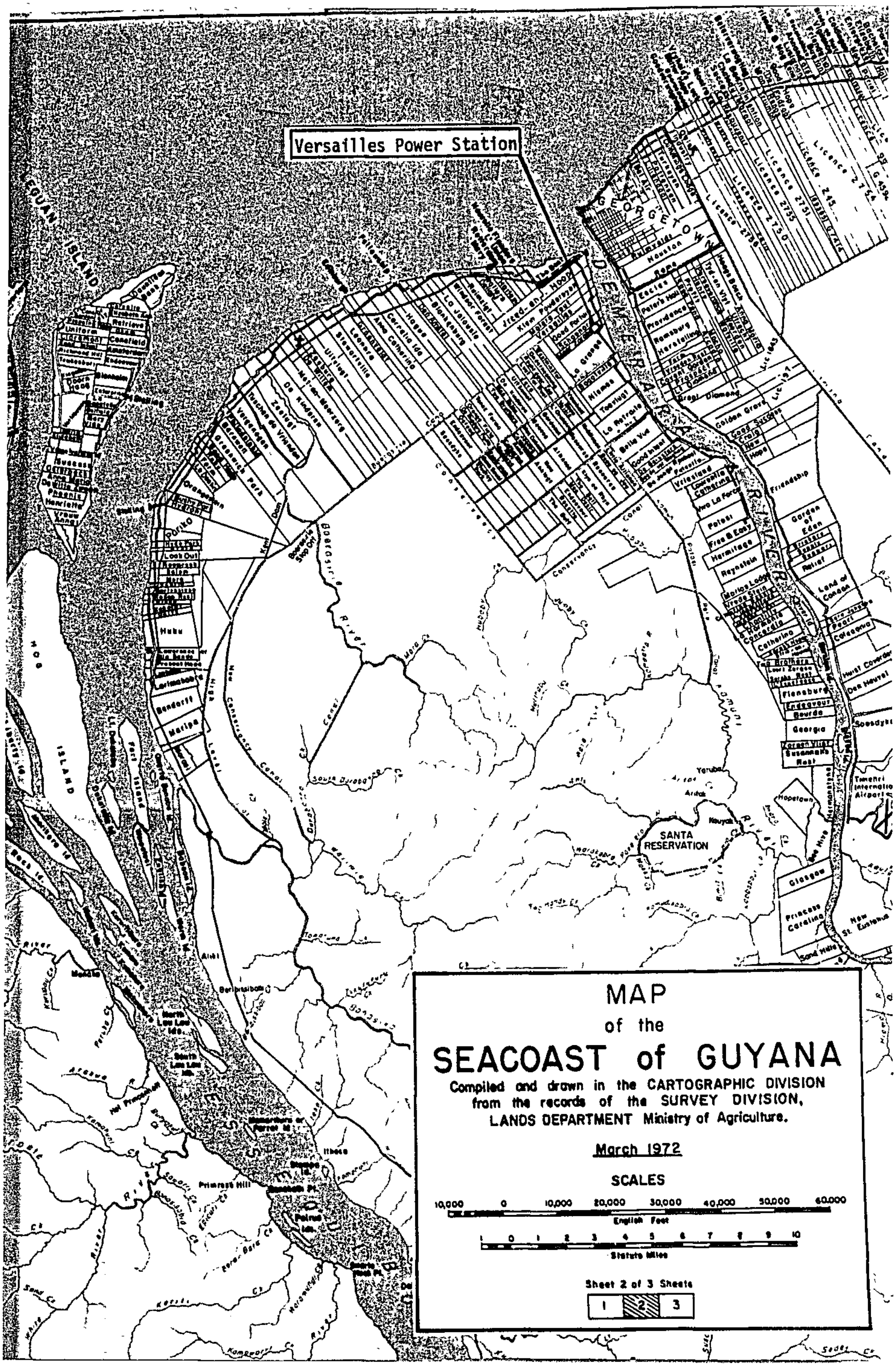


General View of Versailles Power Station

Existing Diesel Generaring Unit Nos. 1 and 2

GENERAL MAP


ATLANTIC OCEAN
VENEZUELA
VERSAILLES POWER STATION
GEORGETOWN
TIMEHRI
Air Port
NEW AMSTERDAM
GUYANA
Demerara River
Berbice River
Corentyne River
Essequibo River
SURINAM
BRAZIL



Versailles Power Station
SANTA RESERVATION
MAP
of the
SEACOAST of GUYANA
Compiled and drawn in the CARTOGRAPHIC DIVISION
from the records of the SURVEY DIVISION,
LANDS DEPARTMENT Ministry of Agriculture.
March 1972
SCALES
English Feet
Statute Miles
Sheet 2 of 3 Sheets

PREFACE

In response to the request of the Government of the Co-operative Republic of Guyana, the Government of Japan decided to conduct a basic design study on the Diesel Power Generator Supply Project and entrusted the survey to the Japan International Cooperation Agency (JICA). The JICA sent to Guyana a survey team headed by Mr. Tetsuo Amagai, Project Management Division, Grant Aid Department, JICA from September 4th to September 22nd, 1983.

The team had discussins with the officials concerned of the Government of Guyana and conducted a field survey in Georgetown area. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Co-operative Republic of Guyana for their close cooperation extended to the team.

November, 1983

Keisuke Arita
President
Japan International Cooperation Agency

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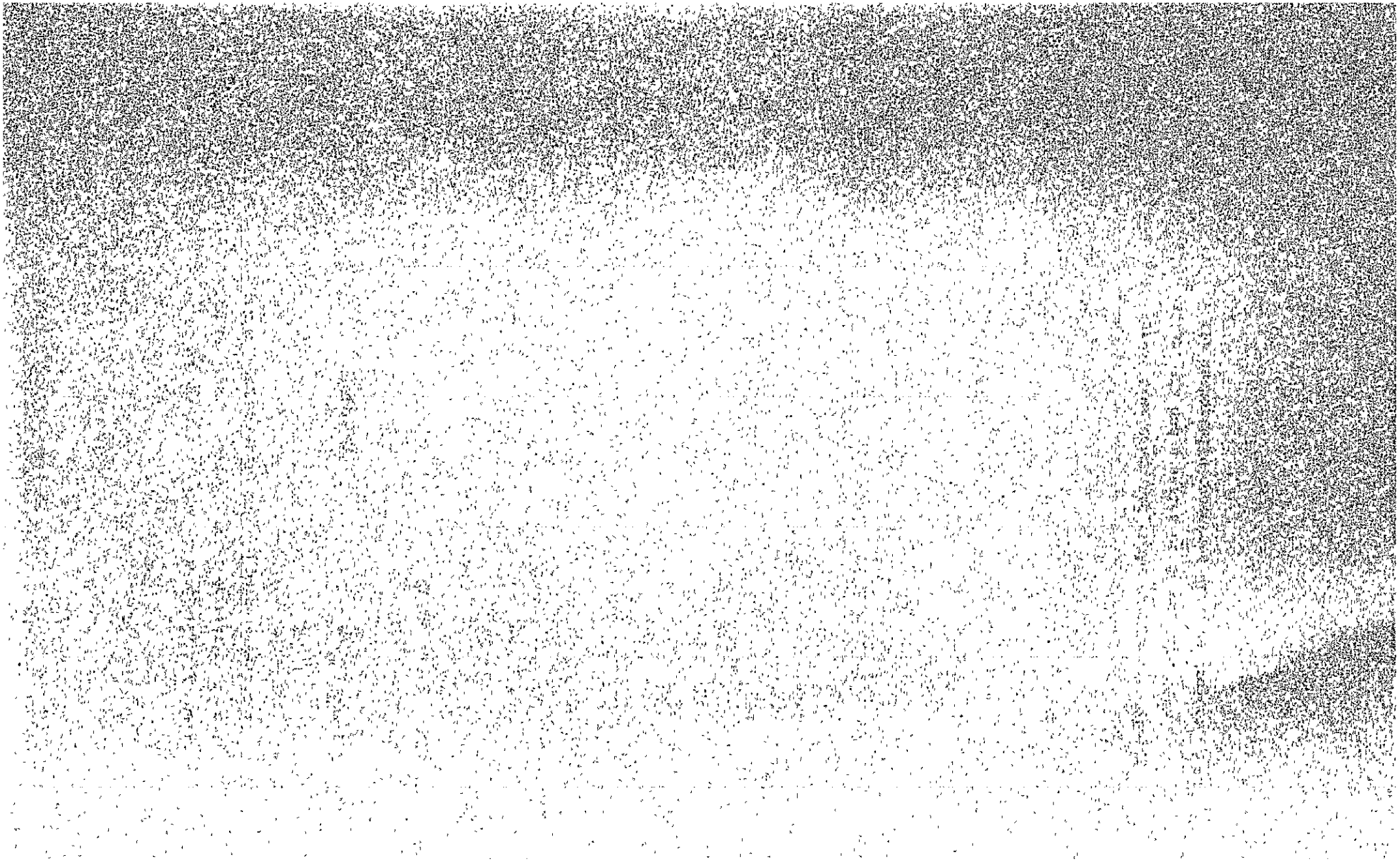
SUMMARY



SUMMARY

The Co-operative Republic of Guyana has an area of land slightly smaller than that of the main land of Japan. Guyana's total population is only around 800,000. Out of this, approximately 200,000 persons reside in Georgetown, the capital of Guyana, and the rest dwell in areas along the coastlines of the Atlantic Ocean and on river banks. The Guyana Electricity Corporation (GEC) supplying electricity to consumers has six (6) independent supplied areas throughout the country. Fifteen (15) generating units with a rated capacity of 82 MW are installed at power stations in Georgetown Electric Power System which provides 80% of total energy supply. At present seven (7) units out of the total number of the generating units are in-operative while other operational ones can hardly generate required capacity. This is attributed to the difficulty in importation of parts necessary for repair of those generating units due to deterioration in the balance of international payments of Guyana effected by stagnation in production of her major export items since 1977.

Under these circumstances, a shortage of electricity supply to meet requirements in the supply areas of Georgetown Electric Power System resulted in load shedding that had been unavoidably executed since 1977.

Giving serious consideration to the status-quo of such electricity supply essential for maintaining people's daily life and domestic industries, the Government of Guyana is currently making strenuous efforts to materialize systematic rehabilitation and development of existing power stations as a national development plan.

Therefore, the Government of Guyana has made a request to the Government of Japan for extending Grant Aid for implementation of the Diesel Power Generator Supply Project at Versailles Power Station. In response to the request made by the Government of Guyana, the Government of Japan through the Japan International Cooperation Agency dispatched a survey team to Guyana for the sole purpose of conducting a basic design study for the requested Project from the 4th to 22nd of September, 1983. During its stay in Georgetown, the survey team conducted field surveys and collection of data and information, and had a series of discussions with responsible officials of the authorities concerned with the Project.

Versailles Power Station is located about 30 km south-west of Georgetown, the capital of Guyana, and supplies electricity mainly to the west Demerara area within the Georgetown Electric Power System areas. This power station was commissioned in 1972 and has four (4) units of diesel engine generators. Two (2) of the four (4) units are in-operative because of severely damaged crankshafts whereas two (2) other units have become superannuated with their respective maximum capacity reduced to around one half of each rated capacity. Accordingly, the supply capability of Versailles Power Station cannot satisfy electricity demand arising from the west Demerara area. GEC makes up for this deficit of the supply by sending electricity from a power station in Georgetown to the west Demerara area through a 11 kV distribution line. One (1) of the two (2) superannuated generating units at Versailles Power Station must be frequently stopped for repair thereof. Whenever the said generating unit is out of service, dependence on electricity transmitted from the power station in Georgetown further increases. This causes remarkable voltage drops and black-outs in localities distant from the power station. Consequently, suffering from electricity outage due to the voltage drops and load shedding, residents in the west Demerara area have been placed in the worst situation among the supply areas of Georgetown Electric Power System.

The requested Aid Project; Diesel Power Generator Supply Project aims at removal of the in-operative and superannuated generating units and installation of new generating units for terminating the chronical electricity outage in the west Demerara area under the condition that the Government of Guyana will simultaneously implement the nation-wide frequency standardization program as described below.

There exist two categories of frequencies; 60 and 50 Hz systems in Georgetown Electric Power System. These two different systems are interconnected at a frequency convertor station. In the past several years GEC has been implementing its frequency standardization program on all electric power systems to establish a 60 Hz supply system. Up to now, about 20% of the program has been completed.

In connection with conversion of 50 Hz generating facilities presently installed at Versailles Power Station to 60 Hz facilities, the phased installation of new generating facilities will necessitate either set-up of frequency converting equipment or duplication of required distribution lines.

Even if reinforcement is made on generating facilities at another power station located somewhere in Georgetown and its adjacent places other than Versailles Power Station and electricity generated at the said power station is sent to the west Demerara area, black-outs caused by voltage drops will not cease and transmission losses increase. The above-mentioned practice is considered inappropriate from the standpoint of the frequency standardization program as well. Consequently, it is believed most suitable that 60 Hz generating facilities are to be installed at the present Versilles Power Station simultaneously with the completion of work related to the frequency conversion in the supply area, as proposed by GEC. This method will be most economical and proper in the stable supply of electricity to consumers.

Notwithstanding the above, in case 60 Hz generators are installed under Japanese Grant Aid, it will become necessary for GEC to undertake relevant work on its responsibility in connection with the frequency conversion; such as replacement of pole-transformers and electrical apparata of consumers synchronously with the installation of the said generating units. In fear of unfavorable inconvenience which might be caused by any delay in the completion of such work due to a shortage of funds and for any other reason(s) on the part of GEC, the survey team modified the particulars of generating units to be installed under Japanese Grant Aid to be 60 Hz/50 Hz use equipment as a result of discussions with GEC.

As of September 1983, maximum demand in the west Demerara area represents 4,400 kW. It is estimated to reach 4,600 kW at the end of 1984 when the Diesel Power Generator Supply Project worked out by GEC is expected to be completed. As a result, the rated capacity of the new generating units should be at least 4,600 kW or more. In case of operating a 60 Hz designed generator at a frequency of 50 Hz, its maximum capacity decreases to be 80%. Hence, the rated capacity of the generating units must be more than 5,800 kW. The required number of the generating units has been determined to be three (3) with a rated capacity of 2,000 kW each on the basis of the basic study mainly focussed on future demand, technical needs and possibility of reducing required cost with maximum utilization of the present building and foundations for engines at the power station.

Costs to be incurred and borne by the Government of Guyana in the performance of work related to the frequency conversion under the above-mentioned nation-wide frequency standardization program will amount to approximately 500 million Yen.

In implementing the Diesel Power Generator Supply Project under Japanese Grant Aid, the Ministry of Economic Planning and Finance will assume responsibility for liaison between the two Governments and for dealing with necessary formalities while GEC will be the implementing agency directly involved with technical matters such as detailed design and installation work for the Project.

The implementation of this Project will take approximately sixteen (16) months counted from the signing of Exchange of Notes, during which detailed design, installation and commissioning tests, etc. are to be carried out.

The annual operation and maintenance cost of Versailles Power Station is estimated at 619 million Yen. It is anticipated that GEC will be able to secure the estimated amount sufficiently out of an annual revenue of 934 million Yen that GEC will obtain from sales of electricity.

The Government of Guyana has been discouraging importation of petroleum as much as possible. Nonetheless, fuel supply for operation of Versailles Power Station is ensured according to special agreement between GEC and its higher authorities concerned.

It is firmly believed that the implementation of this Project will extend greater benefits to some fifty thousand residents of the west Demerara area who live under the extremely severe circumstances in respect of education, medical services, public security and so forth.

The implementation of this Project is greatly meaningful. It is judged that the Project is fully justifiable as a Japanese Grant Aid project.

The generating facilities to be installed under Japanese Grant Aid will be able to fulfil their functions satisfactorily with the completion by GEC of its frequency conversion work. In this context, it is strongly recommended that GEC complete work related to the frequency conversion as soon as possible, overcoming various obstacles including economic constraints to be encountered.

CHAPTER 1

INTRODUCATION

CHAPTER 1 INTRODUCTION

The Guyana Electricity Corporation (GEC) responsible for electricity supply as electric utilities in Guyana has ten (10) thermal power stations throughout the country as of September 1983. These power stations do not function properly because of their overly harsh operation to meet requirements caused by the shortage of electricity supply and because of difficulty in replenishing spare parts owing to the scarcity of foreign exchange.

There are four (4) power stations which comprise Georgetown Electric Power System which supplies electricity to Georgetown and neighboring areas. At Versailles Power Station, one of those power stations belonging to the Georgetown Electric Power System, four (4) generating units are installed. However, only one (1) of the four (4) units is operational. This has caused chronical black-outs and voltage drops in areas distant from the power station thereby greatly affecting the social life and welfare of residents in the Project area.

In order to remove this difficulty, the Government of the Co-operative Republic of Guyana has called for the Government of Japan to extend the latter's grant aid for the implementation of the Diesel Power Generator Supply Project which includes supply and installation of three (3) sets of diesel engine generators and associated devices.

In response to this request, the Government of Japan entrusted the Japan International Cooperation Agency (JICA) to carry out a basic design study on the above-mentioned Project in order to find whether the requested Aid Project will be justifiable in view of the nature of Japanese Grant Aid.

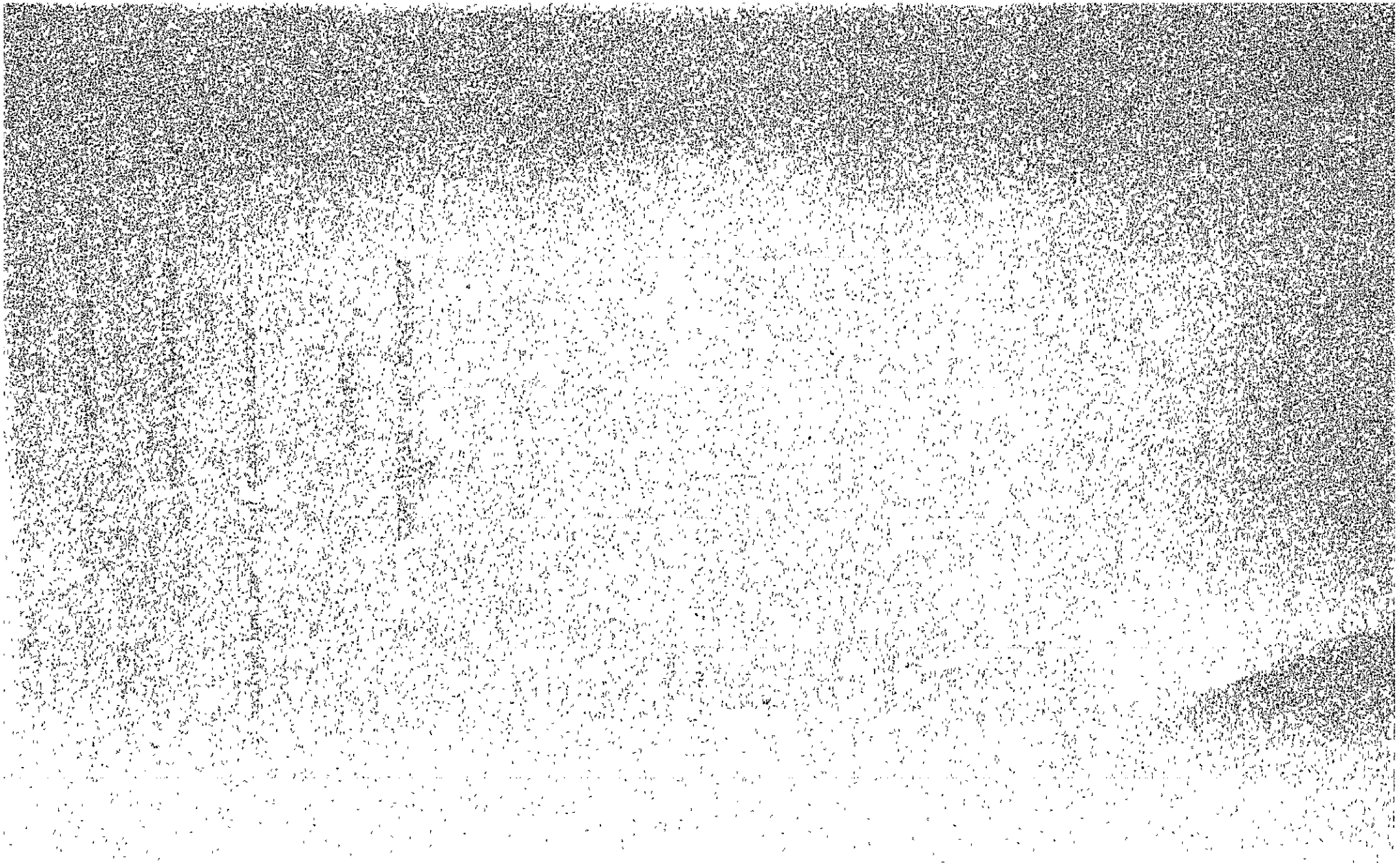
Thus, JICA dispatched a survey team to Guyana for a period of nineteen (19) days from the 4th through 22nd of September, 1983. The survey team collected data and information for the performance of their study, visited the Project area and held a series of discussions with responsible officials of the authorities concerned with the Project in Guyana while they were in Georgetown.

This report has been prepared, based upon the results of analyses of such data and information as mentioned above after their return to Tokyo from Guyana and incorporates the basic design and implementation schedule

essential for the implementation of the Project. Government officials with whom the survey team met, member list of the survey team, names of the authorities concerned of Guyana, Itinerary and Minutes of Discussions (photo copy) are as per Appendixes 1, 2 and 3 of the report, respectively.

CHAPTER 2

BACKGROUND OF THE PROJECT



CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 SOCIO-ECONOMIC SITUATION OF GUYANA

2-1-1 Geographical Situation

Guyana is located between Venezuela in the west and Surinam in the east, bordering with Brazil in the south and is faced with the Atlantic Ocean in the north. The total area of Guyana is approximately 214,969 km^2, which is slightly smaller than the area of the main land of Japan. The land of Guyana is divided into three ares; (1) a narrow but fertile strip area of alluvial soil along the coasts, (2) a forest area which occupies 7/8 of the total land and (3) a savannah area scattered in the north-east and south-west.

2-1-2 Population

The total population of Guyana is approximately 799,000 as of September 1983. The population during the period from 1970 through 1982 has indicated an average annual growth rate of 1.03%. This growth rate can be deemed rather small, compared with annual demographic growth rates of 2.5 to 3.0% observed in other developing countries.

Appendix-4 gives the records of the population from 1970 to 1982 and the projected population between 1983 and 1985.

2-1-3 National Economy

The Gross National Product on a constant price basis increased from 854 million G$ in 1970 to 1,050 million G$ in 1976. This indicates an average annual growth rate of 3.5%. GNP in Guyana in 1977 and thereafter shows a downward tendency. As of 1982, the Gross National Product of Guyana amounts to 886 million Guyana dollars. Therefore, per-capita GNP is calculated to be G$1,112 (US$370). The recorded and projected GNP of Guyana from 1970 through 1983 is as shown in Appendix-4.

2-1-4 Major Industries

(1) Agriculture

Major crops in Guyana are sugar and rice. Both items are major export products which are the main pillars for the Guyanese export industry. These items are greatly influenced by the weather. It is reported that production of the export-oriented products has, in recent years, been sluggish on account of various factors such as labor affairs and technical difficulties. The cultivated land area of sugar cane and paddy rice as of September 1983 is:

Sugar Cane: 5,381 km^2
Paddy Rice: 10,354 km^2

(2) Forestry

The forest area of Guyana is 188,000 km^2 which occupies about 7/8 of the total area of Guyana. The most famous timber product in the country is Ocotea Rodiaei, popularly called the "greenheart", which is of a very hard and endurable nature. Guyana is one of the major producing countries of the said timber in the world. Forest development and timber production programs are presently being implemented on the upper Demerara river. If 80% of the production is placed into export upon materialization of the programs, it is anticipated that this will make contributions to the advancement of the Guyanese economy.

(3) Mining

The share of the mining to the gross domestic product of Guyana decreased from 16.2% in 1977 to 7% in 1982. The reason for the decrease is attributed to a sharp reduction in production of bauxite and allumina especially in 1981 and 1982. Since the bauxite and allumina account for 40 to 50% of the total export amount of Guyana, decrease in production of both items adversely affected the Guyanese economy, which provides a reason for deterioration in the balance of international payments of Guyana.

(4) Manufacturing Industry

The share of the manufacturing industry in Guyana reached 12 to 15% of the gross domestic product value in the 1970's. This is considered to be an outcome of the efforts of the Guyanese Government to foster and encourage local manufacturing industries. The major categories of manufacturing industries are sugar milling and rice milling industries. The production amount of these two kinds of industries accounts for about 1/4 of the total production value of the Guyanese manufacturing industry. In addition, allumina production and timber processing industries are mentioned, but these are rather dependent upon primary products.

2-1-5 Foreign Trade

The foreign trade of Guyana is as shown below:

(In Million US Dollars)

Description \ Year	1976	1977	1978	1981
Export	262.4	255.9	288.8	324.7
Import	363.7	315.4	278.6	412.7

Out of a total export value of 324.7 million US dollars as of 1981, exports of sugar, bauxite and allumina are recorded at 101.9 million US dollars, 86.5 million US dollars and 26.0 million US dollars, respectively. These major items occupy 66% of the total export value of Guyana.

The amount of imports in the same year totaled 412.7 million US dollars. Of this value, importation of the following categories of goods is:

Intermediate goods: 283.7 million US dollars (69%)
Capital goods : 72.0 million US dollars (17.5%)
Consumption goods : 53.6 million US dolalrs (13%)

Guyana's major exporting countries are the UK, the U.S.A. and Canada. Bauxite is exported from Guyana mainly to the U.S.A. and Canada while rice is exported mostly to Caribbean countries.

As of 1981, Japan's exports to Guyana amounted to 8.8 million US dollars (at FOB price) and her imports reached 13.4 million US dollars (at CIF price).

2-1-6 Balance of International Payments

The actual records of the balance of international payments of Guyana are as given in the following table.

Table 2-1-6 Balance of International Payments

(In Million Guyana Dollars)

Description	1979	1980	1981	1982
Exports of Goods & Non-factor Services	+793	+1,042	+1,050	+792
Imports of Goods & Non-factor Services	-918	-1,200	-1,362	-1,037
Resource Balance	-125	-205	-166	-197
Net Factor Services	-72	-85	-150	-181
Interest	-65	-77	-100	-106
Direct Investment Income	-3	-3	-6	-7
Other Factor Services	-5	-3	-45	-43
Current Transfers (net)	+1	-2	+1	-25
Current Account Balance	-197	-243	-462	-426
Capital Account Balance	+61	+22	+314	+60
Overall Balance	-136	-221	-148	-366

Source: Ministry of Economic Planning, Statistical Bureau

As far as reference is made to the above table, the amount of import always exceeds that of export, which causes deficit in the Resource Balance. As already stated before, the export value of sugar and rice occupies a large portion of the total export value. The two items are easily influenced by the weather. The third category of export item; bauxite depends upon current world market prices. Exportation of these three items has, in recent

years, been sluggish whereas importation of goods and services increased. Accordingly, this situation has caused deterioration in the balance of international payments.

2-1-7 External Debt Balance

Because of the stagnant exportation of Guyana, its external debt balance increased from 202.4 million US dollars in 1974 to 420.1 million US dollars in 1978 as given in the following table. Although there was a slight improvement in the overseas debt balance in 1979 and 1980, the situation deteriorated in 1981 again to reach more than 500 million US dollars. It is a matter of urgency for the Government of Guyana to restore her export industry without delay in order to save this unfavorable situation.

Table 2-1-7 External Debt Balance

(In Million US Dollars)

Year	1974	1975	1976	1977	1978	1979	1980	1981
Debt Balance	202.4	265.0	345.8	380.5	420.1	315.5	352.1	522.5

2-2 NATIONAL DEVELOPMENT PLAN

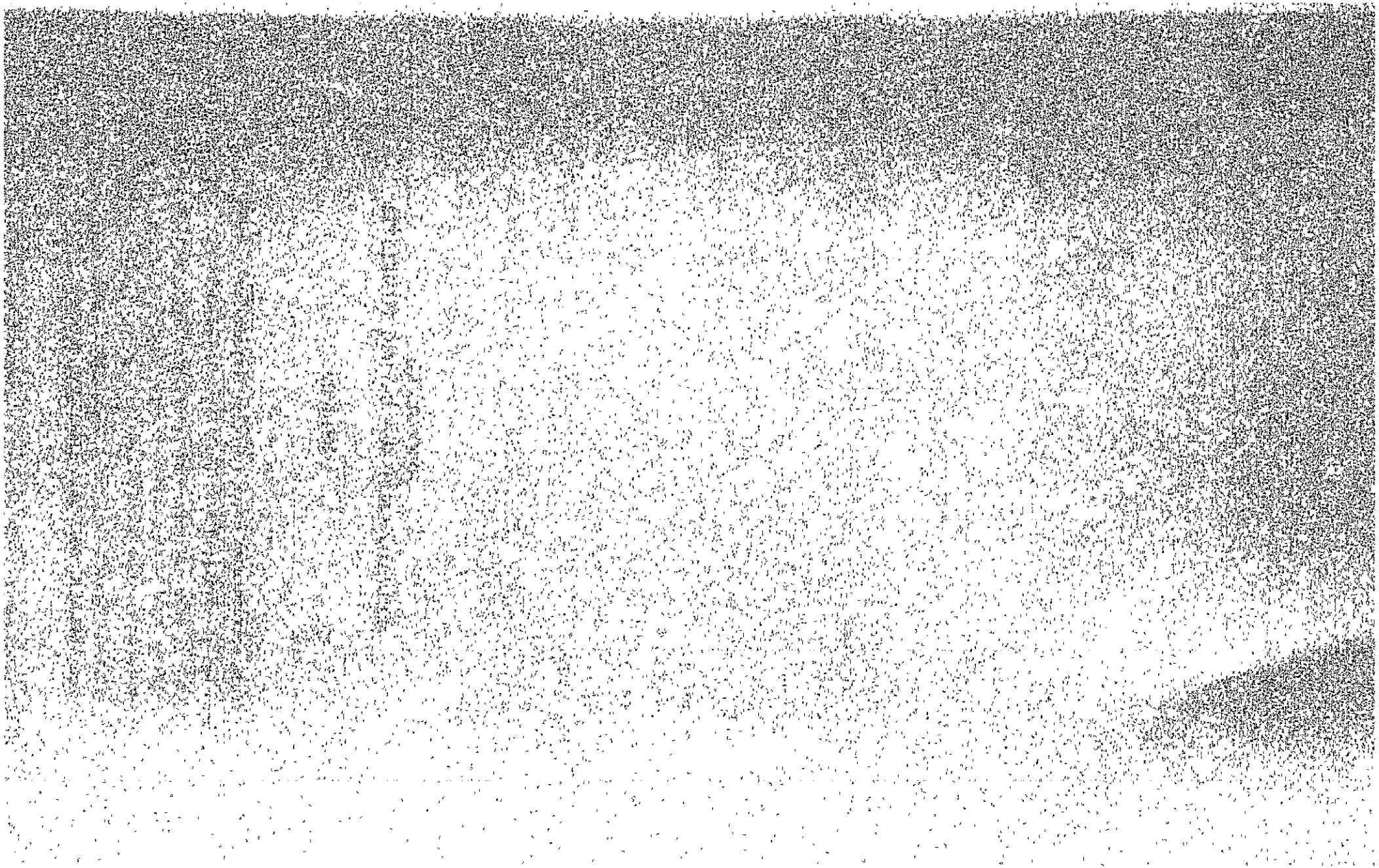
The Government of Guyana views the deteriorating balance of international payments in 1979 and thereafter with great apprehension. In order to cope with the difficult situation, the said Government plans to materialize hydro power generation by utilization of indigenous water resources, discouraging importation of oil as much as possible. The Government of Guyana is committed to systematic rehabilitation and utilization of existing thermal power generating facilities to meet the ever growing electricity demand until the time when hydro power generation is brought to realization, refraining from constructing new thermal power generating facilities.

In line with the national policy mentioned above, GEC, electric utilities in Guyana, deems it a matter of urgency to rehabili-

tate, develop and reinforce its own existing generating facilities for meeting electricity demands arising from agriculture, commercial, industrial, governmental and domestic consumers. GEC is also in the course of implementing programs for standardization of the frequencies thereby interconnecting respective electric power systems on a nation-wide scale with the aim of realizing the economical operation of electric power.

CHAPTER 3

ELECTRICITY DEMAND AND SUPPLY SITUATION IN GUYANA



CHAPTER 3 ELECTRICITY DEMAND AND SUPPLY SITUATION IN GUYANA

3-1 GENERAL SITUATION

The power generation and supply in Guyana are made by Guyana Electricity Corporation (GEC), electric utilities of the country, Guyana Mining Enterprise (GUYMINE) which owns bauxite mines, sugar estates producing sugar cane, rice mills, etc. It is worthy of particular attention that besides those organizations, electricity is also generated and distributed by the Ministry of Works and Housing to domestic consumers in remote areas.

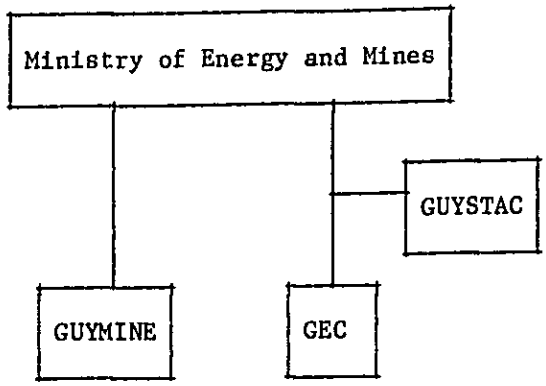
3-1-1 Background of Establishment of GEC

While this country was still called "British Guiana", the British Guiana Electricity Corporation supplied electricity to Georgetown and its neighboring areas. Following the business activities by the British company, Demerara Electric Co., Ltd. carried on the same services to the above-mentioned areas in the 1950's. During this period, there were also Demerara Bauxite Company and Reynolds Bauxite Company which supplied electricity to bauxite mines in Linden and adjacent places. Besides, New Amsterdam Municipality system and privately owned very small systems were existent in the country.

The Government of Guyana found it necessary to increase generating capability, expand and modernize distribution networks, and purchased the undertaking of Demerara Electric Co., Ltd. in 1960. Thus, GEC was founded by the Government as a public utility under Electricity Act on December 24, 1962.

3-1-2 Organization of GEC

GEC is under the jurisdiction of the Ministry of Energy and Mines and comes under the umbrella of the Guyana State Corporation (GUYSTAC) as shown on the next page.



The top management policies of GEC are decided on and controlled by the board of directors composed of eight (8) members.

(1) The organization chart of GEC effective as of September 14, 1983 is represented as shown in Appendix-5. There are Engineering Division, Finance Division, Project Management Department, Administrative Department, Personnel Department and Training Department under the direction of the General Manager.

(2) GEC is staffed with 1,288 persons as of September 1983. A breakdown of these personnel is:

Administrative staff	80
Civil Engineering staff	85
Electrical Engineering staff	90
Financial staff	256
Others (staff on training and other grouping)	777
Total	1,288

Out of the key staff of GEC, seven (7) expatriate persons work for GEC at present.

3-1-3 Share of GEC in Electricity Supply in Guyana

A breakdown of generating facilities and annual energy production of GEC and various organizations other than GEC as of 1983 is as given in the following table.

Table 3-1-3 Generating Facilities in Guyana

GEC-Owned Facilities		Facilities Owned by Organizations Other than GEC		Total Facilities throughout Guyana	
Installed Capacity (MW)	Annual Energy Production (MWh)	Installed Capacity (MW)	Annual Energy Production (MWh)	Installed Capacity (MW)	Annual Energy Production (MWh)
105.7 (61%)	228,880 (63%)	68.4 (39%)	132,067 (37%)	174.1 (100%)	360,947 (100%)

As may be seen from the above table, GEC occupies more than 60% of the total in Guyana in terms of installed capacity and annual energy production. The total energy production in Guyana reaches 360,947 MWh. Therefore, per-capita energy production in Guyana as of 1982 is calculated to be 453 kWh.

Per-capita annual energy generation (annual energy production per person) as of 1980 in Latin American countries is as shown in the following table. As may be seen from the table, the value of per-capita annual energy generation of Guyana is far below those of Venezuela, Surinam and Brazil and is less than half of the average figure (1,172 kWh) of the per-capita annual energy generation of the twelve countries in Latin America. This indicates the less-developed industries and delay in modernization as well as low national income of Guyana.

Table 3-1-3 Per-Capita Energy Generation in Latin American Countries

Year / Country	1980				1982			
	Population (1000 Persons)	Installed Capacity (MW)	Annual Generation (GWh)	kWh per Person	Population (1000 Persons)	Installed Capacity (MW)	Annual Generation (GWh)	kWh per Person
Argentine	27,710	11,795	40,600	1,465				
Bolivia	5,600	430	1,510	270				
Brazil	118,610	31,735	137,383	1,158				
Chile	11,100	3,771	11,500	1,036				
Colombia	27,090	4,860	20,645	762				
Ecuador	8,350	1,125	3,155	378				
Guyana	793	170	416	524	797	174	361	453
Paraguay	3,170	370	810	256				
Peru	17,780	3,192	9,805	551				
Surinam	390	420	1,610	4,128				
Uruguay	2,910	835	3,331	1,145				
Venezuela	13,910	7,807,335	33,349	2,397	16,111	9,794,323	36,417	2,260

3-1-4 Electric Power Systems and Supply Areas

There are the following electric power systems and supply areas in Guyana, of which details are as given in Appendix-6.

Table 3-1-4(1) GEC's Electric Power Systems

Name of Power System	Name of Power Station	Supply Area
Georgetown Interconnected System	Kingston P.S., Garden of Eden P.S., Versailles P.S., Ruimveldt P.S.	Georgetown, East Coast of Demerara, East Bank of Demerara, West Bank of Demerara, West Coast of Demerara
West Berbice System	Onverwagt P.S.	Area along the Atlantic Coast from the Mahaiaca River to the Berbice River
East Berbice and Corentyne System	New Amsterdam P.S., Canefield P.S.	The Atlantic Coast from New Amsterdam to Corriventon, a distance of 60 km
Essequibo Coast System	Anna Regina P.S.	Area, 50 km long along the Atlantic Coast in western Essequibo area
Bartica System	Bartica P.S.	Bartica area
Wakenaam System	Wakenaam P.S.	Wakenaam Island

Table 3-1-4(2) GUYMINE's Electric Power Systems

Name of Power System	Name of Power Station	Supply Area
Linden System	Linden P.S.	Linden Mine and neighboring places
Kawakami System	Kawakami P.S.	Bauxite mine and adjacent places 150 km upstream of the Berbice River from New Amsterdam
Everton System	Everton P.S.	Small mining areas in Everton

3-1-5 Generating Facilities

As of September 1983, GEC owns 10 power stations and 30 generating units in 6 supply areas as shown in Appendix-7. The installed capacity of these stations totals 108.69 MW. Of these generating units, 3 units (10 MW x 3) are steam, 2 units are gas turbines (10 MW x 2) and 25 other units are diesel engine generators. A majority of the said units are commissioned in the 1970's. Because of difficulty in purchasing parts due to a shortage of foreign exchange caused by the deterioration in the balance of payments since 1977, GEC has fallen into trouble reparing and maintaining its own facilities satisfactorily.

At present 12 generating units are in-operative whereas other generators hardly fulfill their functions. The maximum capacity of the operational units are 45.43 MW, accounting for about 42% of the total installed capacity.

As may be seen from Appendix-7, there exist 50 Hz power stations and 60 Hz power stations together. In the Georgetown Electric Power System 50 Hz power stations are interconnected with a 60 Hz power station by means of a frequency covertor installed in Sophia.

3-1-6 Transmission and Distribution Lines

As shown in Appendix-8, there runs a 69kV transmission line from Linden Power Station of GUYMINE to Sophia Convertor Station of GEC. Another 69 kV transmission line between Sophia Convertor Station and #53 Village is presently under construction and expected to be completed by the end of 1985.

The features of the tramsmission lines are as given in the following table.

Table 3-1-6 List of Transmission Lines

Section	Voltage (kV)	Length (km)	No. of Circuits	Remarks
Linden to Garden of Eden	69	81.6	1	Existing
Garden of Eden to Sophia	69	28.8	1	Existing
Sophia to Onverwagt	69	73.6	1	Under Construction
Onverwagt to Canefield	69	41.6	1	Under Construction
Canefield to #53 Village	69	56.0	1	Under Construction

As far as the distribution lines are concerned, 13.8 kV is standardized for use in the 60 Hz supply areas. Three kinds of voltages; 11 kV, 4 kV and 4.16 kV are adopted in the 50 Hz supply areas.

3-1-7 Electricity Tariffs

The electricity tariffs effective as of September 1983 are as follows:

(a) Category A - Residential Consumers

	G$
Monthly Charge	2.30
1st 50 kWh	0.39/kWh
Over 50 kWh	0.68/kWh

(b) Category B - Commercial Consumers

	G$
Monthly Charge	2.30
Unit Charge	0.84/kWh

(c) Category C - Light Industries

	G$
Demand (per kVA)	12.00
1st 200 kWh	0.73/kWh
Over 200 kWh	0.63/kWh

(d) Category D - Heavy Industries

	G$
Demand (per kVA)	11.00
1st 200 kWh	0.63/kWh
Over 200 kWh	0.53/kWh

The energy sold of GEC reached 172 GWh and its revenue amounted to G$97,618,000 in 1982. GEC's electricity charge per kWh on the average represents G$0.57 (around ¥46), which is considered rather expensive in view of the level of the national income in Guyana.

3-2 PRESENT SITUATION OF ELECTRICITY DEMAND AND SUPPLY IN GEC'S SYSTEMS

3-2-1 Electricity Demand and Supply in Whole Electric Power Systems

The total of electricity demand and supply in the entire power systems owned by GEC is as shown in the following table.

Table 3-2-1 Demand and Supply in GEC's Whole Electric Power Systems

Year	Consumption at Consumer's End (GWh)	Energy at Sending End (GWh)	Gross Energy Production (GWh)	Station Service & System Loss (GWh)	Station Service & System Loss Ratio (%)	Max. Demand (MW)
1970	729	147	157	28	17.8	31.4
1971	136	153	164	28	17.1	31.3
1972	144	157	168	24	14.3	33.7
1973	159	171	182	23	12.6	36.8
1974	158	172	184	26	14.1	37.3
1975	165	180	192	27	14.1	39.0
1976	176	213	227	51	22.5	38.7
1977	163	232	249	86	34.5	43.9
1978	170	210	223	53	23.8	44.1
1979	179	225	236	57	24.2	45.2
1980	183	228	240	57	23.7	-
1981	190	243	255	65	34.2	-
1982	172	219	229	57	24.9	-
Average Annual Growth Rate	2.43%	3.38%	3.20%			

A breakdown of energy consumption in 1982 is as follows:

Domestic	63.64 GWh (37%)
Commercial	41.28 GWh (24%)
Industrial	60.20 GWh (35%)
Lighting	6.88 GWh (4%)

Energy consumption of domestic and commercial consumers constitutes 61% of the total energy consumption while industrial con-

sumer's share of the total accounts for only 35%. This is because large enterprises such as bauxite mines, sugar estates and rice mills have their own generating sets independents of GEC and are not its consumers. Therefore, the ratio of consumption for industrial use is rather small.

3-2-2 Electricity Demand and Supply in Georgetown Electric Power System

(1) Present Status of Generating Facilities

The present situation of the Georgetown Electric Power system providing around 80% of the total electricity supply of GEC is as follows:

Table 3-2-2(1) Generating Facilities in Georgetown Electric Power System (As of September 1983)

Power Plant	No.of Unit	Frequency (HZ)	Rated Capacity (MW)	Type	Commission-ing Year	Max. Capacity (MW)	Remarks
Kingston B	1	50	10.0	Steam	1963	9.0	
	2	50	10.0	Steam	1963	-	Out of Order
	3	50	10.0	Steam	1963	9.0	
	1	50	10.0	Gas	1978	-	Out of Order
	2	50	10.0	Gas	1978	-	Out of Order
Ruimveldt	1	50	1.0	Diesel	1959	-	Out of Order
	2	50	1.0	Diesel	1959	0.9	
Versailles	1	50	2.0	Diesel	1972	-	Out of Order
	2	50	2.0	Diesel	1972	-	Out of Order
	3	50	2.0	Diesel	1972	1.0	
	4	50	2.0	Diesel	1972	0.8	
Garden of Eden	2	60	5.7	Diesel	1975	4.0	
	3	60	5.7	Diesel	1975	4.0	
	4	60	5.7	Diesel	1976	-	Out of Order
	5	60	5.7	Diesel	1976	4.0	
Total			82.8			32.7	

There are four (4) power stations in the Georgetown Electric Power System having fifteen (15) generating units with a total rated maximum capacity of 82.8 MW. Because of difficulty in replenishing parts as described before, seven (7) units are in-operative and the maximum capacity of the power stations forming the Georgetown Electric Power System reaches 32.7 MW in total as of September 1983, accounting for only 40% of the total rated capacity.

(2) Present Situation of Electricity Demand and Supply

The electricity demand and supply in the Georgetown Electric Power System from 1975 through 1982 are as shown in the following table.

Table 3-2-2(2) Electricity Demand and Supply in Georgetown Electric Power System

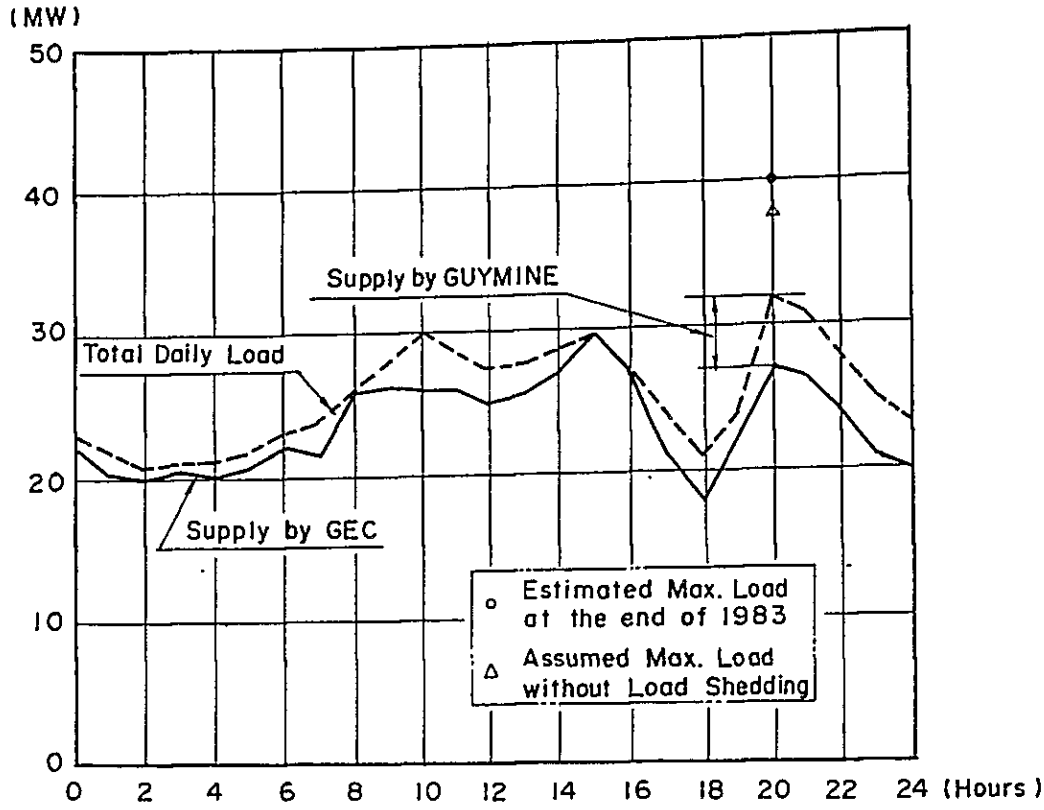
Year	No. of Consumers	Annual Energy Consumption (GWh)	Station Service and System Loss Ratio (%)	Gross Energy Production (GWh)	Load Factor (%)	Maximum Demand (GWh)
1975		144.8	24.8	192.4	64.8	33.9
1976		144.7 (0.13)	25.0	192.9 (0.17)	66.7	33.0 (0.03)
1977	59,066	165.69 (2.9)	25.3	221.9 (3.8)	67.4	37.6 (0.7)
1978	60,828	150.39 (0.7)	24.8	200.0 (0.92)	61.9	36.9 (0.2)
1979	62,709	155.07 (0.7)	23.8	203.5 (0.92)	63.8	36.9 (0.2)
1980	64,649	155.82	23.8	204.4	64.4	36.2
1981	66,649	162.64	23.8	213.4	67.5	36.1
1982	68,710	143.17	23.4	186.8	61.5	34.7

The figure in parenthesis denotes a figure of lost max. demand which is caused by load shedding and not included in the figure shown immediately below.

Although the number of consumers increases by 3% per year, the annual energy consumption, on the contrary, shows a downward tendency. The reason for this decrease is attributable to the load shedding being performed since 1977 due to the shortage of electricity supply.

Electricity demand and supply as of September 1983 are as given in the daily load curve of the Georgetown Electric Power System.

Fig. 3-2-2 Daily Load Curve (As of 7th September, 1983)



The maximum load of the said Electric Power System is 32 MW and occurs at 20 hours (when electric light is switched on). GEC receives electricity from Linden Power Station owned by GUYMINE at the peak time. 32 MW is the figure of maximum load under the oppression of the load shedding as shown in Appendix-9. If there were not load shedding, this figure would reach 38 MW (according to the estimation of GEC).

Maximum load in the Georgetown Electric Power System occurs every December that falls on the harvest season of paddy rice. The incremental load during this period is approximately 2 MW. Accordingly, it is estimated that maximum demand in the said System at the end of 1983 will reach about 40 MW as some 6 MW for termination of the load shedding (estimated by GEC) and 2 MW for the harvest season are added.

3-3 ESTIMATION OF MAXIMUM DEMANDS AND REHABILITATION PROGRAM OF GENERATING FACILITIES

3-3-1 Estimation of Maximum Demands

Estimation has been made on maximum demands in the Georgetown Electric Power System from the end of 1983 up to that of 1986 since the Georgetown Electric Power System is to be interconnected with West Berbice Electric Power System and Corentyne Electric Power System through a 69 kV transmission line at the end of 1985.

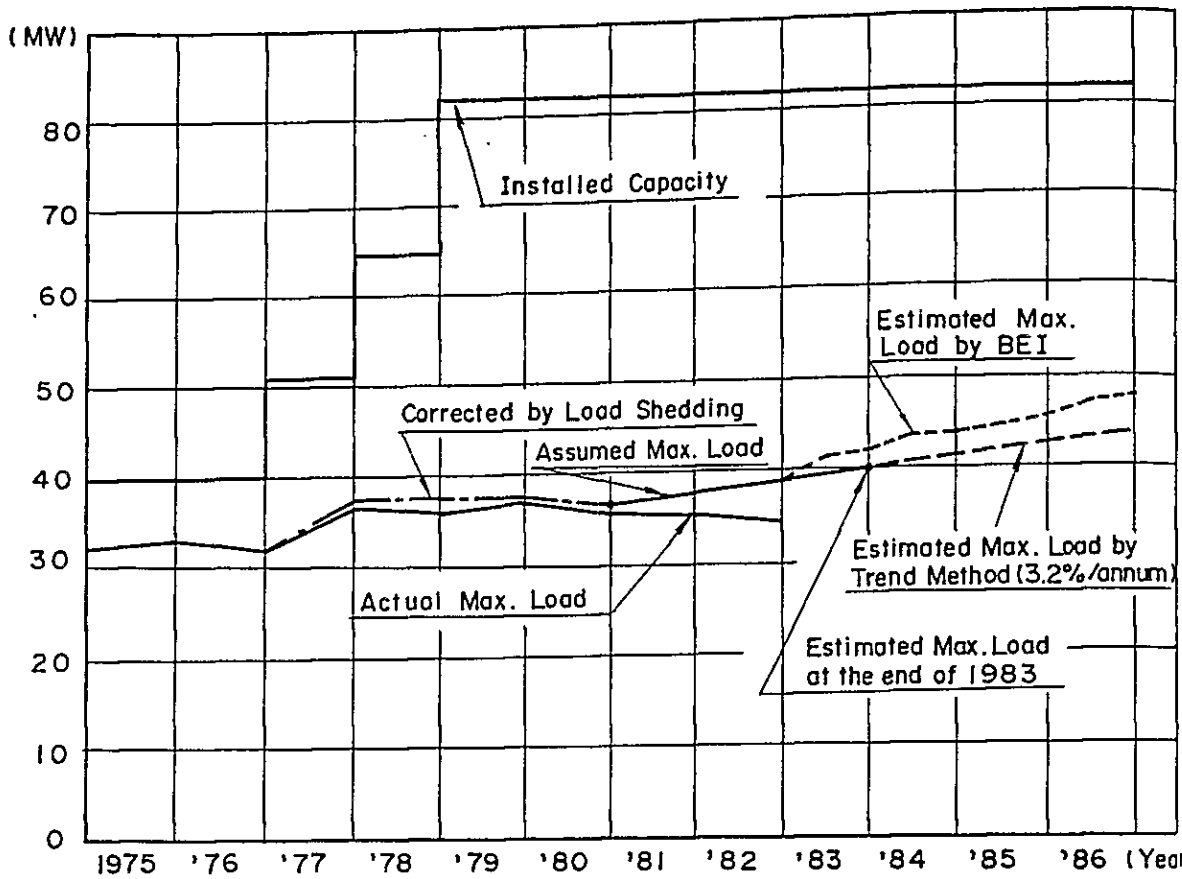
Since power flow will change after realization of the interconnection, maximum demands to arise in Georgetown Electric Power System during the period between 1982 and 1987 are estimated on an "accumulation" basis, as given in Table 3-3-1 below, which is enumerated in a BEI* report prepared in September 1982.

Table 3-3-1 Max. Demands Estimated by BEI

Year	1982	1983	1984	1985	1986	1987
Max. Demand (MW)	39.83	43.18	44.29	46.50	48.83	51.27

The recorded maximum demands from 1975 to 1982 are as shown in Table 3-2-2(2). Since the records of kilowatt hours lost by load shedding in 1981 and 1982 were not available, the estimated maximum demands of 37.5 MW and 38.6 MW in 1981 and 1982 can be obtained from the following Fig. according to an actual maximum demand of 36.4 MW recorded in 1980 and on the assumption of an estimated maximum demand of 40.0 MW at the end of 1983.

Fig. 3-3-1 Estimates of Maximum Demands in Georgetown Electric Power System



An annual increase rate of the number of consumers in Georgetown Electric Power System is 3% on the average during the last 5 years whereas maximum demands in 1981 and 1982 represent an increase rate of 3.2% per annum. Maximum demands in 1984, 1985 and 1986 are estimated to reach 41.3 MW, 42.6 MW and 43.9 MW, respectively if maximum demands from 1983 through 1986 are assumed to increase at the same annual rate (under "Trend Method").

From the figures obtained according to the "Accumulation Method" applied in the BEI report and by means of the "Trend Method" mentioned hereinabove, it is projected that maximum demands in 1984, 1985 and 1986 will be placed within a range between the two kinds of estimated figures stated above.

Note) The British Electricity International (BEI) is a consulting firm from the UK in the field of electric power. This

firm carried out studies on the capacity of GEC's existing transmission and distribution networks, rehabilitation of existing generating facilities and formation of electric power systems for the sake of GEC under a loan from IBRD. BEI has also worked out investment programs for realization of the said schemes. Their report entitled "The Rehabilitation and Development of GEC System, 1982-87" was forwarded to GEC in September 1982 and approved later on.

3-3-2 Rehabilitation Program of Generating Facilities

It is believed essential to install new generating units or rehabilitate existing ones enough to satisfy the maximum demands as stated in 3-3-1 for purposes of adequately meeting later electricity demand in the supply areas of the Georgetown Electric Power System where load shedding is still observed as of September 1983 due to the shortage of electricity supply.

The rated capacity of GEC-owned generating facilities belonging to the Georgetown Electric Power System totals 82.8 MW at present. The Government of Guyana and GEC intend to meet maximum demands in the future by rehabilitation of the latter's existing thermal power generating facilities except for Ruimveldt Power Station (1.0 MW x 2 units commissioned in 1959). For this purpose, they are making all possible efforts to promote the following rehabilitation program.

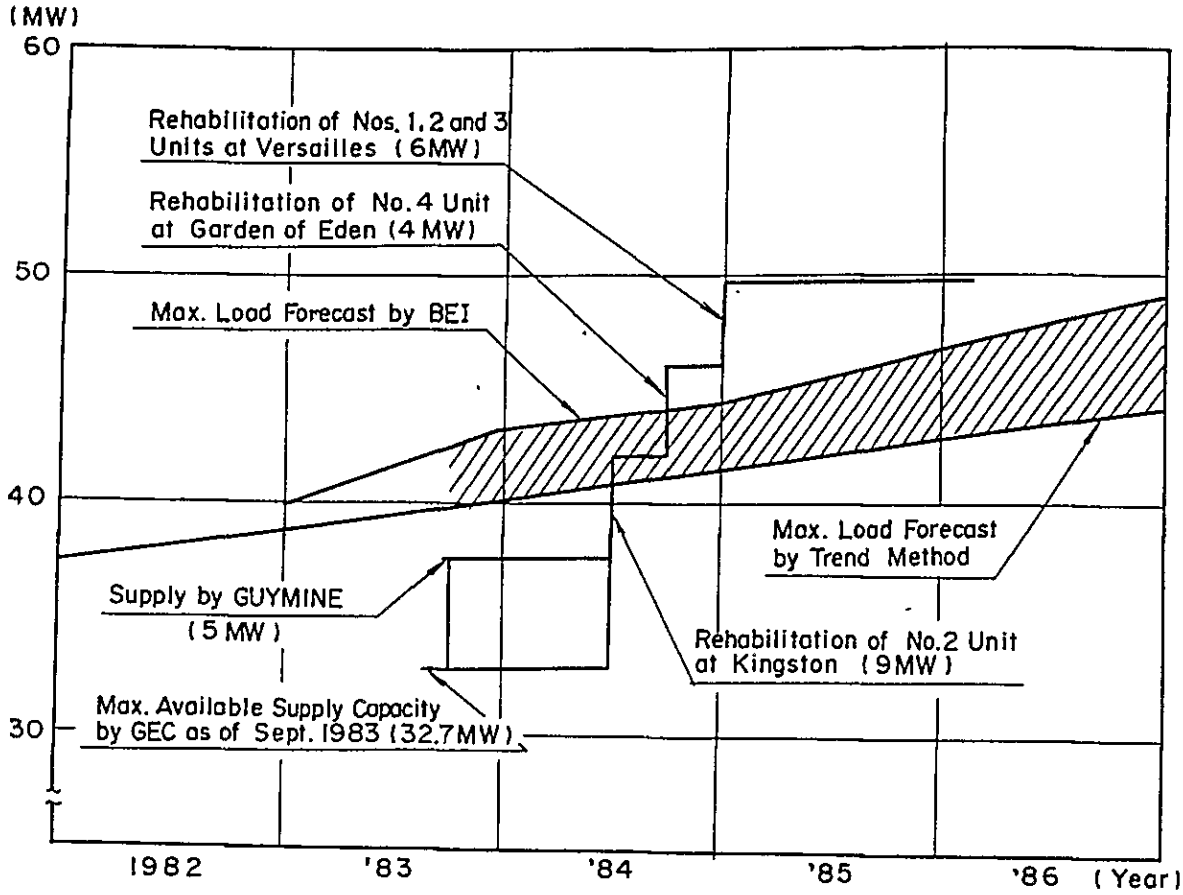
(1) Rehabilitation of Unit No. 2 (steam) at Kingston Power Station : Scheduled to be completed at the end of June 1984

(2) Rehabilitation Unit No. 4 (diesel) at Garden of Eden Power Station : Scheduled to be completed at the end of September 1984

(3) Installation of Unit Nos. 1, 2 and 3 (diesel) at Versailles Power Station: Scheduled to be completed at the end of December 1984

Fig. 3-3-2 shows an electricity demand and supply balance of Georgetown Electric Power System, which is presumed to take place after the realization of GEC's rehabilitation program mentioned above.

Fig. 3-3-2 Electricity Demand and Supply Balance



As a rule, it is essential to have suitable "capability margin" in advance in preparation for the non-operation of the maximum generating unit because of its periodical overhaul or failure if an electricity demand and supply balance is taken into account. Accordingly, if rehabilitation of Unit No. 2 of Kingston Power Station and Unit No. 4 of Garden of Eden Power Station is completed at the end of September 1984 as scheduled, the maximum capacity of the generating facilities owned by GEC will exceed the estimated maximum demand. The largest generating unit of this Electric Power System has a maximum unit capacity of 9.0 MW. Therefore, the supply capability will become insufficient for meeting the estimated maximum demand if and when this largest generating unit of the Electric Power system stops. However, it is anticipated that the estimated maximum demand will be satis-

fied and the load shedding presently being performed be terminated even during overhaul or failure of the above-mentioned largest unit, by receiving some electricity from GUYMINE enough to meet the deficit after new generating units are installed at Versailles Power Station.