BASIC DESIGN STUDY REPORT ON THE PROJECT FOR IMPROVEMENT OF ELECTRICITY POWER SUPPLY TO GREATER FREETOWN IN THE REPUBLIC OF SIERRA LEONE

MARCH, 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request from the Government of the Republic of Sierra Leone, the Government of Japan decided to conduct a basic design study on the Project for the Improvement of Electricity Power Supply to Greater Freetown, and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Sierra Leone a survey team, headed by Mr. Toshimichi Aoki, First Basic Design Study Division, Grant Aid Planning and Survey Department, JICA, from November 26 to December 25, 1989.

The team exchanged views with officials concerned of the Government of Sierra Leone and conducted a field survey at the Project site. After the team returned to Japan, further studies were made and the present report was 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.

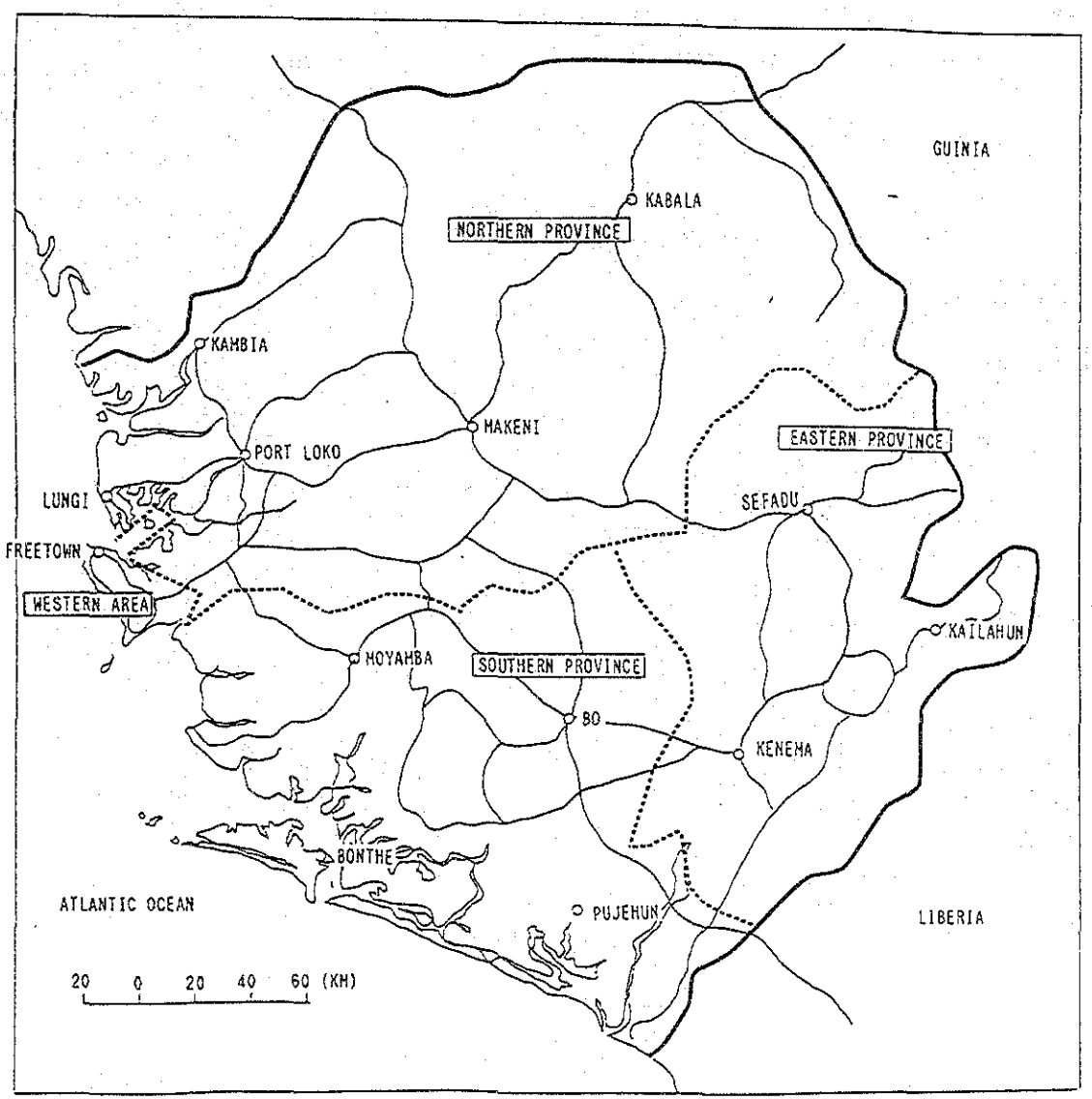
I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Sierra Leone for their close cooperation extended to the team.

March, 1990

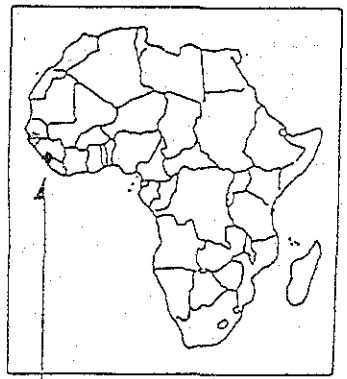
Kensuke Yanagiya

President

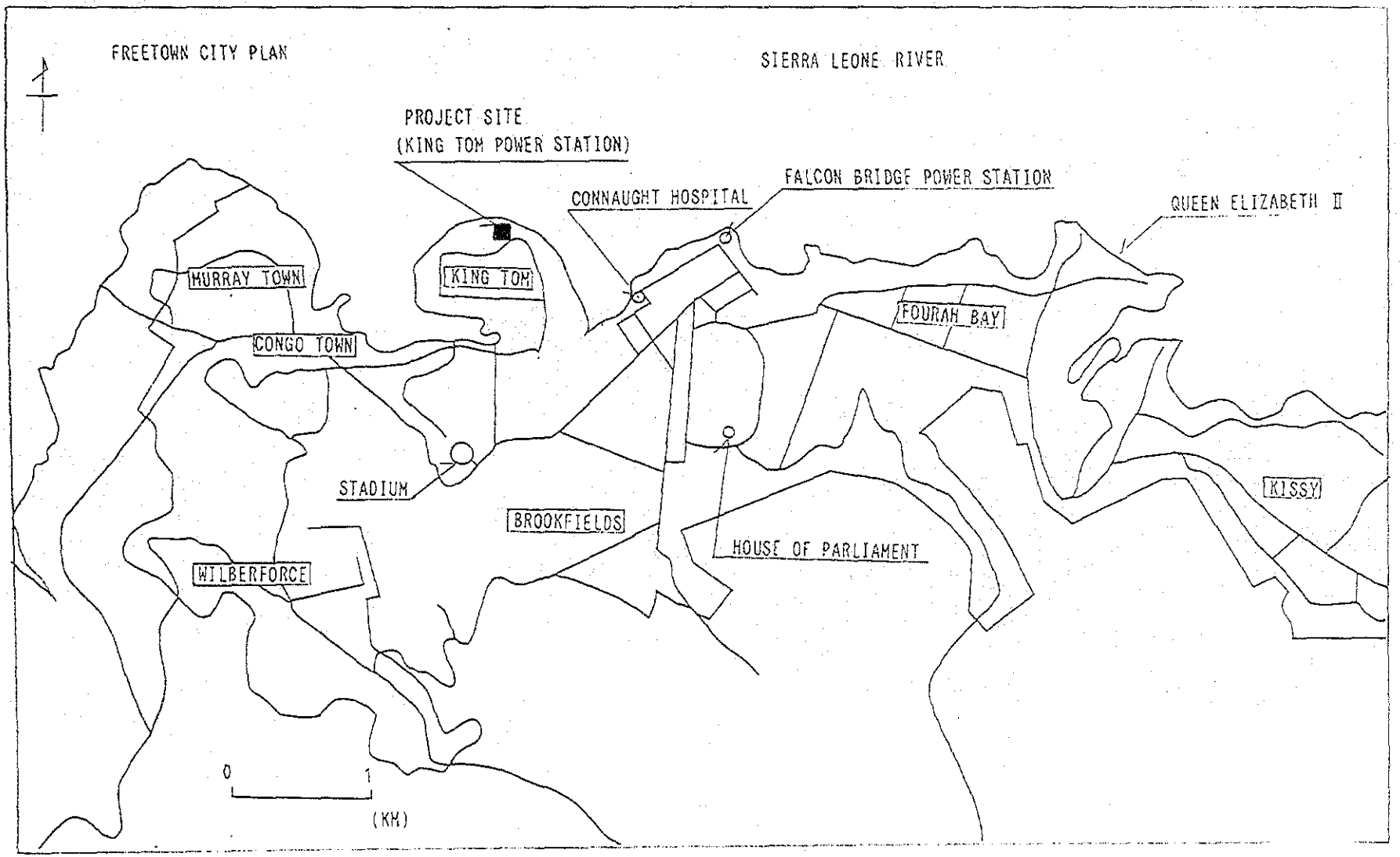
Japan International Cooperation Agency



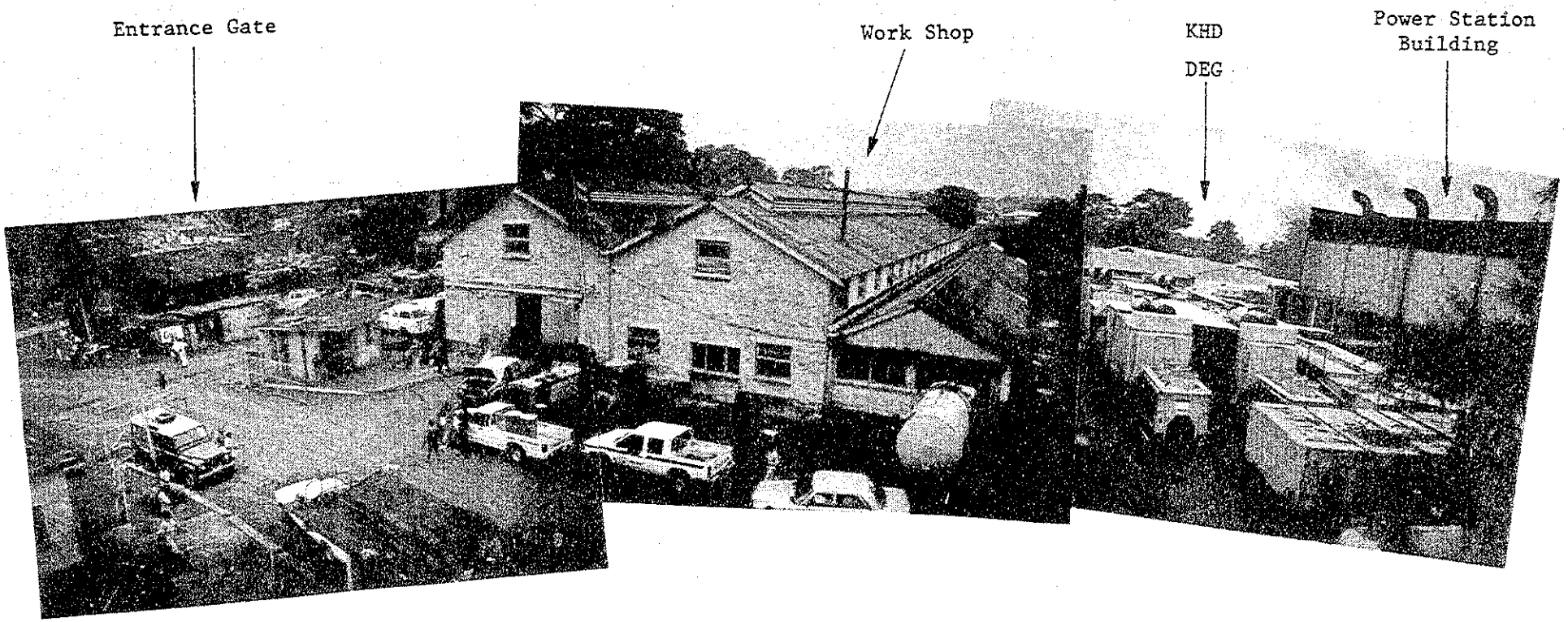
SIERRA LEONE LOCATION MAP



SIERRA LEONE



PROJECT SITE LOCATION MAP



Overall View of Kingtom Power Station

Proposed Site for the Generating Facilities

SUMMARY

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The Republic of Sierra Leone (hereinafter referred to Sierra Leone) is situated on the West African coast between Guinea and Liberia with the total land area of about 71,000 km^2 and the population of about 3.5 million. Per capita GNP is about US$310 in 1986 and the capital is Freetown City.

Its economy depends mainly on mining (diamond, etc.) and agriculture (cocoa, coffee, etc.). With the 2nd 5-year development plan as a starter, the Government stresses agriculture as the top priority sector to attain food self-sufficiency and promote exports. Under the 3rd 5-year plan scheduled for implementation in 1989/90, emphasis is pressed on the improvement of energy supply to meet the growing needs for electric power, as well as to expand farm production.

However, many existing generating facilities operated by the National Power Authority (NPA), the nation's sole public power supply sector, have become obsolete and suffer from lack of maintenance because adequate spare parts are not supplied under the nation's tight financial condition. As a result, these generating facilities are being operated below their capacity.

The above has conspicuous effect on the power supply situation in the capital area, the greater Freetown area, which comprises Freetown City, where nearly 20% of the nation's population is concentrated, and its suburbs. In 1989, the peak demand in the Western Area Grid and distribution network which serves this area was about 40 MW. For this peak demand, only 12.7 MW (about 30% of the peak demand) was supplied by Kingtom Power Station (Establishment: 1964, No. of workers: 155, Area of the Station: About 14,000 m^2, No. of DEG installed: 9 sets (5 sets of them are out of order)), which is the sole power station for this network.

This forces a daily power cut to the greater Freetown area. As a result, people's life, economic activities, and management of social welfare facilities such as hospitals and schools are subjected to extremely serious conditions.

As a measure to improve this power supply situation, the Sierra Leone government formulated 2 major plans: "Capital Area Power Supply Improvement Plan" which mainly consists of rehabilitation of existing Kingtom Power Station with the objective of increasing its output to about 25 MW, and "Construction Plan for new Bunbuna Hydraulic Power Station" with output of 30.5 MW. However, under the tight financial condition that Sierra Leone faces at present, it is impossible to implement both plans simultaneously. Instead, to supply urgently needed power for the time being, the Sierra Leone government developed a plan to construct new diesel generating facilities with a 5 MW output in Kingtom Power Station and requested the Japanese government for grant aid to implement this plan.

In response to this request, the Japanese government decided to conduct the basic design study of this plan. This led to the dispatch of a basic design study team by the Japan International Cooperation Agency to Sierra Leone from November 26 to December 25, 1989 to study the plan's contents, effect and viability as a grant aid project.

Development projects by other foreign aid agencies which have direct bearing on this project include the aforementioned "Capital Area Power Supply Improvement Plan" on which EEC, World Bank, etc., are now conducting studies. This plan aims to drastically improve Sierra Leone's power supply situation by undertaking comprehensive rehabilitation work for Kingtom Power Station and overhauling NPA's organization, structure and operation.

However, no specific date for implementation of this plan has been decided yet because it is large in scale and expected to call for a long construction period. For this reason, the Sierra Leone government has already coordinated with EEC, World Bank, etc., so that this plan may be in no way adversely affected by the current project which has been

developed as an emergency measure to cope with the immediate power supply difficulty.

The survey team grasped the tight power supply situation in Sierra Leone through discussion with local officials concerned and field survey. In particular, the team confirmed the need for the urgent implementation of this project in recognition of the serious situation in which social welfare facilities such as hospitals and schools are placed at present. In NPA's power distribution plan, these social welfare facilities are given high priority as important consumers. These are public facilities serving for large numbers of people. However, power supply even to these important facilities is virtually suspended due to power shortage.

The study team also confirmed that the scale of the proposed generating facilities is appropriate because the anticipated power demand for the social welfare facilities is nearly equal to the output (5 MW) of the requested generating facilities in case the completion of the project is set at 1992.

As for the proposed site of the project, the generating facilities will be installed outdoors in a vacant space in Kingtom Power Station. This is because no space is available in the existing power house or existing foundations that can be used for installation of the generator set. The construction period will be shortened by installing an outdoor type diesel generator with an enclosure which does not require construction of another power house. Special considerations will be given to the design so that the implementation of this project may not interfere with or cause overlapping work to the comprehensive rehabilitation work for the power station that NPA plans to undertake with aid from EEC, World Bank, etc.

Upon returning to Japan, the study team compiled basic requirements for this project based on the results of the field survey. These basic requirements are as follows:

Outline of Project

Facilities construction plan	. Construction of outdoor-type diesel generating facilities (with output capacity of 5 MW, 1 set) and necessary foundation
	. Construction of the following machinery and equipment necessary for the generating facilities: - Fuel supply - Lubricant supply - Cooling water supply - Steam supply - Compressed air supply - Air supply and exhaust - Sludge treatment - Piping
	. Construction of the following electric equipment necessary for operation of the generating facilities: - 11 kV switchgear for connection with existing facilities - 11 kV switchgear on generator side - Local control panel - Remote control panel - Excitation system - DC power supply unit - Transformer for auxiliary equipment - Grounding system - Communication system for maintenance - Wiring and cabling system
	. Test run, adjustments and acceptance test of generating facilities
Equipment and materials procurement plan	. Procurement of spare parts necessary for operation after completion of this project. . Procurement of tools required for maintenance, inspection and service of generating facilities . Procurement of teaching materials for OJT
OJT plan	. Provision of training by engineers dispatched from Japanese contractor . Provision of education in entire flow and general of O & M through classroom training (about 1 week) . Provision of education in operation and maintenance technology through practical training during execution of construction work (about 5 months)

The executing agency for this project in Sierra Leone is the National Power Authority (NPA) which is expected to assume responsibility for controlling operation and maintenance of the generating facilities after the completion of the project.

In case this project is implemented under Japan's grant aid, major items of work to be undertaken by the Sierra Leone side are securing for the

construction site including relocation of the existing structures and assignment of OJT trainees. The cost involved is about 190,000 leones (as of December 1989, 1 Leone = 2.2 Yen).

For the implementation period when this project is carried out, the detailed design work is expected to take a total of 3 months, procurement of equipment and materials: 8 months, and the site construction from the commencement of foundation works to the completion of the project: 12 months.

NPA is required to provide the construction site including temporary facilities yard by the date as specified in the scope of work for the Sierra Leone side. In addition, NPA must make contact, coordination and adjustments with the government's departments concerned and other related agencies in Sierra Leone in order to smoothly carry out the project in cooperation with the Japanese side.

The revenue from the sales of power supplied by the generating facilities for the project in 1992, the anticipated year for implementation of the project, is estimated at 212 million leones, assuming that the rate of operation is 90%. It is considered that this amount can fully meet the anticipated annual operation and maintenance cost of the generating facilities which is about 184 million leones.

As a direct effect of implementation of this project, the output of Kingtom Power Station will be increased by 5 MW. This output will improve the present tight power supply situation in the greater Freetown area, particularly contributing greatly to the stable operation of social welfare facilities and improvement of people's life. Thus, it is concluded that the implementation of this project under Japan's grant aid is highly significant and proper.

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APPENDIX

LIST OF FIGURES AND TABLES

ABBREVIATIONS

ADB	African Development Bank
EEC	European Economic Committee
E/N	Exchange of Notes
GDP	Gross Domestic Product
GTZ	Deutsche Gesellschaft Für Technische Zusammenarbeit
GWh	Giga Watt Hour (= 1,000MWh = 1,000,000kWh)
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
JEC	Japanese Electrotechnical Commission
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
NPA	National Power Authority
O & A	Operation and Maintenance
OJT	On the Job Training
UNDP	United Nations Development Programme

CHAPTER 1 INTRODUCTION

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Mining (diamonds, etc.) and agriculture (cocoa, coffee, etc.) are the mainstay of Sierra Leone's economics. With the 2nd national development plan as a starter, the country has been developing agriculture as the top priority sector in its economy from the standpoint of establishment of self-sufficiency and promotion of exports. Under the 3rd national development plan scheduled to start in 1989/90, major emphasis is placed on improvement of the energy supply situation to meet the growing need for electric power, along with the importance attached to increased agricultural production.

However, in the greater Freetown area, where nearly 20% of the nation's population is concentrated, only 25,000 households are receiving electric energy. Moreover, the present total output is only 12.7 MW as against a peak demand of about 40 MW. As a result, restriction on power supply is imposed every day, which increases residents' dissatisfaction and brings about an adverse effect on economic activities.

The power shortage is caused by obsoleteness of many power generating facilities installed at the power station in the greater Freetown area and also a lack of adequate spare parts supply, which prevents proper operation of these generating facilities.

To improve this situation, the Government of Sierra Leone and NPA formulated the "Capital Area Power Supply Improvement Plan" centering on the plan for rehabilitation of the existing Kingtom Power Station (to increase the total available capacity after rehabilitation to about 25 MW) and the plan for construction of Bunbuna Hydraulic Power Station (with output of 30.5 MW). However, in the present tight financial situation, the Government of Sierra Leone finds it impossible to implement all the projects under these plans at the same time. To supply urgently needed power for the time being, the Government of Sierra Leone requested from the Government of Japan grant aid for construction of 5 MW output diesel generating facilities.

In response to this request, the Government of Japan decided to conduct a basic design study of the Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent a basic design study team headed by Toshimichi Aoki, First Basic Design Study Division, Grand Aid Planning and Survey Department, JICA, to Sierra Leone from November 26 to December 25, 1989. (Appendix 1 shows the list of the study team members and Appendix 2, the itinerary of the local field survey.)

The objective of this survey was to precisely understand the plan for construction of the diesel generating facilities (5 MW) in Kingtom Power Station, as requested by the Government of Sierra Leone, and study the effect of the Project and its propriety as a grant aid project.

On its way to Sierra Leone, the study team visited the Japanese Embassy in Liberia, which concurrently covers Sierra Leone, and discussed this Project with the Embassy. According to the Embassy, several aid agencies including EEC and World Bank are expected to extend aid to Sierra Leone on the "Capital Area Power Supply Improvement Plan." The Embassy reported to the study team that it already informed EEC of Japan's plan to extend a grant aid to the project under review and coordinated with them. Upon entering Sierra Leone, the study team visited the officials concerned for this project (Ministry of Foreign Affairs, Ministry of Energy & Power and NPA). On these visits, the study team explained the objectives of the current survey to the officials concerned and discussed with them the general situation of power supply operation in the greater Freetown area and details of the Project under review.

At NPA, the study team heard that application for financing on the "Capital Area Power Supply Improvement Plan" to EEC, World Bank, Europe Investment Bank, GTZ, etc., is now being examined by these aid agencies and that the outcome of the application will be known by April 1990. This improvement plan is not a plan simply to implement rehabilitation work on the existing power station. Instead, it is an extensive one, even covering the overhauling of NPA's organization, structure, personnel management, etc. In other words, it is very extensive in scope and scale of work, and aims at drastic improvements in power supply. Thus, when it has been started, its completion will take a long period of time (about 7

years). For this reason, a separate emergency measure is required to meet the pressing need for power supply and NPA considers this project for construction of the 5 MW diesel generating facilities is indispensable as an emergency one. According to the Sierra Leone government, the implementation of this project will in no way impede the future undertaking of the "Capital Area Power Supply Improvement Plan" and the government already confirmed that both projects can be well coordinated in technical aspects as well.

Under such a background, the study team conducted a field survey centering on Kingtom Power Station, held discussions with officials in charge, and obtained and studied data & information on the "Capital Area Power Supply Improvement Plan." As a result, the study team reconfirmed contents of the requested project including its background, objectives, etc. The study team was also able to confirm that the implementation of the project will not hinder at all the rehabilitation and renovation plans for the existing generating facilities at Kingtom Power Station to be undertaken by EEC and other aid organizations, and that both Japan's and other aid organization's projects can technically be coordinated, for the following reasons:

(1) The plan of EEC and other aid organizations is intended to drastically improve the power supply situation in the greater Freetown area, while the Project under review is implemented as an emergency measure to meet the present pressing need for power supply. Thus, the two projects will not overlap.

(2) The rehabilitation and renovation plans being studied by EEC and other aid organizations are primarily intended for the generating facilities and auxiliary equipment installed in the existing generator building.

(3) Since the generating facilities to be provided under Japan's Grant Aid are installed in an outdoor vacant lot, they will not interfere with the facilities located inside the generator building which are scheduled to be rehabilitated or renovated.

(4) No facilities will be overlapped in the two projects because existing facilities not subject to the rehabilitation or renovation (such as the oil tanks, water tank, grounding rods, and cable routes) are also used in the project under review.

Based on the reconfirmed major contents of the request such as its background, objectives, etc., a Minutes of Discussion (see Appendix 4) was concluded between both governments on December 5, 1989. Appendix 3 shows the list of the responsible officials of the Sierra Leone party.

The study team further collected and studied data & information. Subsequently, it submitted a field report to NPA on December 19, 1989 to confirm the study concept for the basic design of the project with the Sierra Leone side (see Appendix 5). The Sierra Leone side approved the field report by means of a letter in Appendix 6.

Upon returning to Japan, the study team prepared the following basic design study report for the Project for the Improvement of Electricity Power Supply to Greater Freetown, taking into account the present status of power supply situation in Sierra Leone, present condition of the project site, the project's relations with higher level plans, and propriety, contents and scale of the grant aid.

CHAPTER 2 BACKGROUND OF THE PROJECT

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2-1 General Condition of the Country

2-1-1 Geographical Location

Sierra Leone is situated on the coastal zone of West Africa with a total land area of 71,740 km^2 (according to 1989 Annual Statistical Digest).

The country is divided into 4 areas (Northern, Southern and Eastern Provices, and Western Area).

Freetown city and its suburb, i.e., Greater Freetown (the greater Freetown area) is located in Western Area. The capital where government offices and both commercial and industrial activities are concentrated plays the role as the nation's political and economical center.

In Western Area other than Freetown city, no major commercial or industrial activities exist and these suburban areas are dotted with towns and villages mainly engaged in farming.

Sierra Leone became independent in 1961 as a member of the Commonwealth of Nations.

2-1-2 Population and Land Area

According to the census taken in 1985/86, the population and land area are as shown below.

Table 2-1 Sierra Leone's Population and Land Area

Item	Whole nation	West District		
		Freetown (capital)	Area other than capital	Total
Total population (persons)	3,515,812	469,776	84,467	554,243
Population growth rate (%/year)	2.5	5.5	7.7	5.8
Land area (km^2)	71,740	13	544	557
Population density (persons/km^2)	49	36,137	152	995

Source: 1989 Annual Statistical Digest, Central Statistics Office

2-1-3 Socio-economic Condition

Sierra Leone's economy is supported by mining industry for bauxite, diamonds, etc., and agriculture in coffee, palm oil, etc.

With the 2nd development plan that started in 1983/84 as a starter, agriculture is treated as the top priority sector from the standpoint of establishment of self-sufficiency and promotion of exports, and agricultural production has begun to increase.

However, the nation's trade balance remains in a deficit as shown in Table 2-2. The consumer price index also shows an inflation rate of about 180% a year on average as will be noted from Table 2-3. Thus Sierra Leone is placed under a very severe economic condition.

Its per capita GNP was $310 as of 1986. (Source: Africa Recovery, Oct. 1989, World Bank)

Table 2-2 Transition of Sierra Leone's Trade Balance

(Unit: Million Leones)

Item	1981	1982	1983	1984	1985	1986
Domestic Exports	124.3	109.1	151.7	370.8	548.6	1,113.2
Imports	360.4	297.0	273.1	417.6	781.6	2,321.3
Balance of Trade	-236.1	-187.9	-126.4	-45.8	-233.0	-1,208.1

Source: 1989 Annual Statistical Digest, Central Statistic Office

Table 2-3 Transition of Sierra Leone's Consumer Price Index

	1981	1982	1983	1984	1985	1986	1987	1988
Consumer Price index (Freetown)	160.7	204.0	343.3	572.6	1011.1	1328.7	5096.6	6760.7
Wholesale Price Index (1975 = 100)	-	1.3	1.7	1.7	1.7	1.3	3.8	1.32

Source: 1989 Annual Statistical Digest, Central Statistic Office
Remarks: With consumer price index in base year 1978 as 100.

2-2 Outline of the Actual Condition on the Sector Concerned

2-2-1 Administrative Organization of Power Supply Service

Power supply service in Sierra Leone is carried out by the National Power Authority (NPA), which was established under the National Power Authority Act in 1982. NPA performs all operations and management of power supply service from the planning and construction of power stations and power transmission and distribution to collection of electricity charges.

NPA developed from Electricity Department organized within the Ministry of Energy and Power in 1974. Because of this background, the NPA is still under strong control of the Ministry of Energy and Power which appoints members of the NPA Board and examines NPA's annual budget, operation reports, etc.

As of December 1989, NPA's total number of employees is 1,452 (comprising 1,269 regular employees and 183 part-timers).

As Fig. 2-1 shows, NPA is operated by a board comprising the NPA Director and 5 to 7 members and is made up of 7 divisions including Commercial Technology, Technology and Personnel.

The Power Generation Section of the Technology Division is responsible for execution of this project. This section comprises 155 staff members under the Director of Technology Division.

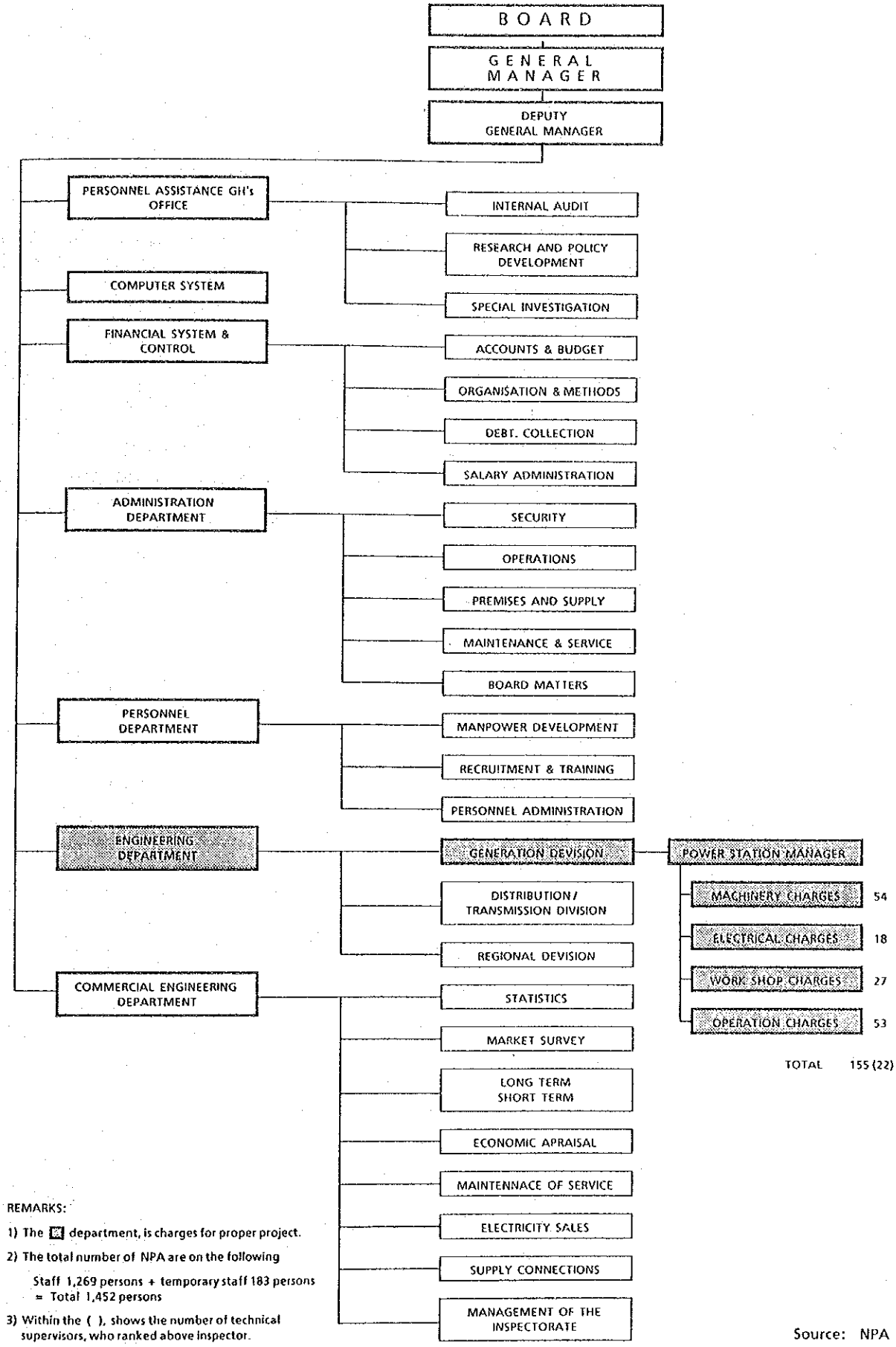


Fig. 2-1 Organization Chart of NPA

2-2-2 Financial Condition of NPA

Table 2-4 shows the financial condition of NPA. As will be noted, the running costs including fuel and labor for 1984/85 and 1985/86 exceeded the revenues from power supply. The balance of revenues and expenditures resulted in a deficit although NPA received the Government's subvention (6.6 million leones in 1984/85 and 8.4 million leones in 1985/86).

In 1986/87, the revenues (118 million leones) surpassed the operation costs (61 million leones) because of the change in the tariffs. However, the balance still remained in a deficit (297 million leones) including the repayment of long-term loans, which amounted to 3 times the revenues, foreign exchange loss and uncollected electricity charges (362 million leones).

Table 2-4 Transition of NPA's Financial Condition
(Profit and Loss Statement)

(Unit: Million leones)

	1984/85	1985/86	1986/87
1. Electricity Sales	28,119	33,370	118,146
2. Cost of Operations			
2.1 Fuel	25,054	27,737	39,556
2.2 Labor	4,975	7,551	8,579
2.3 Maintenance	1,918	1,830	2,414
2.4 Administration	6,123	9,365	8,314
2.5 Depreciation	2,473	2,710	2,761
(Subtotal)	(40,543)	(49,193)	(61,624)
3. Operating Loss Before Government Subvention	Δ12,424	Δ15,823	56,522
4. Government Subvention	6,670	8,464	6,726
5. Provincial Subsidy	Δ5,754	Δ7,359	63,248
6. Financial Charges			
6.1 Interest on long term loans	3,558	4,201	21,550
6.2 Bank charges and interest	64	53	134
6.3 Loss on exchange	30,793	+8,605	336,344
6.4 Provision for bad debts	267	232	4,179
(Subtotal)	(34,682)	(+4,119)	(362,207)
7. Other Income	544	654	1,545
8. Loss for the Year	Δ39,892	Δ2,586	Δ297,414
9. Loss Brought Forward	Δ15,108	Δ55,000	Δ57,586
10. Loss Carried Forward	Δ55,000	Δ57,586	Δ355,000

Source: NPA

This worsened financial condition is attributable to the failure to revise the tariffs as required to ensure reasonable revenues despite the fact that the power generation cost has risen due to sharp increase in fuel cost, rise in labor cost and foreign exchange fluctuations.

This aggravated financial condition has caused a shortage of fuel supply and a lack of necessary spare parts for maintenance of the power generating facilities.

To improve the deteriorated financial condition, NPA applied to the Government in November 1989 for approval to introduce a new tariff system which will increase current electricity charges by about 1.8 times. Table 2-5 shows the anticipated profit and loss under the new tariff system in 1989/90 in comparison with the operation results under the current tariff system. Under the current system tariff, it is predicted that the operations will result in the red in 1989/90. However, NPA expects that the Government will approve the proposed new tariff system and with this new system the revenues from electricity supply will substantially exceed the operation costs, thereby improving the financial condition.

As UNDP Report (Issue and Options in the Energy Sector, 1987) indicates, it is strongly desired as NPA's long-range management policy that NPA introduce a system under which it can establish reasonable electricity charges linked to both fluctuations of exchange rates and increases in fuel oil cost.

Table 2-5 Anticipated NPA Profit and Loss Statement with Introduction of New Tariffs in 1989/90

(Unit: 1,000 leones)

Item	Current tariff system		New tariff system	
	Annual profit & loss	%	Annual profit & loss	%
Unit generated (GWh)	99.2	100.00	99.2	100.00
Station consumption (GWh)	3.0	3.00	3.0	3.00
Less line loss (GWh)	14.3	15.00	14.3	15.00
Sales (units) (GWh)	81.9	82.00	81.9	82.00
Sales (value)	310,100		546,478	
Expenses				
1. Operation costs				
1.1 Total oil cost	274,700	63.01	274,700	63.01
1.2 Water	9,200	2.11	9,200	2.11
1.3 Labor	32,000	7.34	32,000	7.34
1.4 Maintenance	26,000	5.96	26,000	5.96
1.5 Station other cost	400	0.09	400	0.09
1.6 Administration cost	93,700	21.50	93,700	21.50
Total expenses	436,000	100.00	436,000	100.00
2. Profit/loss financial	Δ125,900		110,478	
3. Financial Charges	47,000		47,000	
4. Depreciation	100,000		100,000	
5. Net operating surplus/profit	Δ272,900		36,522	

Source: NPA

2-2-3 Power Supply Situation

(1) NPA's Generation Facility and Private Generation Facility

As described earlier (see 2-2-1), NPA is responsible for the power supply service in Sierra Leone and operates all the power generating facilities including power stations, substations and power transmission and distribution networks.

However, many of companies and establishments in the mining industry and commerce that constitute major consumers have installed their own standby diesel engine generating units. This is because power supply from NPA for industrial and commercial use is frequently interrupted due to lack of supply capacity so stable power supply cannot be hoped for. Table 2-6 shows the operation status of NPA's generating facilities and these standby generating units.

As will be noted from this table, the total installed capacity of standby generating units for the whole country in 1986/87 was 63 MW. This is about the same as the nation's total installed capacity (63 MW) under NPA control.

Also, according to statistics on generated energy, as the table shows, the total generated energy by private standby generating units in 1986/87 amounted to 104 GWh. In contrast, NPA's total nationwide generated energy was 71 GWh (about 70% of the total energy generated by private standby generating units). This may indicate available output of generating facilities controlled by NPA have markedly dropped.

According to UNDP Report (Issue and Options in the Energy Sector, 1986), about half of the private standby generating units (total installed capacity: 30 MW) in 1986 were located in the greater Freetown area. Total generated energy is reported to be about 40 GWh a year (about 63% of energy generated by NPA in the greater Freetown area during the same period).

Electrification by NPA's generating facilities for industrial use is generally as shown below.

Whole country : Approx. 6% (according to the above report)

Greater Freetown area: Approx. 32% (estimated by Study Team)

Table 2-6 Operation Status of NPA's Generating Facilities and Private Standby Generating Units

	National Power Authority			Private Generation			Total
	Western Area Grid	Isolated Provincial System	Total	Mines	Small Procedures	Total	
Installed capacity (MW)							
1986/87	*50	13	*63	33	30	63	126
Generation (GWh)							
1971/72	76	17	93	70	-	70	163
1981/82	132	30	162	72	-	72	234
1986/87	*63	8	*71	64	40	104	175
Losses (%)							
1981/82	27	35	28	10	-	10	-
1986/87	27	40	29	10	-	10	-

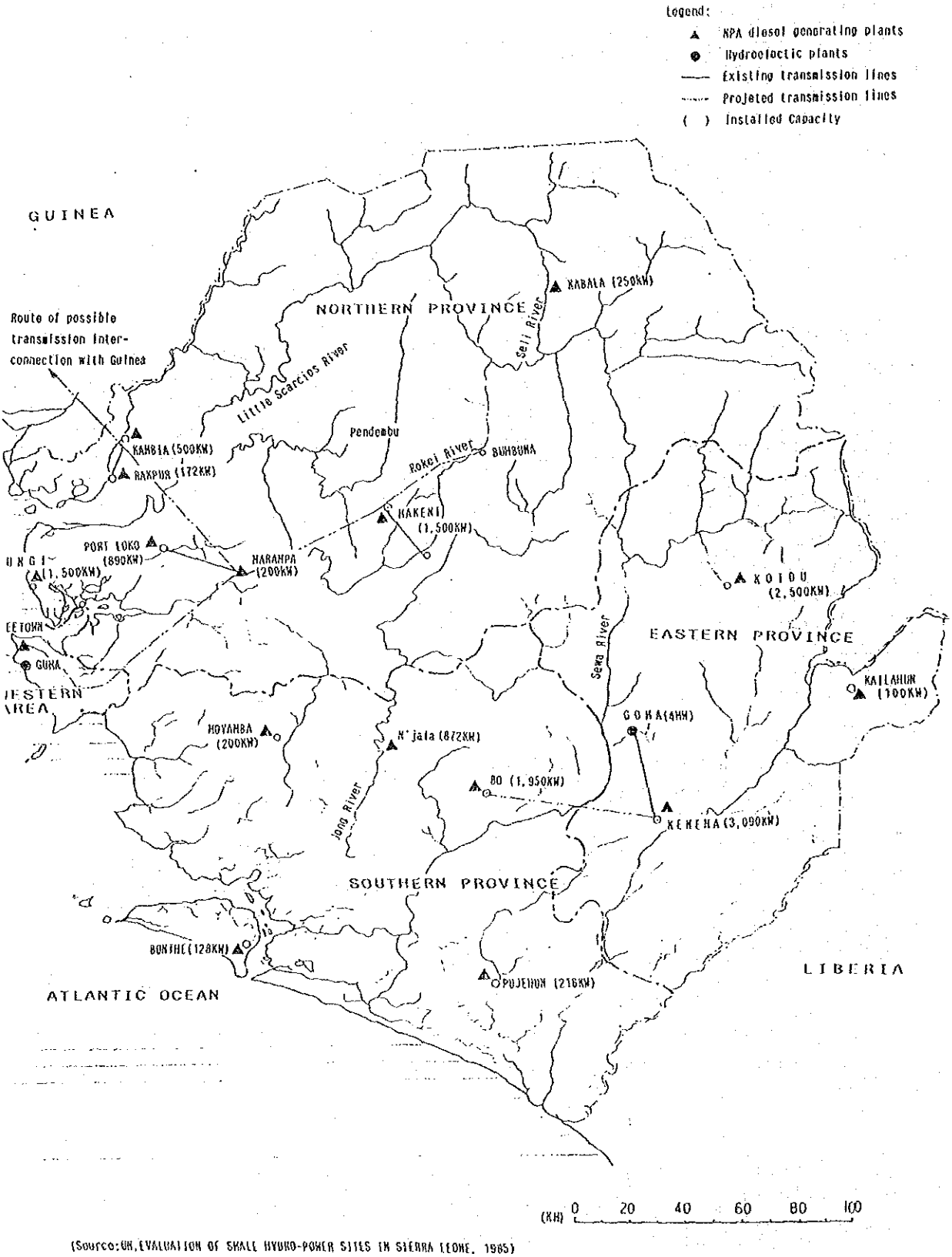
Source: UNDP, Sierra Leone Issue and Opinions in the Energy Sector, 1987
Remark: * indicates numerical values from NPA supplied data.

(2) Power Supply Situation of NPA (its power generating facilities)

The transmission and distribution networks for power generating facilities operated by NPA include networks by small- scale diesel generating units in 14 provincial districts aside from Western Area Grid in the greater Freetown area where the Kingtom Power Station is situated.

These transmission and distribution networks each supply power independently without being linked with any other network, and no nationwide network has been formed yet.

Fig. 2-2 shows the location of power stations and transmission lines in the whole country.



(Source:UN,EVALUATION OF SMALL HYDRO-POWER SITES IN SIERRA LEONE, 1985)

Fig. 2-2 Location of Power Stations and Transmission Lines in the Whole Country

1) Power generating facilities

The power generating facilities operated by NPA consist of diesel and hydroelectric power stations. At present, power supply depends mainly on diesel generating facilities. The only hydroelectric power stations is Goma Hydroelectric Power Station (with an installed capacity of 4 MW) built under aid from China. However, it is not a stable source of supply because its output drops to 0.5 MW in the low water season.

The nation's largest power station is Kingtom Power Station, the subject for the current study (as of December 1989, its total installed capacity is 50.2 MW with an available capacity of 12.7 MW).

Table 2-7 shows the operation status of power stations in various places. Fig. 2-2 shows the location of these power stations.

Table 2-7 Characteristics of Provincial Load Centers Supplied by the National Power Authority

Load Center	Inst. Cap. (kW)	Peak Demand (kW)	Volts (V)	Annual Energy Supply (MWh)	
				1977-85	1984-85
1. Kambia	500	100	415	N.A	N.A
2. Rokupr	172	90	415	N.A	N.A
3. Port Loko	890	400	415	1,608	1,245
4. Lungi	1,500	980	415	N.A	N.A
5. Moyamba	200	150	400	589	517
6. N'jala	872	380	415	N.A	N.A
7. Bo	1,950	1,300	3,300	6,013	2,908
8. Bonthe	128	100	415	N.A	N.A
9. Koidu	2,500	2,000	11,000	8,666	2,734
10. Kailahun	100	98	415	N.A	N.A
11. Kanema	3,090	1,900	11,000	7,832	3,885
12. Pujehun	216	85	415	N.A	N.A
13. Makeni	1,500	1,000	415	N.A	N.A
14. Kabala	250	146	415	502	362
Total	13,868	8,029	-	-	-

N.A. = Not available Source: UN, Evaluation of small hydro-power sites in Sierra Leone, 1985

Sierra Leone is blessed with favorable conditions for construction of hydroelectric power stations because it abounds in rivers with its considerably rugged terrain.

According to UNDP Report (Issue and Options in the Energy Sector, 1986), the total capacity of potential hydroelectric power generation for the whole country is estimated at 1,200 MW. Thus, the Sierra Leone Government, which suffers from the shortage of foreign exchange, considers construction of hydroelectric power stations is indispensable as a future stable source of power and is promoting construction plans.

2) Transmission and distribution facilities

At present, NPA uses the following voltages for transmission and distribution of power:

Transmission system: 11 kV and 3.3 kV, 50 Hz
Distribution system: 415/240 V, 50 Hz

Existing transmission and distribution lines are of aerial cable or wire type. UNDP Report (Issue and Options in the Energy Sector, 1986) indicates no major technical problems in each of transmission and distribution lines.

However, the performance of some high voltage switchgears at each power distribution station has substantially dropped due to rusty contact parts and obsoleteness.

Also, many meters on transmission and distribution systems are affected by mechanical breakdown and defects due to lack of adequate maintenance. Error in reading consumers' meters occurs frequently and overall improvement in this area is considered necessary. Because of defects in meters, electric charges cannont be accurately collected. This causes a loss in revenues by 10 to 15% in the greater Freetown area and as high as 20 to 25% on a nationwide scale. Thus, much improvement in meters is desired.

2-3 Related Plan and Programme

2-3-1 National Development Plan

As a national development plan, Sierra Leone formulated the 3rd 5-year development plan for implementation starting in 1989/90. However, as of December 1989, this 5-year plan was not made public because it was yet to be approved by government legislature.

This 3rd development plan is said to succeed the objectives of the 2nd development plan which had been formulated with the 3 years of 1983/84 to 1985/86 as the plan implementation period (actually the plan was implemented after being delayed for 2 years).

The development objectives of the 2nd development plan and measures to attain these objectives are as follows:

(1) Development objectives

- o To accelerate the process of economic recovery and stabilization,
- o To initiate structural changes and reduce the reliance on non-renewable resources,
- o To raise the living standards of the rural community through the implementation of an integrated rural development program,
- o To increase the welfare of the broad mass of population.

(2) Strategy

- o Improved efficiency of capital already invested;
- o Speedy execution of on-going projects.

According to the record of a speech which the Finance Minister delivered at the time of compilation of the 1989/90 budget, the Minister proposed that the planned 3rd 5-year development plan be revised to a medium range one by shorting its period to 3 years because of rapid changes in various economic indexes in the country including foreign exchange fluctuations in recent years and sharp rises in commodity prices.

Furthermore, it was proposed that efforts be made to accomplish the following additional objectives under the national development plan:

- To improve living standards in all strata of the people
- To complete social infrastructure which is effective for strengthening the nation's self-sufficiency

Meanwhile, the Ministry of Development and Planning has drawn up emergency economic development plans as a means to attain the goals of the national development plan. Table 2-8 shows an outline of these plans.

Table 2-8 Emergency Development Plans Formulated by the Ministry of Development & Planning

Item	Significance of development	Emergency measures
Agriculture	Nation's top priority sector for development	- To establish food self-sufficiency, involving reform of market structure and rationing system
Industry	Development of small-scale industry from viewpoint of assistance and promotion of multiple industries (manufacturing industry for farm implements, machine parts, etc.)	- To reserve foreign exchange for optical investment
Social welfare	Foundation for development of talented personnel	- To place emphasis on medical service and education - To install effective pharmaceutical product supply facilities - To rehabilitate primary and junior high schools and training schools
Energy	Foundation for development of industry Social foundation	- To rehabilitate Kingtom Power Station
Water supply	Foundation for development of industry Social foundation	- To review capital area water supply system currently affected with frequent supply failure
Road	Foundation for development of industry Social foundation	- To repair existing 5,000 km roads (2nd road maintenance plan, World Bank)

2-3-2 Development Plan for Project Implementing Sector

As for development plans in the Project implementing sector, many aid agencies are conducting surveys. These aid agencies include UNDP, World Bank, GTZ of West Germany, EEC, etc., and are studying the rehabilitation plans for Kingtom Power Station and improvement of NPA's management capability.

These surveys point out that the biggest contributing factor to the worsened power supply situation that Sierra Leone faces at present is lack of NPA's management capability. Thus, various recommendations and proposals have been made for reconstruction of NPA on a long range base, such as the need for drastic structural reform of NPA if it is to operate as a stable source of electric energy in the future.

Table 2-9 shows survey objectives and recommendations in major survey reports.

As described in Chapter 1, NPA has applied to EEC, GTZ, World Bank, etc., for funds needed in implementing "Capital Area Power Supply Improvement Plan." This plan consists of two major plans. One of these plans is to improve NPA's management capability through organizational improvements as proposed in World Bank and EDF International reports as shown in the above table. The other plan calls for complete rehabilitation of Kingtom Power Station as mentioned in GTZ report.

2-3-3 Role of This Project

As mentioned earlier (2-3-1), Sierra Leone places particular emphasis on agricultural policy in order to attain the nation's economic independence.

Power supply service is also given the highest priority next to agriculture to meet growing needs for power supply as the agricultural policy is expanded, as well as to provide foundations for basic fields of living such as medical service and education.

Table 2-9 Report on the Survey of Leading Overseas Assistance Agencies

Title of the Report	Implementation System	Financing System	Term	Outline of the Objects of Survey and Proposals
Sierra Leone: Issues and Options in the Energy Sector (UNDP/ World Bank Joint Report)	World Bank	UNDP: ENERGY Account	1986 - 87	Objects of Survey (1) The survey was conducted as a coherent part of the UNDP/WB Energy Sector Survey Program. (2) Survey of the existing states of energy, economy and each energy sector (petroleum, electric power, firewood) including management of organizations and future programs with a view to bringing up points at issue. Proposals (relative to electric power) (1) NPA should be made independent from MEP (Ministry of Energy and Power). (2) Establishment of tariff system capable of covering the cost of power generation and allocation of foreign currency needed for importing spare parts used for periodical check and maintenance of equipment. (3) Drafting of short-and-long-range programs by MEP. (4) Upward revision of pay for the NPA engineers. (5) Reinforcement of high-ranking management groups. (6) Drafting of middle management group training programs. (7) Construction of training facilities for the middle-ranking engineers. (8) Implementation of OJT for acquiring maintenance knowhow for preventive maintenance and periodical check .
DIESEL POWER STATION KING TOM (GTZ Report)	LAHMEYER INTERNATIONAL	GTZ	1987	Objects of Survey (1) Rehabilitation of the King Tom Power Station having been the object, the survey was aimed at undertaking scrutiny of the existing state of the power generating facilities from the technical aspect and bringing out points at issue. (2) Survey of the existing state of civil engineering and construction works related to the above and bringing up of the points at issue. (3) Survey of the existing organization of NPA from the standpoint of operation, maintenance, management and repairs and bringing up of points at issue. Proposals (1) Rehabilitation work should be proceed in the following order: 1. Rehabilitations on the power generating facilities (including auxiliary equipment) made by KHD and repair on the hoist and crane. Replacement of the 11 kV switchboard. Installation of new sludge and waste oil disposal equipment. 2. Rehabilitations on the power generating facilities, (including auxiliary equipment) made by SULZER. 3. Rehabilitations on the foundations for MAN No. 1 and No. 2 unit including auxiliary equipment. 4. Rehabilitations on MAN No. 1 and No. 2 including auxiliary equipment. 5. Rehabilitations on all the structures and outer compounds. (2) The rehabilitation work period shall be 17 months and the cost of repairs shall be 22,830 KDM. (3) For the purpose of providing guidance for operating and managing the power generating facilities and rehabilitation work, at least two (2) foreign specialists should be stationed at the power station during the work. (4) Improvement of the NPA organization is needed in parallel with the rehabilitation work. (5) Acquisition of related documents (drawings, specifications included) management knowhow is needed simultaneously with acquisition of spare parts management knowhow. (6) In order to complete the repair work in safety during the given period, safe cleaning of the power generating plant and repair on defective parts are needed under guidance of some European engineers.
REHABILITATION OF THE ELECTRICITY SECTOR FACT FIDING STUDY (EDF INTERNATIONAL Report)	EDF INTERNATIONAL	EEC	1988	Objects of Survey (1) Survey of the system, organization, financial resources, talented personnel resources and technical problems of the sector and bringing up points at issue. (2) Preparation of repair program, including organization reforms and technical guidance. Proposals (1) As emergency countermeasures the following measures should be worked out within six (6) months: 1. Change the committee members. 2. NPA's technical and management divisions should be cut off from the government organization as an independent entity. 3. Tariff system should be collected from the foreign enterprises in foreign currency. 4. A technical guidance team should be accepted into the organization in order to improve NPA's management function. 5. The government should freeze NPA's debts till completion of the emergency countermeasures. 6. Measures aimed at reducing NPA's staff members by 30% within three (3) years should be worked out. 7. The government should excuse NPA from paying all taxes till completion of the reforms. 8. The government should intercede with the National Oil Company in behalf of NPA to supply fuel at minimum price lower than the international market price. 9. The government should allow NPA to change tariff automatically in line with the fuel price and inflation till completion of the reconstruction. (2) As short-term countermeasures the following measures should be worked out during 12 to 18 months: 1. Implementation of power generating facilities (including auxiliary equipment) repairs. 2. Implementation of rehabilitation work on the power transmission and distribution network in the Greater Free Town. 3. Reorganization of user control division for grasp of user data, such as accurate demand on power. 4. Implementation of reorganization and equipment reinforcement for the sake of promoting higher efficiency in the general affairs and accounting divisions. 5. Installation of equipment for power generating facilities development. (3) As intermediate countermeasures the following measures should be worked out during 25 to 36 months: 1. Establishment and maintenance of local centers. 2. Determination of power generating facilities development program. 3. Development of training centers for learning new technologies and control methods. 4. Unification of equipment specifications. 5. Reforms in the pay system of NPA.

However, as already described (see Chapter 1), there is a wide gap between the peak energy demand and total generated energy (about 27.3 MW as of 1989). It is impossible to narrow this gap at a stroke, particularly under the nation's present tight financial condition.

This project for installation of 5 MW diesel generating facilities will serve as one of the emergency measures taken to meet targets for the national development plan. The generating facilities to be constructed under the project will play the role of providing a social foundation for public facilities that contribute to social welfare such as medical service and education in the present tight energy supply situation.

2-4 Outline of the Request

2-4-1 Background of the Request

In Sierra Leone, needs for electric power have been growing along with increased agricultural production in recent years. Particularly in the greater Freetown area, peak demand reached about 40 MW by 1989. For this growing demand, Kingtom Power Station is the only source of power supply to the greater Freetown area at present. However, its total generated energy in 1989 was only 12.7 MW because the output of its generator dropped due to highly deteriorated equipment, shortage of spare parts and lack of proper maintenance control. Consequently, the area served by this Power Station is affected by a power cut practiced on a daily basis. This power stoppage causes adverse effect on residents' everyday life and economic activities.

To improve this situation, the Sierra Leone government and NPA formulated plans to construct a hydroelectric power station and rehabilitate the existing Kingtom Power Station. However, it is financially impossible for the nation to implement both plans at the same time. Thus, to meet the emergency need for power for the time being, the Sierra Leone government requested from the Government of Japan grant aid in newly constructing 5 MW diesel generating facilities.

2-4-2 Contents of the Request

Contents of the request which the study team has confirmed through discussion with the officials concerned in Sierra Leone are as follows:

(1) To supply and install 5 MW output diesel generating facilities (including necessary auxiliaries and electric equipment)

(2) To perform test run, adjustments and acceptance test of the above generating facilities

(3) To supply spare parts for the above generating facilities

(4) To undertake foundation work for the above generating facilities

(5) To provide training to NPA staff and transfer technology on operation and maintenance (O & M) of the generating facilities during execution of the Project

NPA understands that the lack of spare parts is one of the causes of the drop in the output of the existing power station. Thus, they strongly desire the supply of spare parts to cover at least 24,000 hours of operation in order to provide adequate maintenance to the generating facilities for the Project and ensure their long, stable operation.

NPA also requests transfer of technology for optimum control of maintenance and operation of the generating facilities to secure a highly reliable and stable source of power to meet the serious power shortage in Sierra Leone. For this reason, they strongly desire NPA staff's training in Japan and the dispatch of engineers from Japan after completion of the Project, in addition to OJT during execution of the construction work.