

**BASIC DESIGN STUDY REPORT  
ON  
THE PROJECT FOR  
URGENT IMPROVEMENT OF ELECTRIC POWER  
SUPPLY SYSTEM IN FREETOWN  
IN  
THE REPUBLIC OF SIERRA LEONE**

**MARCH 2007**

**JAPAN INTERNATIONAL COOPERATION AGENCY**

**YACHIYO ENGINEERING CO., LTD.**

<b>GM</b>
<b>JR</b>
<b>07-067</b>

## PREFACE

In response to a 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 Urgent Improvement of Electric Power Supply System in Freetown and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Sierra Leone a study team from August 20 to September 19, 2006.

The team held discussions with the officials concerned of the Government of Sierra Leone, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Sierra Leone in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

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

March 2007

Masafumi Kuroki  
Vice-President  
Japan International Cooperation Agency

March 2007

## **LETTER OF TRANSMITTAL**

We are pleased to submit to you the basic design study report on the Project for Urgent Improvement of Electric Power Supply System in Freetown in the Republic of Sierra Leone.

This study was conducted by Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from August, 2006 to March, 2007. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Sierra Leone and formulated the most appropriate basic design for the project under Japan's Grant Aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Mitsuhisa Nishikawa  
Project manager,  
Basic design study team on the Project  
for Urgent Improvement of Electric Power  
Supply System in Freetown  
Yachiyo Engineering Co., Ltd.

## **SUMMARY**

# SUMMARY

## ① Country Profile

The Republic of Sierra Leone (hereinafter referred to as “Sierra Leone”) is situated in western Africa on the Atlantic coast. It has a population of 5.7 million (State of World Population 2006) and an area of approximately 70,000 km<sup>2</sup> (about the size of Hokkaido). Sierra Leone is in a tropical climate zone, so it experiences high temperatures and humid throughout the year, and has both a rainy season (May to October) and a dry season (November to April).

Since 1991, Sierra Leone has been under an ongoing civil war, which was first initiated by the Revolutionary United Front (RUF) who opposes the government. Despite continued political instability due to a military coup in May 1997, a peace agreement between the Government of Sierra Leone and the RUF was signed thanks to the support of the Economic Community of West African States (ECOWAS), international organizations and the DDR project (disarmament, demobilization and reintegration), resulting in a return to relatively stable conditions. With an opportunity at hand, in January 2002 President Kabbah declared an end to the process of disarmament and the termination of civil war, thus paving the way for international and bilateral assistance for reconstruction and the resettlement of his people.

Main products such as cacao and coffee and mineral resources such as diamonds, gold and bauxite in Sierra Leone have high export potential, and are a major source of foreign currency. However, the economy remains sluggish due to the weakness of many of these products on the international market, inefficient economic management, and dominance of illegal activities such as smuggling. As the civil war intensified, the economy began to fail due to devastation in farming and mineral producing areas. Currently, the economy of Sierra Leone is in a period of reconstruction (9.2% recorded growth in GDP in 2003 and 7.4% in 2004). However, since approximately 30% to 40% of the annual budget is dependent on development assistance, fiscally the government is still in the red. Sierra Leone’s per capita GNI (gross national income) is US\$210 (estimated by the World Bank in 2004).

## ② Background, Details and Outline of the Requested Project

A project formulation study on the infrastructure (electric power, roads and water supply) was carried out by Japan through the Japan International Cooperation Agency (JICA) between June and July 2005 with the aim of formulating a project pertaining to assistance for reconstruction in Sierra Leone. During the said study, it was confirmed that output from the generator (approximately 30 MW of the total rated output) at the Kingtom Power Station, which is the only power plant supplying electric power in Freetown City, the capital of Sierra Leone, had dropped

due to deterioration in the generators and auxiliary facilities and available output had fallen to the 20 MW level. On the other hand, the maximum power demand of the city was estimated to be approximately 45 MW at the time in 2006. In addition to deteriorated power generating units, a distribution loss of approximately 40% or more, was due to damaged or deteriorated power distribution systems, and so power supply capacity is extremely insufficient. As a result, rolling blackouts are a frequent occurrence and the household electric power consumers are able to receive electricity for only a few hours, one day a week.

Faced with this situation, the Ministry of Energy and Power (MEP) and the National Power Authority (NPA) are installing diesel engine generators through the assistance of South Africa's national electricity supplier (ESKOM) and the *Banque Arabe pour le Développement Economique en Afrique* (BADEA: Arab Bank for Economic Development in Africa), and are constructing the Bumbuna hydropower plant through a syndicated loan mainly from Italian Commercial Bank partially guaranteed by the World Bank in order to secure necessary generation capacity. However, even after the construction of the new power source is completed, the available output of the Bumbuna hydropower plant will fall from 50 MW to 18 MW during the dry season (for 4 to 5 months); therefore it will be still difficult to secure the necessary capacity of stable electricity supply.

In view of the situation, in 2005 the Government of Sierra Leone deemed crucial the installation of a new power source to recover the capital function, and introduced a plan to develop a new power source of 100 MW over a ten-year period. The Government of Sierra Leone submitted a request to the Government of Japan for Grant Aid for the construction of a new diesel power generator with a total output of 10 MW as part of the output and the rehabilitation of the city's power distribution network in an effort to reduce distribution loss.

In response to this request, the Government of Japan carried out a preliminary study which was conducted by JICA in March 2006, confirming the relevance of constructing a 10 MW diesel engine generator, by collecting and analyzing data necessary to implementing a basic design study through (1) confirmation of the operation and maintenance conditions of the existing diesel engine generator and auxiliary facilities at the Kingtom Power Station, (2) investigation of deterioration and state of failure of the existing power distribution equipment in the distribution network in Freetown and a preliminary examination on the range of rehabilitation, (3) confirmation of the state of assistance for the electric power sector by the above-mentioned donors, and (4) confirmation of the existence of problems from an environmental and social point of view. With respect to the rehabilitation of the 33 kV and 11 kV distribution network (systems), it was also confirmed that the scope of assistance should be narrowed down in collaboration with

improvements to the Freetown power distribution network through the Power and Water Project (PWP) being financed by the World Bank.

③ Overview of Findings of the Study and Contents of the Project

Based on the above-mentioned request and the findings of the preliminary study, the Government of Japan decided to carry out a Basic Design Study and the Japan International Cooperation Agency (JICA) dispatched a Basic Design Study Team to Sierra Leone from August 20 to September 19, 2006 in order to reconfirm the requested components and to discuss the contents of the implementation with concerned authorities in Sierra Leone. At the same time, a survey of the project site was conducted and related materials collected.

After returning to Japan, the Basic Design Study Team examined the necessity and social and economic effects and the relevance of the Project based on the materials of the field survey and compiled the results in a draft final report. From February 25 to March 2, 2007 JICA dispatched the study team to explain and discuss the draft final report (Basic Design Study Report) and obtained the consent with Government of Sierra Leone.

The requested Japanese assistance formulated from the results of the study includes the construction of a powerhouse necessary for the 10 MW (5 MW × 2 units) diesel engine generators (DEGs), the procurement and installation of equipment and materials, and rehabilitation of the 33/11 kV power distribution systems. The Basic Plan for the requested Japanese assistance that was compiled based on the findings of the field survey and discussions with the Sierra Leonean side is outlined in the following table. Within the contents of the rehabilitation for 33/11 kV systems, the “construction of 11 kV distribution line between the Kingtom Power Station and the Congo Cross Primary Substation” described in (3) 1) of 1, the “provision of 11 kV distribution equipment between the Falcon Bridge Primary Substation and the Blackhall road Primary Substation” described in (1) of 2 and the “provision of 11 kV distribution equipment between the Regent Primary Substation and transformer stations for 11 kV power distribution” described in (2) of 2 in the following table were not included in the components during the stage of the preliminary study. However, since rehabilitation of 11 kV distribution systems is to be excluded from the Power and Water Project (PWP) by the World Bank, those components are urgently needed, so the Sierra Leonean side has asked that they be included within the scope of the requested Japanese assistance. The additional components were judged to be relevant from a crisis standpoint in order to produce effects of the Project and will be included in this Project.

## Outline of the Basic Plan

	Description
Freetown Power Distribution Network Improvement Plan (Phase-1)	<p><b><u>1. Procurement &amp; Installation of Following Equipment:</u></b></p> <p>(1) Construction of 33 kV Regent primary substation with the following equipment 33 kV, 11 kV indoor-type feeder panel &amp; low-voltage feeder panel A power distribution transformer (33/11 kV, 5 MVA), a station transformer (11 kV/415 to 240 V, 630 kVA) Other necessary auxiliary equipment &amp; foundations</p> <p>(2) Extension of 33 kV distribution lines from Wilberforce Primary Substation to Regent Primary Substation 1) Approx. 3.2km of underground cable and approx. 1.3km of overhead line. 2) A 33 kV power feeder panel in Wilberforce Primary Substation.</p> <p>(3) Construction of 11 kV power distribution lines 1) Between Kingtom Power Station and Congo Cross Primary Substation: Approx. 3.3 km of overhead line &amp; approx. 0.5 km of underground cable, 2) A 11 kV feeder panel each for Kingtom Power Station and Congo Cross Primary Substation 3) Between Congo Cross Primary Substation and Wilberforce Primary Substation: Approx 2.5 km of overhead line</p> <p><b><u>2. Procurement of Following Equipment and materials (Installation work shall be done by Sierra Leone)</u></b></p> <p>(1) Materials for 11kV power distribution line between Falcon Bridge Primary Substation and Blackhall Road Primary Substation: Approx. 0.8 km of overhead line and approx. 2.6 km of underground cable</p> <p>(2) Materials for 11kV power distribution line between Regent Primary Substation and following distribution substations: 1) To Guma Water Reservoir: Approx. 1.3 km 11kV of overhead line 2) To Radio transmitting station: Approx. 1.6 km of 11kV overhead line 3) To Wilberforce line: Approx. 100 m of 11 kV overhead line</p> <p>(3) 11kV power distribution equipment &amp; materials for the substations. 1) One (1) 500 kVA &amp; one (1) 200 kVA transformers and two (2) of RMU (Ring Main Unit) 2) One (1) 315 kVA &amp; one (1) 200 kVA transformers and two (2) of RMU (Ring Main Unit)</p> <p>(4) Procurement of spare parts for power distribution facilities &amp; maintenance tools (5) Procurement of operation &amp; maintenance manuals for power distribution facilities and implementation of OJT</p>
Kingtom Power Station Extension Plan (Phase-2)	<p><b><u>3. Procurement &amp; Installation of Following Equipment:</u></b></p> <p>(1) Procurement &amp; installation of 2 sets of diesel engine generator (DEGs) with output capacity of 5 MW each.</p> <p>(2) Procurement &amp; installation of the following mechanical auxiliaries for the relevant power generating facilities Fuel oil supply system, lubricating oil system, air intake &amp; exhaust gas system, cooling water system, compressed air system, sludge treatment system, piping system.</p> <p>(3) Procurement &amp; installation of the following electrical equipment necessary for the relevant power generating facilities 1) Auxiliary equipment Generator control &amp; monitoring panels, generator protection relays panel, LV motor control panel, DC power supply system 2) 11 kV high voltage electric equipment 11 kV high voltage panel, 11 / 0.415 kV station transformer, cabling &amp; wiring, etc.</p> <p>(4) Procurement of spare parts for power generating facilities &amp; auxiliary equipment and maintenance tools (5) Procurement of operation &amp; maintenance manuals for power generating facilities &amp; auxiliary equipment and implementation of OJT (On-the Job Training)</p> <p><b><u>4. Building Construction Work</u></b></p> <p>(1) Construction of a powerhouse (one story, partially two stories) with total floor approx. 1,087 m<sup>2</sup> (including building utilities) (2) Construction of foundations for DEG &amp; auxiliary equipment.</p>



## Construction Period and Estimated Project Cost

In the case of implementing the Project through the Japan's Grant Aid scheme, the total project cost is estimated to be approximately ¥2,241 million (approximately ¥2,222 million to be taken by Japan and approximately ¥19 million to be taken by Sierra Leone). Major undertakings to be taken by the Sierra Leonean side include the removal of foundations of the existing diesel engine generator and the auxiliary equipment and installation of 11 kV power distribution equipment and materials to be procured by Japan (only provision of equipment and materials). The construction period of the Project, including a detailed design, will be approximately 17.5 months for the Improvement of Freetown Distribution Network (Phase-1) and 21.5 months for the Extension of Kingtom Power Station (Phase-2).

## Examining the Appropriateness of the Project

Following the completion of the Project, the facilities and equipment to be improved by the Project will be operated and maintained by NPA, which is the implementing agency. Since the personnel of NPA have basic knowledge in the operation and maintenance of diesel generating facilities and power distribution equipment, it is expected that the facilities and equipment will be appropriately maintained even after the completion of the Project through OJT in operation and maintenance provided at the execution stage of the Project, and through the provision of spare parts and preparation of operation and maintenance manuals.

Approximately one million (1,000,000) residents in Freetown and surrounding areas are expected to benefit from the Project. Implementation of the Project will secure the capacity needed to ensure a stable supply of electric power since the generating capacity will exceed 7.0 MW at peak load in the target year (2012). In addition, power distribution capacity will increase by improving distribution lines connecting primary substations. As a consequence, stability of the electric power supply will increase thus improving people's living standards, more stable operation of public facilities, and stimulate vital industrial and economic activity. Since significant effects are anticipated from the Project, the requested assistance through the Japan's Grant Aid scheme appears to be appropriate.

Major undertakings to be implemented by Sierra Leone are described as follows in order to produce the desired continuous effects of the Project.

- (1) Although the total generating output until 2014 will exceed the peak demand through the implementation of the Project, power sources to meet a growth of power demand after 2015 should be surely developed and the marginal supply capacity (reserve capability) should be ensured so as to stop the generating system for periodical maintenance.

- (2) By ensuring budget necessary for appropriate maintenance of the power generation, transmission and distribution systems and purchase of spare parts, in order to minimize the possibility of suspensions in service due to an emergency or repair work by any chance, it should be planned to constantly store emergency spare parts.
- (3) The results of the OJT and the counterpart (C/P) training should be certainly conveyed to all operation and maintenance personnel. At the same time, it should be endeavored to create preventive maintenance skills and to maintain and improve operation and maintenance skills.
- (4) In order to maximize the Project's effects, power supply improvement projects through the assistance of other donors should also be certainly implemented.
- (5) Short-term and medium-term demand forecasts should be reviewed by annually reexamining the total generating output and electricity demand.

# CONTENTS

Preface	
Letter of Transmittal	
Summary	
Contents	
Location Map	
List of Figures and Tables	
Abbreviations	
Chapter 1 Background of the Project .....	1-1
1-1 Background of the Study .....	1-1
1-2 Natural Conditions .....	1-3
1-3 Environmental and Social Considerations .....	1-5
Chapter 2 Contents of the Project.....	2-1
2-1 Basic Concept of the Project.....	2-1
2-1-1 Overall Goal and Project Objectives .....	2-1
2-1-2 Outline of the Project .....	2-1
2-2 Basic Design of the Requested Japanese Assistance .....	2-2
2-2-1 Design Policy .....	2-2
2-2-1-1 Basic Concept.....	2-2
2-2-1-2 Natural Conditions.....	2-2
2-2-1-3 Socio-economic Conditions.....	2-3
2-2-1-4 Procurement Conditions .....	2-3
2-2-1-5 Effective Use of Local Construction Companies, Local Materials and Equipment.....	2-3
2-2-1-6 Maintenance and Management Capability of Implementing Agency .....	2-4
2-2-1-7 Scope of Facilities and Equipment, Grade Setting .....	2-5
2-2-1-8 Construction and Procurement Methods, Work Period .....	2-5
2-2-2 Basic Plan.....	2-6
2-2-2-1 Master Plan .....	2-6
2-2-2-2 Basic Plan Overview .....	2-10
2-2-2-3 Equipment and Facility Plan Overview .....	2-11
2-2-3 Basic Design Drawings (Refer to attached materials).....	2-31
2-2-4 Implementation Plan .....	2-31
2-2-4-1 Implementation Policy.....	2-31
2-2-4-2 Implementation Conditions .....	2-33

2-2-4-3	Scope of Work .....	2-34
2-2-4-4	Consultant Supervision.....	2-36
2-2-4-5	Quality Control Plan.....	2-38
2-2-4-6	Procurement Plan.....	2-39
2-2-4-7	Operation Guidance Plan.....	2-41
2-2-4-8	Implementation Schedule .....	2-43
2-3	Obligations of Recipient Country .....	2-45
2-4	Project Operation Plan.....	2-46
2-4-1	Basic Concept.....	2-46
2-4-2	Operation Plan on the Relevant Power Generating System .....	2-47
2-4-3	Periodical Inspection Items .....	2-48
2-4-4	Fuel Oil Procurement Plan .....	2-51
2-4-5	Spare Parts Purchase Plan .....	2-51
2-5	Project Cost Estimation .....	2-56
2-5-1	Initial Cost Estimation.....	2-56
2-5-2	Operation and Maintenance Cost .....	2-57
2-6	Other Relevant Issues .....	2-60
Chapter 3 Project Evaluation and Recommendations .....		3-1
3-1	Project Effects.....	3-1
3-2	Recommendations.....	3-2
3-2-1	Recommendations to be Taken by Recipient Country .....	3-2
3-2-2	Technical Cooperation and Coordination with Other Donors.....	3-2

## Appendices

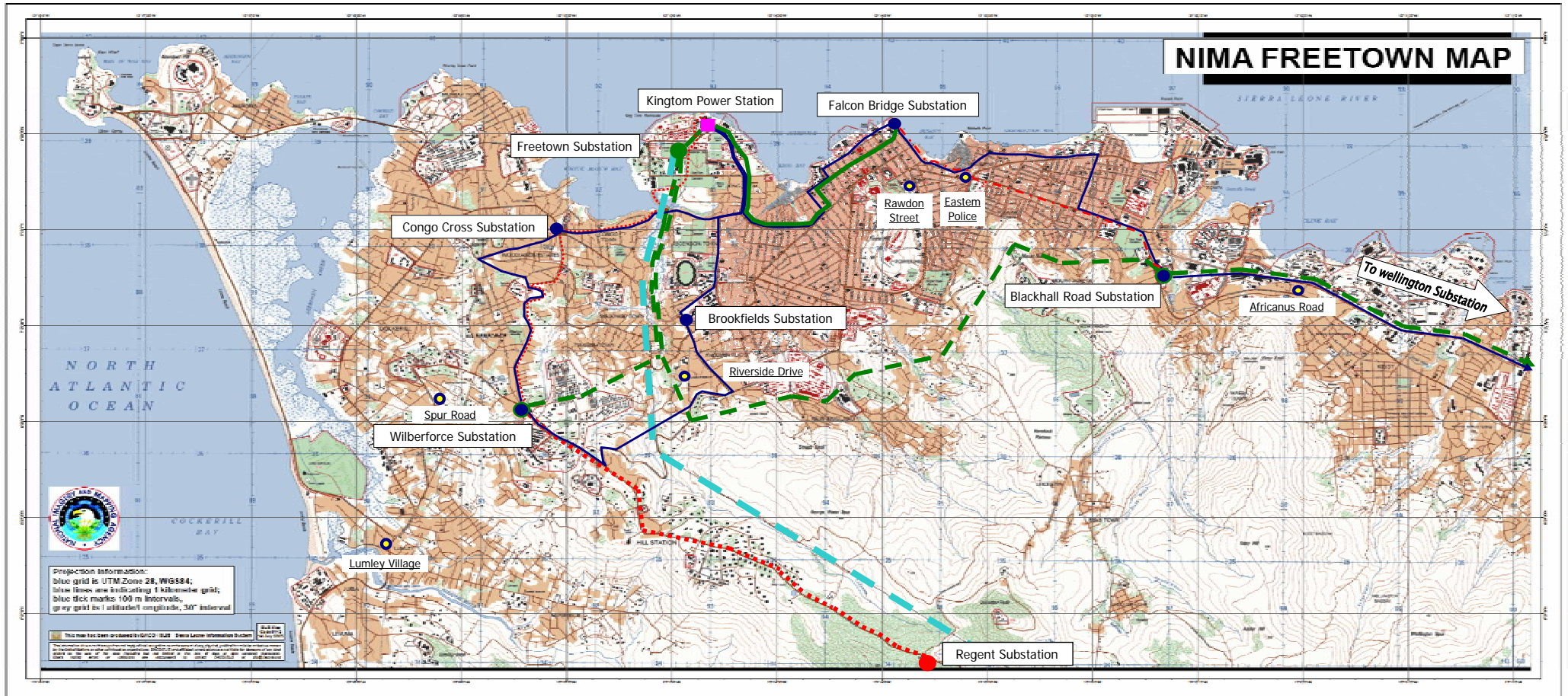
1. Member List of the Study Team
2. Survey Schedule
3. List of Parties Concerned in the Recipient Country
4. Minutes of Discussions
5. Basic Design Drawings
6. Demand Forecast in Freetown Power System



シエラレオネ共和国全図  
Map of the Republic of Sierra Leone



# Project Sites



- [Remarks]
- Kingtom Power Station (Scope of the Project)
  - 11 kV Primary Substation
  - 11 kV Secondary Substation
  - 33 kV Substation (Existing)
  - 33 kV Substation (to be upgraded under the World Bank Project)
  - 33 kV Substation (Scope of the Project:Procurement and Installation)

- 11 kV Distribution Line (Existing)
- ⋯ 11 kV Distribution Line (Scope of the Project:Procurement and Installation)
- - - 11 kV Distribution Line (Scope of the Project:Procurement(Installation by NPA))
- 33 kV Distribution Line (Existing:Faulty)
- - - 33 kV Distribution Line (to be constructed under the World Bank Project)
- ⋯ 33 kV Distribution Line (Scope of the Project:Procurement and Installation)
- 161 kV Sub-transmission Line (Plan)

Source of the Map: [http://www.daco-sl.org/encyclopedia/2\\_data/2\\_3b3\\_t.htm](http://www.daco-sl.org/encyclopedia/2_data/2_3b3_t.htm)

