Ghana Grid Company Ltd. (GRIDCo)
Ministry of Power
The Republic of Ghana

PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR
POWER SUPPLY TO ACCRA CENTRAL
IN
THE REPUBLIC OF GHANA

AUGUST 2015

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

YACHIYO ENGINEERING CO., LTD.

WEST JAPAN ENGINEERING CONSULTANTS, INC.

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to the Consortium consist of Yachiyo Engineering Co., Ltd. and West Japan Engineering Consultants, Inc..

The survey team held a series of discussions with the officials concerned of the Government of Ghana, and conducted field investigations. As a result of further studies in Japan, 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.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Ghana for their close cooperation extended to the survey team.

August, 2015

Takumi UESHIMA

Director General,

Industrial Development and Public Policy Department

Japan International Cooperation Agency

SUMMARY

① Overview of the Country

The Republic of Ghana (hereinafter referred to as “Ghana”) is located in central western Africa between 4° and 11° north latitude, and 3° west and 1° east longitude, Ghana faces the Gulf of Guinea to the South, and is bordered by Togo to the east, the Republic of Cote d’Ivoire to the west, and the Republic of Burkina Faso to the north. The population of Ghana is about 25.5 million (FY2012). Its territory is approximately 238,000 km^2 (about 0.6 times of the area of Japan) and almost completely flat land less than 300 meters above sea level. Its climate is tropical and humid throughout the year with an annual average temperature of about 25℃ to 30℃. The rainy season extends from March to July, and its maximum monthly rainfall reaches less than 180mm.

In 1995, the Government of Ghana formulated the "Vision 2020" which comprises comprehensive long-term development guidelines for the purpose of promoting sustainable economic growth, poverty reduction and democratic policies and actively pursued the economic development of the country. Especially, such subjects as development of human resources, economic growth, agricultural development and provision of circumstances for these developments are prioritized. For power sector development, “to achieve sure access to electricity in villages holding population more than 500” is adopted as the final objectives.

However, economy of Ghana is dependent on the primary industry, as its main exporting materials are cacao, gold and timber materials. Ghana is exposed to fluctuation of their international market prices. As the result, Ghana is designated as the heavily-indebted poor country (HIPC).

② Background of the Project

Ghana has developed a National Electrification Scheme (NES) and Self-Help Electrification Plan (SHEP), reaching a high electrification access rate of 72% as of the end of 2011. However, with commercial oil production starting in 2010 and recorded economic growth rates of 15%, power demand is expected to rise sharply in the future. The Ghanaian government and public power utility formulated a Transmission Master Plan in 2011 and expect national power demand to grow an average of 6.3% annually from 2009 to 2020. However, power development projects based on this growth have been stalled, particularly by power distribution facilities in the Accra area. The Ghanaian government has thus requested grant aid from Japan to achieve self-reliant, sustainable socioeconomic growth with the Preparatory Survey on the Project for Power Supply to Accra Central in the Republic of Ghana.

③ Outline of the study findings and Project contents

In response to the request, JICA dispatched the Survey Team to Ghana from January 11 to February 19, 2014 (first field survey) in order to reconfirm the contents of the request and discuss the contents for implementation with related agencies on the Ghana side (responsible government agency: Ministry of Power (MoP), and implementing agency: GRIDCo), and survey the Project sites and gather related

materials and data.

On returning to Japan, the Survey Team examined the necessity, social and economic impacts and validity of the Project based on the field survey materials and compiled the findings into the draft preparatory survey report. JICA dispatched the Survey Team to Ghana for the middle field survey on August 25, 2014 in order to reconfirm the contents of the request. Also, JICA dispatched the Survey Team to Ghana for the second field survey (outline explanations) from February 21 to March 1, 2015 in order to explain and discuss the draft preparatory survey report and reach a basic agreement with the Ghanaian counterparts.

The Project plan compiled based on the survey findings targets the procurement and installation for the improvement of transmission and distribution lines and substation facilities, and the construction of new substations and related facilities. The Outline of the Basic Plan is as follows;

Outline of the components of the Project

Components		Quantity
Procurement and Installation Work		
1. Accra Central BSP		
(1) 161 / 34.5 kV Transformers (ODAF, Outdoor, Metal Enclosure Type)		125 MVA × 3units
(2) 170 kV Gas Insulated Switchgears (GIS) (Double Bus Type)		
1) Incoming Feeders	(Outdoor Type)	2 sets
2) Transformers Feeders	(Outdoor Type)	3 sets
3) Bus Coupler	(Outdoor Type)	1 set
4) Voltage Transformers	(Outdoor Type)	2 sets
(3) 33 kV GIS (Double Bus Type)		
1) 161/34.5 kV Transformer bays	(Indoor Type)	3 sets
2) 33/11 kV Transformer bays	(Indoor Type)	3 sets
3) 33 kV Feeder bays	(Indoor Type)	14 sets
4) Bus Coupler bay	(Indoor Type)	2 sets
5) Bus Section bays	(Indoor Type)	1 set
6) Station Transformer bays	(Indoor Type)	3 sets
7) Earthing Transformer bays	(Indoor Type)	2 sets
(4) SCADA Interface Panel		1 set
2. 161kV Transmission Line from the Avenor Branch Point to Accra Central BSP (1 Circuit for Achimota Line and 1 circuit for Mallam Line)		
(1) 161 kV Overhead Line (ACSR, TERN, twin bundle or equivalent)		Approx. 3 km
(2) 161 kV Underground Cable (XLPE Cable, Copper, 1,600 mm^2)		Approx. 0.4 km
Procurement Work		
3. Testing Equipment and Maintenance Tools for the Equipment of the Project		1 lot
4. Spare Parts for the Equipment of the Project		1 lot
Construction Work		
5. Foundation for the Equipment of the Project (Gas Insulated Switchgears, Transformers, Towers for 161 kV Transmission Line)		1 lot
6. Building for a control room of Accra Central BSP		1 building

④ Project implementation schedule and cost estimation

In the event where the Project is implemented based on the Japan's Grant Aid scheme, the total cost of the Project will be (*confidential*). The costs to be borne by the Ghana side will be 2,057,486 US$ (approximately 212.8 million yen). The contents and costs to be borne by the Ghana side are as given below:

① RAP Compensation: 554,315 US$ (57.3 million JPY)

② Expenses for Environmental Permit: 8,670 US$ (0.9 million JPY)

③ Expenses for Accra Central BSP: 113,228 US$ (11.7 million JPY)
(Leveling the land, Removing the un-used equipment, Construction of fences and gates, etc.)

④ Installation Work of 161 kV Transmission Towers for connection to 161 kV Lines of the Project: 100,000 US$ (10.3 million JPY)
(including final connection work : Tower N0 → N1)

⑤ Removal Work of 33 kV Overhead Line between Avenor Primary Substation (D) and Graphic Road Primary Substation (E): 86,670 US$ (9.0 million JPY)

⑥ Removal Work of the existing 33 kV Distribution Panels at Graphic Road Primary Substation (E) : 1,517 US$ (0.2 million JPY)

⑦ Procurement of 6units of Energy meter: 6,042 US$ (0.6 million JPY)
(GRIDCo:3units, ECG:3units)

⑧ Procurement and Installation of equipment related to SCADA system at Accra Central BSP (RTU, Multiplexer, ODF) including final connection work:

1,000,000 US$ (103.5 million JPY)

⑨ Contingency (10 % : Payment of bank commission based on banking, etc.):
- Commission of the Authorization to Pay (A/P)
- Payment commission

187,044 US$ (19.3 million JPY)

The implementation schedule for the Project including the detailed design will be approximately 26 months.

(1) Relevance

The Project is deemed to be highly appropriate as an aid undertaking since it will aid realization of development plans and energy policy in Ghana and impart benefits for the general public of Ghana.

(2) Efficiency

1) Quantitative effects

Outcome indicator	Base value (2013) (Current value)	Target value (2021) (3 years after the completion of the Project)	Reference Value (2021) Without the Project
1. Facility capacity of 161/34.5 kV Transformers (MVA) *	726	1,608	1,233
2. Transmission and distribution loss (MW) *	30	49	70
3. CO_2 reduction (ton)*	-	Approx. 72,800	-

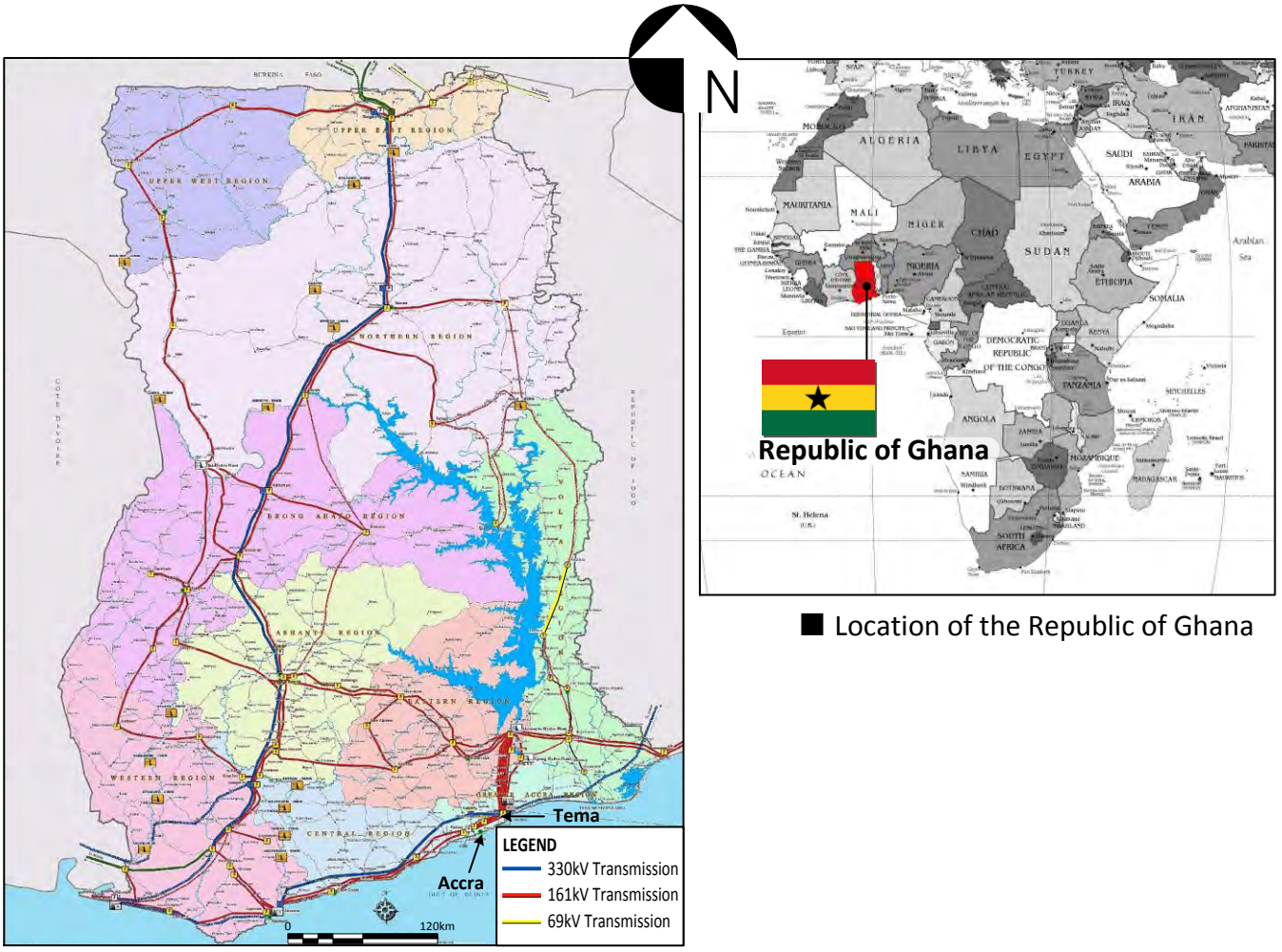
[Note]*1: Accra area

2) Qualitative effects

Present Status and Problems	Project Countermeasures (Grant Aid Project)	Extent of Project Effects and Improvement
1. With frequent power outage and voltage drop caused by aging equipment for transmission, distribution and substation system and overload operation, Accra area has the following issues. 1) Industrial and economic development is hindered. 2) Operation of public welfare facilities, especially healthcare facilities, is affected.	Procurement and installation of the following equipment: **1. 161/34.5 kV Substation equipment** • 375 MVA＝125 MVA×3 banks **2. 161 kV Transmission equipment** • 161 kV overhead line (Approx. 3.0 km) and 161 kV steel towers (18) • 161 kV underground cable (Approx. 0.4 km)	Stable power supply will revitalize the industries and economic activities in Accra and improve stable operation of public welfare facilities and healthcare services as well as the living environment of local residents. As the population of Accra is 1.84 million, the indirect impact will be significant.
2. In Ghana, there are frequent power interruptions and power loss caused by the deterioration and overload of the transmission and distribution facilities.	Same as the above	The project reduces dependency on Achimota BSP and Mallam BSP which are next to Accra Central BSP on power supply. Also, the project alleviates the risk of unstable power supply and power loss.
3. Ghana has serious problems such as unstable power supply and power shortages in Accra area and other cities, which interferes with economic activity. Also, the BSP is not easy to construct due to the land limitations.	A Gas Insulated Switchgear is introduced.	Introduction of Gas Insulated Switchgear enables to minimize the installation space and to construct a compact-type BSP.

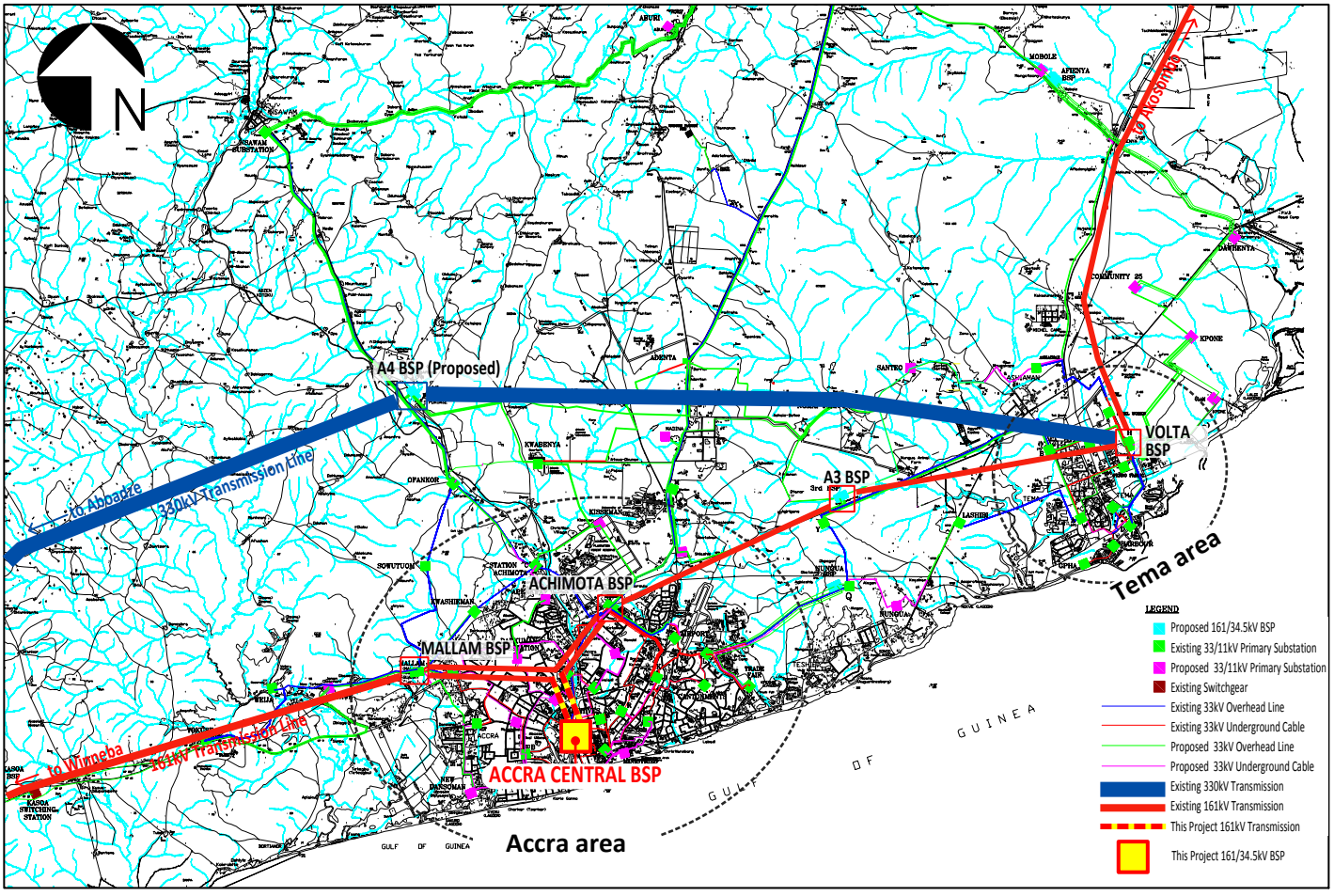
To sum up, since Project implementation can be expected to have major effects, it is confirmed to be relevant for implementation under the Grant Aid scheme of the Government of Japan. Moreover, the Ghana side is deemed to possess adequate personnel and budget for implementing the Project and conducting operation and maintenance after implementation.

Contents



■ Location of the Republic of Ghana

■National Transmission Network of Ghana



■Power facilities in the central business district of Accra

Location Map of the Project Site

The Project for Power Supply to Accra Central
[Architectural Rendering of Accra Central BSP]

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Abbreviations

BSP	Bulk Supply Point
CHRAJ	Commission on Human Rights and Administrative Justice
CIF	Cost Insurance & Freight
E/N	Exchange of Notes
EAA	Environmental Audit and Assessment
EC	Energy Commission of Ghana
ECE	Environmental Compliance and Enforcement
ECG	Electricity Company of Ghana Limited
EIA	Environmental Impact Assess
EP	Environmental Permit
EPA	Environmental Protection Agency
ESA	Environmentally Sensitive Area
ESIA	Environmental and Social Impact Assessment
G/A	Grant Agreement
GCB	Gas Circuit Breaker
GDP	Gross Domestic Product
GPRS	Ghana Poverty Reduction Strategy
GRIDCo	Ghana Grid Company Limited
GSGDA	Ghana Shared Growth and Development Agenda
HS	Harmonized Commodity Description Coding System
IEC	International Electrotechnical Commission
IMF	International Monetary Fund
JEC	Japanese Electrotechnical Committee
JICA	Japan International Cooperation Agency
LVB	Lands Valuation Board
LVD	Lands Valuation Division
M/D	Minutes of Discussions
MoEP	Ministry of Energy and Petroleum
MoP	Ministry of Power
NED	Northern Electricity Department
NEDCo	Northern Electricity Distribution Company
NES	National Electrification Scheme
O&M	Operation and Maintenance
OCB	Oil Circuit Breaker
ODAF	Oil Directed Air Forced Cooling
ODF	Optical Cable Distribution Frame
OJT	On the Job Training
ONAF	Oil Natural Air Forced
ONAN	Oil Natural Air Natural
OPGW	Optical fiber composite overhead ground wire

PER	Preliminary Environmental Report
PRSP	Poverty Reduction Strategy Paper
PURC	Public Utilities Regulatory Commission
ROW	Right of Way
RTU	Remote Terminal Units
SCADA	Supervisory Control and Data Acquisition System
SHEP	Self Help Electrification Project
SNEP	Strategic National Energy Plan
USTDA	United States Trade and Development Agency
VRA	Volta River Authority

Chapter 1 Background of the Project

1-1 Background of the Project

Ghana has developed a National Electrification Scheme (NES) and Self-Help Electrification Plan (SHEP), reaching a high electrification access rate of 72% as of the end of 2011. However, with commercial oil production starting in 2010 and recorded economic growth rates of 15%, power demand is expected to rise sharply in the future. The Ghanaian government and public power utility formulated a Transmission Master Plan in 2011 and expect national power demand to grow an average of 6.3% annually from 2009 to 2020. However, power development projects based on this growth have been stalled, particularly by power distribution facilities in the Accra area. The Ghanaian government has thus requested grant aid from Japan to achieve self-reliant, sustainable socioeconomic growth with the Preparatory Survey on the Project for Power Supply to Accra Central in the Republic of Ghana.

1-2 Natural Conditions

(1) Location, features and topography of the planned area

The planned area for an Accra Central Bulk Supply Point substation (BSP) is located 2.5 kilometers north from the Gulf of Guinea coastline along the Korle River. A lagoon stretches approximately two kilometers from the mouth of the river, after which an urban area specified as a heavy industrial zone begins. Resting about 500 meters from the Korle River, the planned area borders heavy and light industrial zones. It is also between flat lowlands (diluvial plain) and a gently-sloped river terrace.

While there is an embankment on the Korle riverbank visually estimated at four meters and no record of any overflow in the area, measures should be considered for temporary flooding due to combinations of high tide, storm surges and localized torrential rains. On the existing primary substation building on Graphic Road (completed in 1962), the first floor was planned at 1.5 meters above ground level. This figure should be referenced in designs for the planned area.

Geologically, hard bedrock has been confirmed 20 to 40 meters below the planned area with sand, silt and clay comprising the bulk of the soil. The boring survey (Feb. 3, 2014) revealed ground water levels of 1.2 to 1.6 meters below ground level, rather high for the dry season. There was also notable ground water flooding in the underground wiring pit of the existing building. The basement is therefore in need of waterproofing and swift drainage measures.

(2) Topographic condition

The site area for the planned substation is a slightly rounded trapezoid totaling 3,220 square meters, with a lower base of 52 meters, height of 81 meters and upper base of 11 meters. With existing substation facilities already in place and to be managed by the Electricity Company of Ghana Limited (ECG) as the Graphic Road primary substation even after the BSP is complete, the effective area for the new Accra Central BSP substation is about 1,200 square meters, an extremely small area for a BSP. In comparison, the Malam BSP is 17,255 square meters and the

Achimota BSP is 9,800 square meters, measuring 14 and eight times larger than the planned site area, respectively. Given the extreme care needed in the site usage plan, the study team thus measured site dimensions in advance, then re-outsourced a detailed survey to reconfirm the figures.

The highest ground level on site is Gate A in the southeast corner at 6.8 meters above sea level, about 1.5 meters higher than the lowest point of 5.3 meters near Gate B. A tributary of the Korle ends in the northwest of the site, and thus all drainage in the area faces northwest.

(3) Geological condition

The ground is relatively stable with N-values of 7 to 17, comprised mostly of sand and silt from the surface to near 10 meters in depth. Soil at depths below 11 meters are also stable with N-values of 8 to 40, but N-values of 20 and higher do not arise until depths of 20 meters. There is solid bedrock from 20 to 40 meters, and the site is a sloped diluvial area atop this bedrock.

Considering the scale and loads of the structures in this project, a structural analysis will be required to decide whether to go with spread footing or a pile foundation. The plan calls for construction of the following: 1) four 100 ton transformers on heavy metallic plates with sound and fireproofing on a reinforced concrete base frame (total load 600 tons; over 1,440 tons in deadweight with base); 2) 100 tons of switchboards loaded on a reinforced concrete base frame (over 350 tons in deadweight); and 3) a four-story administrative building (960 tons between load and deadweight).

According to the geological survey, ground water levels are 1.2 to 1.8 meters (survey taken at the end of the dry season). As ground water levels will inevitably impact foundation work given seasonal changes, steel sheet piles will need to be integrated into the plan for earth retaining purposes.

(4) Earthquakes

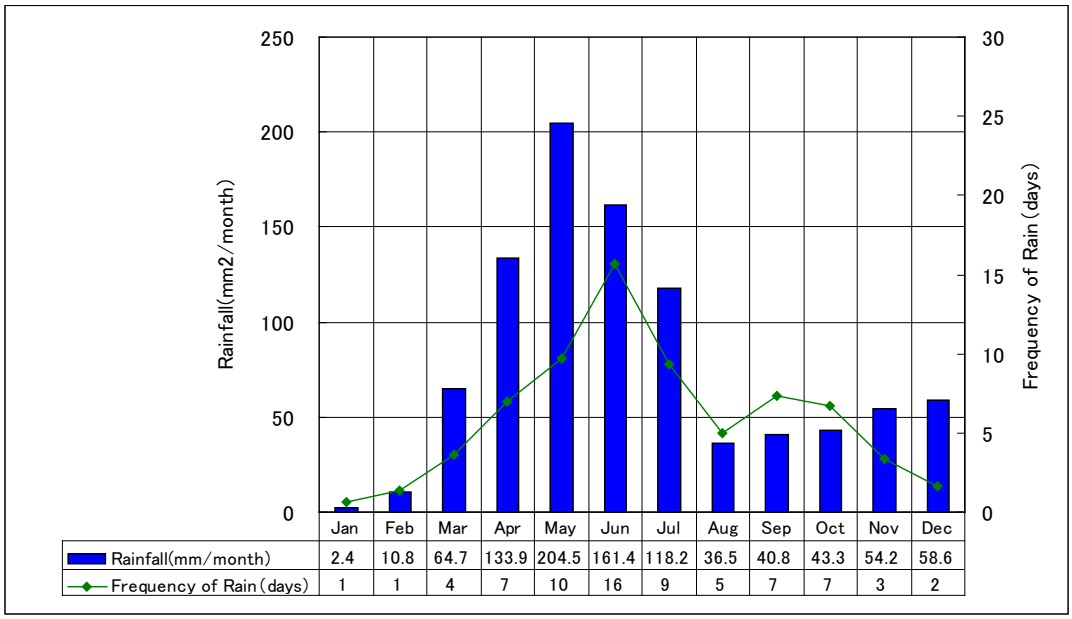
On June 22, 1939, a magnitude 6.8 earthquake hit 20 kilometers offshore from Accra at a depth of 13 meters. The quake killed 22, injured 130 and collapsed 1,500 homes. A magnitude 4.9 earthquake on April 14, 1872 offshore from Accra did only minor damage. ECG reports that there was an earthquake as recent as 1996. While lateral stress was estimated at 0.1 (40% of Japanese standards) assuming a seismic intensity of 4, the locally used value of 0.12 will be used in the interest of safety.

(5) Ground water quality

Chlorides from seawater and sulfides from drainage have been confirmed in ground water. The impacts from chlorides and sulfides must be accounted for in designs for underground structures.

(6) Weather conditions

The Accra climate has rainy and dry seasons. The main rainy season is from March to July, meanwhile, the main dry season is from August to February. The harmattan blows sand off the Sahara Desert around January, making things extremely dusty. Figure 1-2.1 gives annual rainfall in Accra, taking averages from 2007 to 2009.

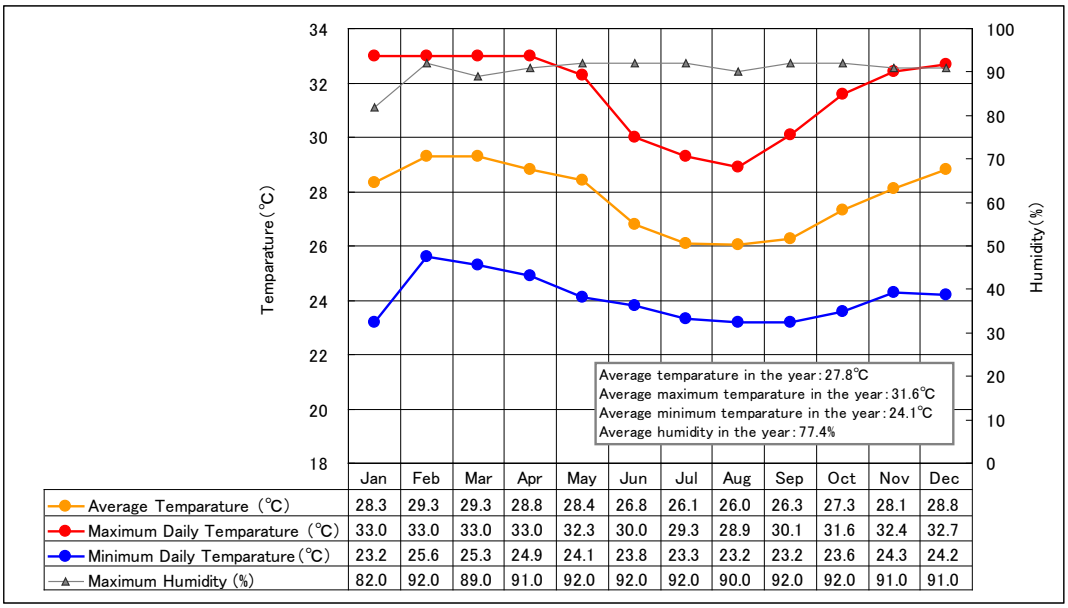


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall(mm/month)	2.4	10.8	64.7	133.9	204.5	161.4	118.2	36.5	40.8	43.3	54.2	58.6
Frequency of Rain(days)	1	1	4	7	10	16	9	5	7	7	3	2

【Source】Ghana Meteorological Agency

Figure 1-2.1 Annual rainfall in Accra (averaged, 2007-2009)

Temperatures are hot throughout the year, culminating in days with maximum high temperatures of 33°C in the main dry season. Meanwhile, high temperatures drop to 28°C in the coldest main rainy season, making for a difference of 5°C in high temperatures throughout the year. Minimum temperatures stay around 23°C year round. Humidity is also high throughout the year, averaging just under 80% for the year and exceeding 90% on many days throughout the year. Figure 1-2.2 gives annual temperatures and humidity in Accra, taking averages from 2007 to 2009.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Temparature (℃)	28.3	29.3	29.3	28.8	28.4	26.8	26.1	26.0	26.3	27.3	28.1	28.8
Maximum Daily Temparature (℃)	33.0	33.0	33.0	33.0	32.3	30.0	29.3	28.9	30.1	31.6	32.4	32.7
Minimum Daily Temparature (℃)	23.2	25.6	25.3	24.9	24.1	23.8	23.3	23.2	23.2	23.6	24.3	24.2
Maximum Humidity (%)	82.0	92.0	89.0	91.0	92.0	92.0	92.0	90.0	92.0	92.0	91.0	91.0

【Source】Ghana Meteorological Agency

Figure 1-2.2 Annual temperatures and humidity in Accra (averaged, 2007-2009)

1-3 Environmental and Social Considerations

1-3-1 Environmental Impact Evaluation

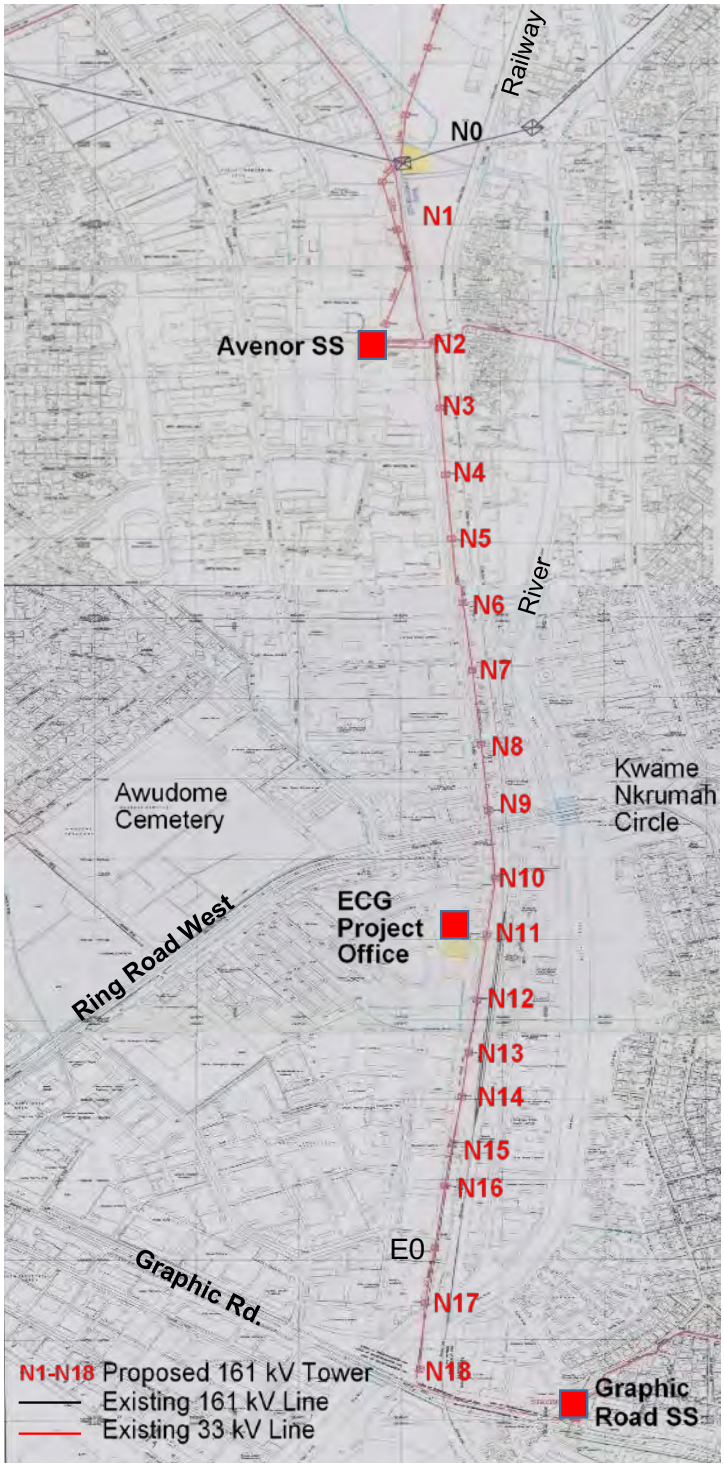
1-3-1-1 Summary of the Project Components

The project components are summarized in Table 1-3-1-1.1 although it is described in Chapter 2. Major components are construction of a building for a control room, installation of transformers and gas insulated switchgears in Accra Central BSP, and installation of 161kV Transmission Line from the Avenor Branch Point to Accra Central BSP. Besides, as the recipient, Ghana side is responsible to remove the existing 33 kV sub-transmission line and 33 kV distribution panels in Graphic Road primary substation. The project locations of the towers of 161 kV transmission lines are shown in Figure 1-3-1-1.1. The serial numbers and detail route is shown in Appendix-5. (See DWG No. T-01)

Table 1-3-1-1.1 Summary of Project Components

Category	Components		Quantity
Procurement and Installation Work	1. Accra Central BSP	(1) 161/34.5 kV Transformers	125MVA 3 units
		(2) 170 kV Gas Insulated Switchgears (GIS)	1 unit
		(3) 33 kV GIS (Double Bus Type)	1 unit
		(4) SCADA Interface Panel	1 unit
	2. 161kVTransmission Line from the Avenor Branch Point to Accra Central BSP	(1) 161 kV Overhead Line	3.0 ㎞
		(2) 161kV Underground Cable	0.4 ㎞
Procurement	3. Testing equipment and Maintenance Tools for the Equipment of the Project		1 unit
	4. Spare Parts for the Equipment of the Project		1 unit
Construction	5. Foundation for the equipment of the Project	• Gas Insulated Switchgears, Transformers	1 unit
		• Towers for 161 kV Transmission Line	18 towers
	6. Building for a control room of Accra Central BSP		1 building

【Source】 JICA Study Team



【Source】JICA Study Team

Figure 1-3-1-1.1 Location of Project Site

1-3-1-2 Outlines of the Project Site

The natural conditions and the social conditions are described in the section 2-3 and 1-2-1-3 respectively. The Project site is located in Accra urbanized area, Okai Koi South in Accra Metropolis, in Greater Accra Region. The land is mostly flat at about 10 meters above sea level, which is used by factories, workshops, bus parking spaces, rail tracks and informal settlers. There are no protected areas, national parks, specific cultural heritages are located in the project site.

Attached Table 5 of the Environmental Assessment Regulations of Ghana lists the different types of ESAs as shown below. However, there is no definitive information on the locations of ESAs and it is essential to check the existing of any local ESAs in the project areas. It is judged that no ESAs exist in the project site because the project site is located in Accra urbanized area.

Environmentally Sensitive Areas (ESAs)

1. All areas declared by law as national parks, watershed reserves, wildlife reserves and sanctuaries, including sacred groves
2. Areas with potential tourist value
3. Areas which constitute the habitat of any endangered or threatened species of indigenous wildlife (flora and fauna)
4. Areas of unique historic, archaeological or scientific interest
5. Areas which are traditionally occupied by cultural communities
6. Areas prone to natural disasters (geological hazards, floods, rainstorms, earthquakes, landslides or volcanic activities)
7. Areas prone to bushfires
8. Hilly areas with critical slopes
9. Areas classified as prime agricultural land
10. Recharge areas of aquifers
11. Water bodies characterized by one or any combination of the following conditions (a) Water tapped for domestic purposes, b) Water within controlled and/or protected areas, c) Water which supports wildlife and fishery activities)
12. Mangrove areas characterized by one or any combination of the following conditions (a) Areas with primary pristine and dense growth, b) Areas adjoining the mouth of major river systems, c) Areas near or adjacent to traditional fishing grounds, d) Areas which act as natural buffers to shore erosion, strong winds or storm floods)

1-3-1-3 Legal and Institutional Frameworks of Environmental and Social Considerations in Ghana

(1) Legal Framework for Environmental and Social Considerations

Table 1-3-1-3.1 shows the legal framework for environmental and social considerations in Ghana. The Environmental Assessment Regulations 1999 (LI 1652) in particular stipulate the types of projects subject to environmental impacts assessment and the procedure for the said assessment, forming the basis for environmental impacts assessment in Ghana.

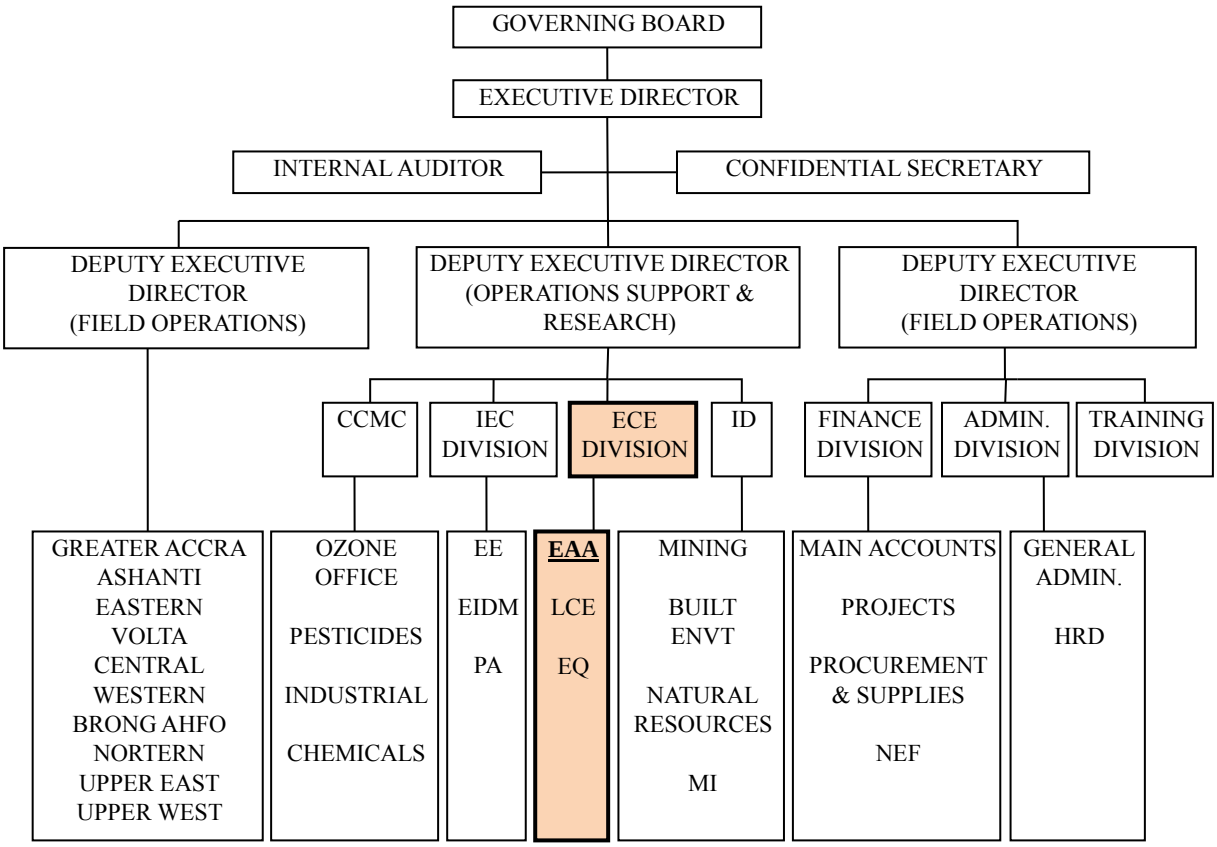
Table 1-3-1-3.1 Legal Framework for Environmental and Social Considerations

Category	Title	Year of Enforcement
Constitution	The Constitution of the Republic of Ghana	1992
Environmental Impact Assessment	The Environmental Protection Agency Act 1994 (Act 490)	1994
	Environmental Assessment Regulations 1999, LI 1652	1999
Protected Areas	Wildlife Reserves Regulations	1971
	Wildlife Conservation Regulations	1971
	Wetland Management (Ramsar Sites) Regulations	1999
Land Acquisition and Resettlement	The Land Title Registration Law 1986 (PNDCL. 152)	1986
	State Land Act (Act 125)	1962
	State Lands Regulations (LI 230)	1962
	The Lands (Statutory Wayleaves) Act (Act 186)	1963
	The Lands (Statutory Wayleaves) Regulations (LI 334)	1964
	The Ghana Land Policy	1999
	State Lands (Amendment) Act (Act 586)	2000
Cultural Heritage	The Cultural Policy of Ghana	2004
Guidelines	Environmental Assessment in Ghana, A GUIDE	1996
	Environmental Impact Assessment Procedures	1995
	Environmental Guidelines for Energy Sector	2007

【Source】Legislations of Ghana, Environmental Protection Agency (EPA)

(2) Institutional Framework

Environmental impacts assessment in Ghana falls under the jurisdiction of the Environmental Protection Agency (EPA) which was established in 1994 based on the Environmental Protection Agency Act 1994 (Act. 490). As shown in Figure 1-3-1-3.1, the Environmental Audit and Assessment (EAA) Section belonging to the Environmental Compliance and Enforcement (ECE) Division is in charge of environmental impacts assessment.



CCMC-Chemical Control and Management
IEC-Information Education and Communication
ECE-Environmental Compliance and Enforcement
EE-Environmental Education
EIDM-Environmental Information and Data Management
PA-Public Affairs

EAA-Environmental Audit and Assessment
LCE-Legal Compliance Enforcement
EQ-Environmental Quality
HRD-Human Resource Development
ID-Intersectoral Division
MI-Manufacturing Industries

【Source】Environmental Protection Agency (EPA), the Master Plan Study for the Power Distribution Sector (2008)

Figure 1-3-1-3.1 Organizational Structure of the Environmental Protection Agency (EPA)

(3) EIA Procedure in Ghana

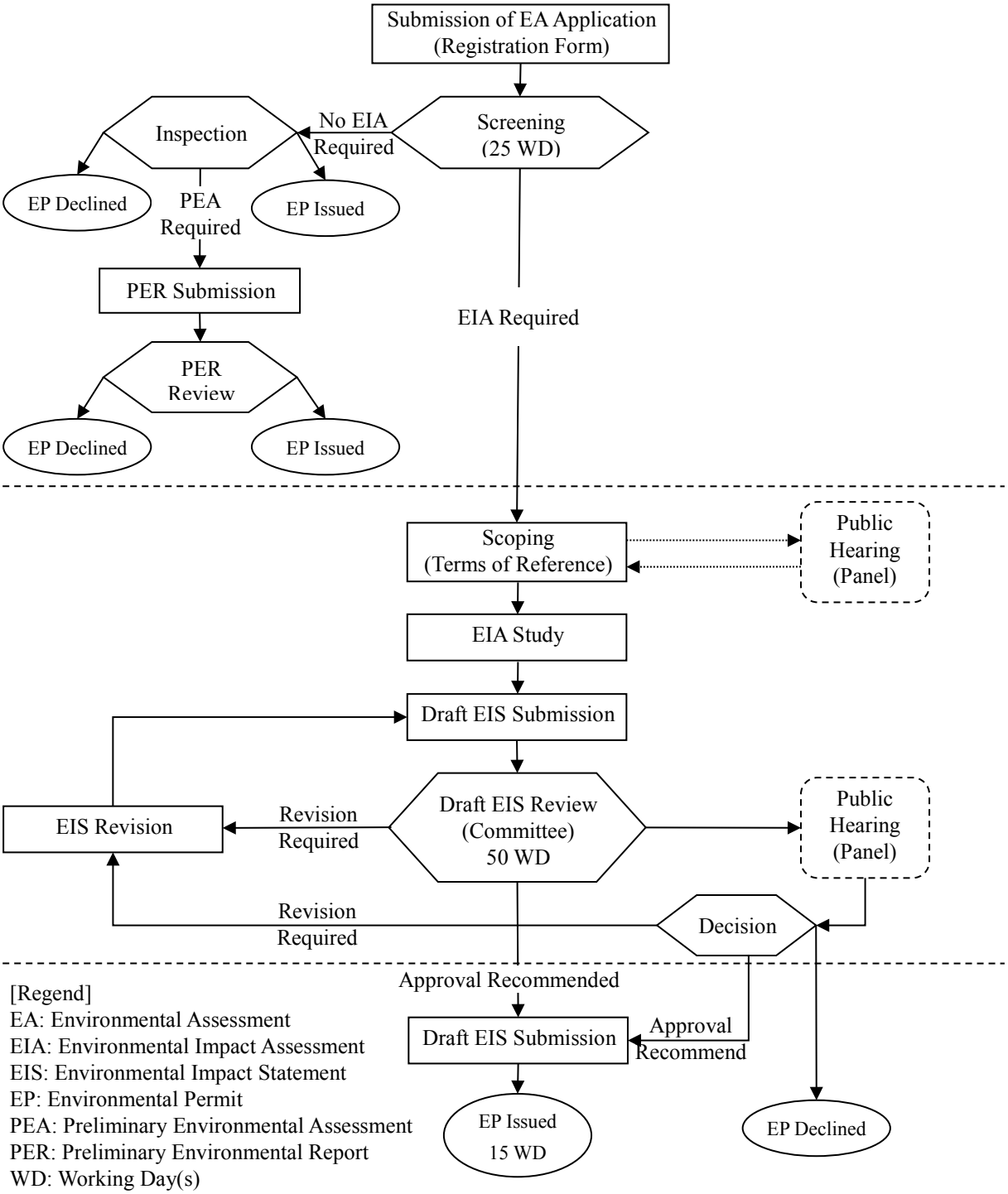
1) Procedure to Obtain Environmental Permit

In Ghana, the Environmental Assessment Regulations 1999, LI 1652 stipulates the types of projects subject to an EIA and the EIA procedure. According to these regulations, anyone planning to implement a project which may have an impact on the environment must register the project with the EPA in advance and obtain an environmental permit (EP) for the project.

Figure 1-3-1-3.2 describes the procedure to obtain EP in Ghana. In such a case, the person concerned must firstly complete the environmental assessment registration form designated by the EPA and must submit this form to a local office of the EPA along with the project drawings and other documents demanded by the EPA. After this registration, the registered project is reviewed by the Technical Screening Committee within 25 working days of the date of registration and one of the following judgments is made.

- Issue of an EP

- Demand for the submission of a preliminary environmental report (PER)
- Demand for the implementation of an EIA
- Rejection of the project



【Source】Environmental Protection Agency (EPA), the Master Plan Study for the Power Distribution Sector (2008)

Figure 1-3-1-3.2 Procedure to Obtain Environmental Permit

2) EIA Screening

The Environmental Assessment Regulations demand an EIA for the following categories of work in the power generation and transmission fields. As the project components include

installation of transformers and gas insulated switchgears in Accra Central BSP, and installation of 161kV transmission line, an EIA will be required for the Project.

- Construction of a thermal power station
- Construction of a dam and hydropower station
- Construction of a combined cycle power station inside a national park
- Construction of a nuclear power station
- Construction of a transmission line

Source: Environmental Assessment Regulations, Schedule 2 (Regulation 3), Paragraph 13

3) Environmental Guidelines for the Energy Sector

The EPA's Environmental Guidelines for the Energy Sector demand EIA involving high voltage transmission lines, either HVDC (High Voltage Direct Current) or HVAC (High Voltage Alternating Current), either overhead or underground, equal or exceeding 70 kV class. Therefore, EIA will be required for the Project.

(4) Expected Procedure to Obtain an Environmental Permit (EP) for the Project

Following the procedure shown in Figure 1-3-1-3.2, GRIDCo started the process to obtain the Environmental Permit (EP) for the Project as they submitted an Environmental Assessment (EA) application of the Project on Environmental Protection Agency (EPA) in October 2013. EPA requested GRIDCo to conduct ESIA for the Project in the end of December 2013 after the screening process. Table 1-3-1-3.2 explains an expected time schedule of ESIA that GRIDCo has planned to obtain the EP for the Project.

Table 1-3-1-3.2 Expected Schedule for the EP

No.	EIA Procedures	Scheduled Month	Year
1	Submission of EA Application (Registration Form)	October	2013
2	Project Screening	December	
3	Scoping (Terms of Reference) including Public Hearing	February	2014
4	ESIA Study	February – April	
5	Draft EIS Submission	April	
6	Draft EIS Review (50 Working Days) including Public Hearing	April - November	
7	Draft EIS Submission after Review	December	
8	EP Issued (15 Working Days)	February	2015

【Source】GRIDCo,, JICA Study Team

1-3-1-4 Comparison of the Alternatives

Two alternatives of tower types with the zero option (the case without the Project) were compared in Table 1-3-1-4.1. Two types of towers are an ordinary lattice type steel tower as the Alternative 1 and a steel mono pole type as the Alternative 2. They have different features and structures. The lattice type is usual steel tower with four legs and can be manually built from the lower part. Therefore, it does not require special machinery for the construction works. However, a large crane is required to hoist a 10 meters part of column for the construction of mono pole tower. A special excavator is also necessary to install the foundation deep in the ground.

Both alternatives can contribute to improve the existing blackout, voltage fluctuations and voltage drop in the Accra central area. Consequently, it will create a stable power supply, improve efficiency of power supply and decrease losses of electricity transmission and distribution.

A unit cost per tower of the mono pole type (Alternative 2) will be three times more than the lattice type (Alternative 1) although a space for basement of tower is less than the Alternative 1. Moreover, the mono pole type requires special machinery, a large crane, and space to place 10 meters parts temporally for the construction works. Therefore, the mono pole type needs more land and it will adversely impact on surrounding occupants, structures and traffic more than the Alternative 1.

On the other hand, the usual lattice type needs more space for foundation structure of tower than the Alternative 2 but the construction cost is lower than the Alternative 2. The required land including the construction space is less than the Alternative 2 because the lattice type tower is mostly constructed manually and special machinery is not required. As a result, it will adversely impact on surrounding occupants, structures and traffic less than the Alternative 2.

Neither the Alternative 1 nor Alternative 2 adversely impact on natural environment as the project site is located in the light industrial area of Accra City. The foundation of mono pole tower is deeper than the lattice type tower to secure strength of the tower, which is also deeper than the existing tower foundation, and it can affect on aquifer in some locations.

The Zero Option does not solve the existing electricity problems, unstable and insufficient power supply (blackout, voltage fluctuations and voltage drop), losses of electricity transmission and distribution in the Accra central area. Consequently, the risks of deterioration on living environment, socio-economic activities and social services in the Accra central area will not decrease and can increase more. Therefore, the Alternative 1 is the most appropriate for the Project.

Table 1-3-1-4.1 Comparison of the Alternatives

No.	Item	Alternative 1	Alternative 2	Zero Option
①	161kV Transmission Line Route	The existing 33kV sub-transmission line route is mostly used for the 161 kV transmission line route and the new towers are installed at the same location of existing towers.	Same as on the left	-
②	Location of Accra Central BSP	Accra Central BSP is constructed in the existing Graphic Road primary substation.	Same as on the left	-
③	Tower Type	Steel lattice type	Steel mono pole type	-
④	Structure	An ordinal four legs steel tower can be manually built from the lower part. The construction works do not require special machinery.	A column steel tower is built by 10 meters part. The construction works require a special crane to hoist the part and an excavator for foundation deep in the ground.	-
⑤	Benefits to the existing consumers	◎	◎	×
		The existing blackout, voltage fluctuations and voltage drop will be improved by the Project. A stable power supply will improve efficiency and decrease losses of transmission and distribution.	Same as on the left	No benefits to the existing consumers in the Accra Central Area.
⑥	Cost	○	△	◎
		A unit cost per tower and normal construction works can cost lower than the Alt-2.	A unit cost per tower will be three times more than the Alt-1. Uses of special machinery also cost more than the Alt-1.	No cost.
⑦	Social environment	○	△	◎
		A space for basement of tower is more than the Alt-2 but the required land including the construction space is less than the Alt-2 because of manual works.	A space for basement of tower is less than the Alternative 1 but the required land including the construction space is more than the Alt-1 to secure the working space for the large crane. It will adversely impact on resettlement and traffic more than the Alt-1.	No impacts on social environment.
⑧	Natural environment	○	△	◎
		There is no impact on natural environment as the project site is located in the light industrial area. The foundation of tower has 2.3 m deep and can affect on aquifer less than the Alt-2.	There is no impact on natural environment as the project site is located in the light industrial area. However, the foundation of tower has 7 m deep to secure strength of tower, which is deeper than the existing foundation, and can affect on aquifer more than the Alt-1.	No impacts on natural environment.
⑨	Evaluation	◎	○	×
		The entire construction cost is lower than the Alt.-2 and it will adversely impact on the surrounding occupants, structures, and traffic less than the Alt.-2.	The entire construction cost is higher than the Alt.-1 and it will adversely impact on the surrounding occupants, structures, and traffic more than the Alt.-1.	The risks on living environment, socio-economic activities and social services in the Accra central area by the existing electrical problems will not decrease and can increase more.

【Source】JICA Study Team

1-3-1-5 Existing Conditions around the Towers

Table 1-3-1-5.1 summarizes the existing conditions around the Towers on the Project Route. Three critical sites for resettlement were identified at tower number N6, N9 and N14 on the

Project Route. Those towers are surrounded by small scale buildings with simple structure of the informal settlers. These structures and the resident socio-economic activities will be affected by the constructions of 161 kV transmission towers.

Meanwhile, an existing 33 kV sub-transmission tower is located in very little space in a plastic factory, LETAP Packaging Factory. (See Number E0 in Table 1-3-1-5.1.) The site has no enough space which can be secured for the construction works without affecting the factory buildings. Nor the access can be secured easily in the factory. Therefore, the Team has concluded to exclude this site to construct 161 kV transmission tower from the Project Route.

Table 1-3-1-5.1 Existing Conditions around the Towers

No.	Type	Location Code	Distance (m)	Local Conditions	Note
N0	by GRIDCo	N: 5.584262 E:-0.219947	-	− Along a road − Parking space for trucks and cars	No resettlement
N1	(YY)	N: 5.582600 E:-0.220268	190.0	− Open space owned by Accra City	No resettlement
N2	(YY)	N: 5.579820 E:-0.220282	310.0	− Along Otublohum Rd. − At the T intersection corner − Small scale shops with simple structure are adjoining	Some resettlement Commercial: 4 population, 1 household
N3	(YY)	N: 5.578316 E:-0.220180	160.5	− Along Otublohum Rd. − Parking space for large buses, small scale buildings with simple structure are adjoining	No resettlement
N4	(XX)	N: 5.576812 E:-0.220021	160.5	− Along Otublohum Rd. − Small scale buildings with simple structure and goat market are adjoining	Some resettlement Commercial: 4 population, 1 household
N5	(XX)	N: 5.575289 E:-0.219864	155.4	− Along Otublohum Rd. − Parking space for large buses, small scale buildings with simple structure are adjoining	No resettlement
N6	(XX)	N: 5.573832 E:-0.219733	181.3	− Along Otublohum Rd. − Surrounded by small scale buildings with simple structure	Critical site of resettlement Dwelling: 34 population, 4 households Commercial: 4 population, 1 household
N7	(XX)	N: 5.572297 E:-0.219612	150.2	− Along Otublohum Rd. − Parking space for large buses and machinery, small scale buildings with simple structure are adjoining	No resettlement
N8	(YY)	N: 5.570694 E:-0.219432	165.7	− Along Otublohum Rd. − Parking space for large buses, a simple structure building are adjoining	No resettlement
N9	(YY)	N: 5.569124 E:-0.219311	150.2	− Along Otublohum Rd. − Surrounded by small scale buildings with simple structure	Critical site of resettlement Dwelling: 42 population, 5 households Commercial: 29 population, 4 household
N10	(YY)	N: 5.567666 E:-0.219160	150.2	− Along railway − Wall of bus terminal is close − Grass field	No resettlement
N11	(XX)	N: 5.566368 E:-0.219313	129.5	− Along railway − Wall of ECG Project Office is close − Grass field	No resettlement
N12	(XX)	N: 5.564893 E:-0.219509	150.2	− Along railway − Wall of ECG Project Office is close − Grass field	No resettlement
N13	(XX)	N: 5.563630 E:-0.219680	119.1	− Along railway − Cultivation	No resettlement
N14	(YY)	N: 5.562670 E:-0.219829	98.4	− Along railway − Surrounded by small scale buildings with simple structure	Critical site of resettlement Dwelling: 13 population, 3 households Commercial: 15 population,

No.	Type	Location Code	Distance (m)	Local Conditions	Note
					3 household
N15	（YY）	N: 5.561550 E:-0.219956	103.6	− Along railway − Wall of ESKAY Therapeutics LTD is close − Small scale buildings with simple structure (recycle shop) are adjoining − Public toilet is close	Some resettlement Dwelling: 6 population, 1 households
N16	（YY）	N: 5.560646 E:-0.220109	145.0	− In the parking space of TOYOTA Ghana Workshop Limited	In factory
E0	-	-	-	− In LETAP Packaging Factory − Factory buildings are very close to the existing 33 kV tower	Narrow Space, Excluded from 161 kV transmission route
N17	（YY）	N: 5.557966 E:-0.220427	258.9	− In the parking space of NAMCO Netherland African Manufacturing Co. − A wall and small scale structure are close	In factory
N18	NEW Type	N: 5.556549 E:-0.220630	145.0	− Along Graphic Road − Car Service Workshop is adjoining	In business establishment

【Source】JICA Study Team

1-3-1-6 Evaluation of Anticipated Environmental and Social Impacts

Anticipated environmental and social impacts are summarized as shown in Table 1-3-1-6.1 incorporating the results of the site survey and interviews with various stakeholders.

Table 1-3-1-6.1 Evaluation of Anticipated Environmental and Social Impacts

Category	No.	Likely Impacts	Evaluation		Reasons of Rating and Anticipated Impacts
			Pre-/ Construction Phase	Operation Phase	
Social Environment	1	Involuntary Resettlement	B-	D	[Pre-Construction Phase] JICA Study Team has planned the size of land for the 161 kV transmission towers to be replaced from the existing 33 kV sub-transmission towers as the maximum 15 meters square around the towers, which secures appropriate space for the material yard, safety and access of working activities. Within the area of each tower, the population occupying the lands around the towers were surveyed by local consultant. Total 151 peoples in 23 households were identified within the areas as of the beginning of February 2014 and they can be resettled. They were aware of occupying the lands informally. GRIDCo/ECG will use public space for the route of 33 kV underground cable to avoid or minimize land acquisition and impacts on occupants and structures. However, even if the occupants are affected, it will be temporary relocation during the construction period.
	2	The poor people	B-	D	[Pre-Construction Phase] The above 23 households who were informal settlers, and 10 households were under the World Bank's poverty line which is under 1.25 US dollar per day per person in income level.
	3	The indigenous and ethnic people	D	D	There are no indigenous people or ethnic minorities in the Project site.

Category	No.	Likely Impacts	Evaluation		Reasons of Rating and Anticipated Impacts
			Pre-/ Construction Phase	Operation Phase	
	4	Local economy such as employment and livelihood, etc.	B+/-	A+	[Pre-Construction Phase] 67 building owned by 23 households (commercial/ residential mixed use or residence), and 10 buildings (commercial use) owned by 9 households living outside of the 15 meters square areas, total of 77 buildings can be affected. However, these buildings have simple and small temporary structures which were built of wood or iron containers to procure a local carpenter and material. [Construction Phase] The construction of Accra Central BSP and the installation work of the transmission line will mainly be manually conducted, and the demand for workers (especially unskilled) will provide a temporary boost for local employment. Local service sector located around the Project site will provide the construction workers foods and beverages. It can facilitate business opportunities for the local service sector. [Operation Phase] As the power situation will be improved in the Accra Central Area, effect on the livelihood and lives of residents, and also on the development of economic activities of factories and business offices are expected.
	5	Land use and utilization of local resources	D	D	As the scale of the Project is not large and the geographically affected areas are very limited, no adverse impacts on land use are anticipated.
	6	Water Usage or Water Rights and Rights of Common	D	D	As there are no lakes or reservoirs around the Project site, no adverse impacts on water usage are anticipated. A river is located at 100 to 200 meters from the site but a lot of garbage is strewn on the water.
	7	Existing social infrastructures and services	B-	A+	[Construction Phase] In a place for installing the underground cable of 161kV transmission line, the works can damage the telephone line buried. Further, where underground cables cross the road, it also can damage drainages and/or water pipes in the roadside. On the other hand, it is not in the 161kV transmission route, small churches, Islamic place of worships, schools, community centers were located in the surrounding area, and their activities should not be disturbed by the construction works. [Operation Phase] As the power situation will be improved in the Accra Central Area, effect on public facilities and social services including schools and hospitals are expected.
	8	Social institutions such as social infrastructure and local decision making institutions	D	D	The scale of the Project is not large and the geographically affected areas are very limited. As the Project aims at improving the power supply as a public service, no adverse impacts on social institutions are anticipated.
	9	Misdistribution of benefit and damage	D	D	The Project aims at providing stable power supply as a public service. This item is, therefore, not affected specifically.
	10	Local conflict of interests	D	D	The Project aims at providing stable power supply as a public service. This item is, therefore, not affected specifically.
	11	Cultural heritage	D	D	As there is no cultural heritages to be considered in the project site, no impacts will occur in regard to cultural heritage. For the houses of worship located around, consultations are necessary before the construction start.

Category	No.	Likely Impacts	Evaluation		Reasons of Rating and Anticipated Impacts
			Pre-/ Construction Phase	Operation Phase	
	12	Landscape	D	D	There is no rare natural or cultural landscape in the vicinity of the Project site and no negative impacts will occur on the local landscape. The transmission towers are higher than the existing towers but it will not involve any major alteration of the existing landscape.
	13	Gender	D	D	The Project aims at providing stable power supply as a public service. This item is, therefore, not affected specifically.
	14	Children's rights	D	D	The Project aims at providing stable power supply as a public service. This item is, therefore, not affected specifically.
	15	Hazards (Risk), Infectious diseases such as HIV/AIDS	D	D	As the scale of the construction work is not large and local labors will be employed, there is few tangible risk of a disaster or the occurrence of infectious diseases due to the mass inflow of laborers from other areas. However, the external workers could induce/illicit for sexual relationships with the local peoples and sensitizations are necessary for both of them.
	16	Working conditions	B-	D	[Construction Phase] As the 161 kV transmission towers are ordinal lattice type with four legs, manual work is accounting for the bulk of the construction work and can be built from the ground level. As the substructures have been designed at sizes of 1.5 meters to 2.3 meters in depth and 6 meters to 7 meters in width, the use of heavy construction machinery is very limited. However, as the height of tower is 30 meters and the works are attendant by danger, the safety work conditions should be secured for the workers.
Natural Environment	17	Protected Areas	D	D	As the project site is located in Accra urbanized area, it is not located in protected areas.
	18	Flora, Fauna and Biodiversity	D	D	The project site is located in the Accra urbanized area, no negative impacts are, therefore, anticipated on the local flora and fauna.
	19	Hydrological Situation	C-	D	The results of boring survey showed that the underground water level was over -2 meters, and the shallow aquifer was found. The Project site is located at the north of 2.5km from coastline of the Gulf of Guinea. The area is assumed diluvial plains as clay and silt were dominated in the geological conditions, and this shallow aquifer can also be widespread. On the other hand, the groundwater quality is not suitable for a domestic water because chloride as the effects of seawater and sulfide as the effects of drainage were found. As the project site is urbanized, the residents would not use the groundwater of this shallow level. In addition, compared to the other BSPs, the construction area of the new building of Accra Central BSP has a very compact design. The substructure of 161kV towers also have not designed large scale, and the towers are designed to be placed 150 meters apart at 18 locations. Therefore, adverse impact on the widespread aquifer is not expected.
	20	Topography and Geographical features	D	D	As the Project site is generally flat, the construction work will not involve any major alteration of the topography or civil engineering work, no impacts are anticipated on the local topography or geology.
Pollution	21	Air Pollution	D	D	As manual work is accounting for the bulk of the construction work and the use of heavy construction machinery is very limited, air pollution due to the Project, if any, will be negligible.

Category	No.	Likely Impacts	Evaluation		Reasons of Rating and Anticipated Impacts
			Pre-/ Construction Phase	Operation Phase	
	22	Water Pollution	B-	D	[Construction Phase] As the groundwater level is shallow at the project site, the water quality is getting worse in the urbanized area. On the other hand, t the Study Team has proposed a system that a transformer is installed in a closed metal box to reduce the noise, and insulating oil is also contained in this metal box. Further, the insulating oil is stored in special cans in order to maintain its quality so as not to touch the air. Therefore, the adverse impact on the water pollution due to spill of the insulating oil is limited.
	23	Soil Contamination	B-	D	[Construction Phase] Similar to the item "Water Pollution", the insulating oil of the transformer is contained in the metal boxes, and pits are installed below the boxes. In addition, the insulating oil is managed and place a predetermined containers and place until the installation. Thus, the adverse impact on the soil pollution due to spill of the insulating oil is limited.
	24	Waste	B-	D	[Pre-Construction/Construction Phase] As an undertaking of Ghana side, the towers of 18 places in the existing 33kV sub-transmission lines, and electrical wire of about 3,000 meters are be removed, and these can be waste material. However, engineers of GRIDCo/ECG will determine the removed towers and wires can be reused or not. The remaining materials which cannot be recycled, will be disposed to a recycling manufacture, thereby reducing the impacts.
	25	Noise and Vibration	D	B-	[Operation Phase] The outdoor type transformers of 125 MVA-161/34.5 kV planned in the Accra Central BSP usually generate operation noise at 85 dB(A) level according to the NEMA standard (U.S.). Business establishments are located around the BSP but not located in the exclusive residential district. However, one side of the site is bounded by a warehouse of business office, the noise can affect them. On the other hand, the land use around the BSP, which was described from GRIDCo, was a light industrial area. In this area, the ambient noise standards of Ghana is 60 dB(A) at nighttime. Therefore, the Study Team has proposed a system that a transformer is installed in a closed metal box as a measure to comply with this level, and obtained the agreement of GRIDCo. Thus, the noise level is reduced below the standard value.
	26	Ground Subsidence	D	D	As the Accra Central BSP located in the existing Graphic Road substation and 3.15km 161 kV transmission line have no large-scale alteration of the topography is planned, no ground subsidence is anticipated to occur.
	27	Offensive Odor	D	D	No offensive odor is anticipated to originate from the BSP and the transmission lines.
	28	Bottom sediment	D	D	The installation works will not induce to affect on bottom sediment due to soil erosion from the works. As no large-scale alteration of the topography or civil engineering work is planned for the installation works.
Others	29	Accidents	B-	D	[Construction Phase] As manual work is accounting for the bulk of the construction work and the use of heavy construction machinery is very limited. However, as the height of tower is 30 meters and there are structures between the towers in some locations, falling accident of workers can be expected, and falling accident of equipment can damage the structures.

Category	No.	Likely Impacts	Evaluation		Reasons of Rating and Anticipated Impacts
			Pre-/ Construction Phase	Operation Phase	
	30	Trans boundary issues, Global Warming	D	D	No trans boundary issues and global warming are anticipated as the Project only involves the components consist of the construction of a building for a control room, the installation of transformers and gas insulated switchgears in the existing BSP, and the installation of 161kV transmission line only at 3.15 ㎞.

Rating:

A+/-: Significant positive/negative impact is expected.

B+/-: Positive/negative impact is expected to some extent.

C+/-: Extent of positive/negative impact is unknown (Examination is needed. Impacts may become clear as study progresses.)

D: No impact is expected

【Source】JICA Study Team

1-3-1-7 Mitigation Measures

As the environmental items which may experience negative impacts of the Project based on the evaluation results, their mitigation measures are identified as shown in Table 1-3-1-7.1.

Table 1-3-1-7.1 Proposed Environmental Mitigation Measures

No.	Items	Likely Impact	Mitigation Measures	Organization
	[Pre-Construction/Construction Phase]			
1	Involuntary Resettlement	Loss of structures	• GRIDCo prepares the RAP through the ESIA following the Framework for Environmental and Social Management of Bulk Transmission Line Projects in Ghana, Draft Land Acquisition and Resettlement Policy Framework, which are based on WB OP 4.12, and implement it.	GRIDCo/ECG, Local consultant
2	The poor people	Loss of structures and incomes	• Same as above.	GRIDCo/ECG, Local consultant
4	Local economy such as employment and livelihood, etc.	Loss of incomes	• Same as above.	GRIDCo/ECG, Local consultant
7	Existing social infrastructures and services	Obstructions of buried telecommunication lines, water pipes, or drainages	• A contractor coordinates with a telecommunication company and the municipality to identify the locations of buried telecommunication lines, water pipes, drainages Installation works of underground cables in the utility space beside road, and avoids to obstruct them.	GRIDCo/ECG, Supervising Consultant, Contractor
16	Working conditions	Safety and health of workers for constructions of transmission lines and towers	• GRIDCo requires a contractor to prepare an environmental management plan according to the Framework for Environmental and Social Management of Bulk Transmission Line Projects in Ghana. • A contractor with a supervising consultant implements all measures for safety and environmental management, and avoid or minimize the risks of accidents on workers and residents. • A contractor with a supervising consultant provide the workers personal protective wear and gears to ensure good and safe working conditions in accordance with the labour laws of Ghana	GRIDCo/ECG, Supervising Consultant, Contractor

No.	Items	Likely Impact	Mitigation Measures	Organization
22	Water Pollution	Contamination of groundwater due to leak of insulating oil of transformer	• Insulating oil is enclosed in the metal boxes as well as it is for the transformers • Moreover, pits are installed under the transformers to prevent the leak of insulating oil	Supervising Consultant, Contractor
23	Soil Contamination	Contamination of soil due to leak of insulating oil of transformer	• Insulating oil is enclosed in the metal boxes as well as it is for the transformers • Moreover, pits are installed under the transformers to prevent the leak of insulating oil	Supervising Consultant, Contractor
24	Waste	Waste disposal of removed parts of 33kV sub-transmission lines and towers	• GRIDCo/ECG reuse the removed parts of 33kV sub-transmission lines and towers wherever • GRIDCo/ECG dispose remaining waste to recycle services	GRIDCo/ECG
29	Accidents	Accidents of workers or structures due to construction works	• As same as "Working Conditions" • A contractor prevents drop accidents of wires with personnel safety nets while they remove the existing sub-transmission wires or install new transmission wires, and they gradate wires from thinner one to thicker one in the air.	GRIDCo/ECG, Supervising Consultant, Contractor
	[Operation Phase]			
25	Noise and Vibration	Noise emanating from the operation of transformers in Accra Central BSP	• The transformers are enclosed in the metal boxes to keep below 60 dB(A) permissible ambient noise level in night according to Environmental Quality Guidelines for Ambient Noise	GRIDCo, Supervising Consultant, Contractor

【Source】JICA Study Team

1-3-1-8 Monitoring Plan

An environmental monitoring plan was proposed as shown in Table 1-3-1-8.1, and the resettlement activities are the most important monitoring items. However, an Environmental Management & Monitoring Plan will be prepared in the ESIA. Besides, EPA will give some requests in the EP as conditions to be managed and monitored especially for construction works. GRIDCo and a contractor will satisfy the conditions. GRIDCo will also requires a contractor an environmental management plan which designates mitigation measures especially for pollution during construction. Therefore, the pollution and safety management and monitoring in the construction phase are excluded in this section. A contractor will submit GRIDCo weekly reports. The EP will designate that GRIDCo should submit EPA monitoring reports.

The Environment Unit in the Engineering Department mainly plays a monitoring role and ensures that targets and objectives are achieved. Especially, the monitoring and evaluation will be done to ensure that the social issues and impacts have been addressed properly and in a participatory, fair, and transparent manner, in particular where resettlement processes take place.

Table 1-3-1-8.1 Proposed Monitoring Plan

No.	Item	Subject	Location	Frequency	Organization
	[Pre-Construction/Construction Phase]				
1	Involuntary Resettlement	Consent buildings with the PAPs	Around planned 161kV transmission towers	During resettlement activities in the processes	GRIDCo, LVD

No.	Item	Subject	Location	Frequency	Organization
		Progress of compensation payment	Around planned 161kV transmission towers	During resettlement activities in the processes	GRIDCo, LVD
		Progress of PAP relocation	Around planned 161kV transmission towers	During resettlement activities in the processes	GRIDCo
		Progress of structure clearing	Around planned 161kV transmission towers	During resettlement activities in the processes	GRIDCo
		Process of grievance redress	Around planned 161kV transmission towers	During resettlement activities in the processes	GRIDCo, Grievance Redress Committee (GRC)
	[Operation Phase]				
25	Noise and Vibration	Ambient noise level in dB(A)	Accra Central BSP	Monthly (a half year after the operation starts)	GRIDCo, Supervising Consultant, Contractor

【Source】JICA Study Team

1-3-1-9 Stakeholder Meetings

GRIDCo conducted a stakeholder meeting on 12 February 2014. The meeting was chaired by the Director, Engineering of GRIDCo and attendants were environmental officers and an electrical engineer from GRIDCo, and a system planning officer from ECG. Total 25 stakeholders, the inhabitants around the existing towers, were participated in the meeting.

The director explained that GRIDCo intends to construct 2.8 km 161 kV transmission line using the ECG existing 15 m corridor from Avenor to Acrra central substation. The director further explained that the proposed project to improve the bulk power evacuation and reliability in the business center of Accra would be funded with a grand from Japan International Cooperation Agency (JICA).

The director also explained that GRIDCo is required to conduct an Environmental & Social Impact Assessment (ESIA) coupled with Property Impact Assessment for preparation of Resettlement Action Plan (RAP) for the proposed project under the Environmental Assessment Regulations, 1999 (LI 1652) in Ghana. The director informed the attendants that GRIDCo is in the process of engaging an Environmental and Social Specialist to undertake ESIA and RAP in order to assess the various Environmental and Social issues associated with the proposed project and more importantly recommend mitigating measures to offset the adverse effects of the project.

The most concerned issue of the meeting during the open discussion was compensation for properties and livelihood that will be affected by the proposed project. The director assured all the attendants that GRIDCo is mandated to mitigate the impact on the livelihood of individuals and communities displaced or affected by its operations in accordance with the environmental policy and corporate responsibility of GRIDCo.

1-3-2 Land Acquisition and Resettlement

1-3-2-1 Necessity of Land Acquisition and Resettlement

1) Accra Central BSP

There is no land acquisition and resettlement for Accra Central BSP because it is planned in the existing site of Graphic Road Primary Substation.

2) 161kV Transmission Line

3.0 km of the 161 kV transmission line is installed on the existing route of 33 kV sub-transmission line in order to avoid and minimize land acquisition and resettlement. The Lands (Statutory Wayleaves) Act 1963 (Act 186) stipulates that the ROWs are created in respect of a highway, any other structure or works for the purpose of, or in connection with, a public utility service including supplying electricity, water for any purpose or gas, or for supplying sewerage, transport or telecommunication facilities or facilities connected with the operation of a port, railway, tramway or an airport.

The construction manual of distribution line of ECG which owns the 33kV sub-transmission lines states that ROW of 33 kV sub- transmission line is 15 meters wide. Therefore, the project route of 161 kV transmission line was planned on the same route of the existing 33 kV sub-transmission line to avoid land acquisition and minimize the resettlement wherever possible.

On the other hand, adequate work space which considers material storage, the safety and the access is needed around the towers although it is the rebuilding of the tower in the same locations. Besides, there are parking spaces and simple structures of informal occupants around the existing towers. Therefore, the Study Team made more effort on the design of tower foundation to reduce the size for further minimizing the resettlement. In addition, a location of the existing tower in a narrow space in a factory was excluded from the plan to consider the impact on the plant facilities.

A new tower is planned at only one place, however, there is neither land acquisition nor resettlement because it is open space owned by the Accra City. GRIDCo will coordinate with the city to use the land. In addition, the 161kV underground cable of 0.4 kilometers will be installed in the road reserve for such infrastructure facilities as electricity supply, water supply, sewerage and communication in order to avoid and minimize land acquisition and resettlement as well as the overhead line section.

1-3-2-2 Legal Framework

1) Legislations

There are laws related to the land acquisition, State Lands Act, 1962 (Act 125) and State Lands (Amendment) Act, 2000 (Act 586), which stipulate the procedures of land acquisition. The law states that the Lands Commission decides the necessity and values of compensation if the land acquisition, demolition of building, abandonment of cultivated land or resettlement are necessary.

The law also stipulates that compensation amount of land is evaluated with the market or replacement value of the land.

Moreover, GRIDCo has an environmental management system for their project in "Framework for Environmental and Social Management of Bulk Transmission Line Projects in Ghana", which includes the policies of ESIA, land acquisition and resettlement. GRIDCo also drafted "Land Acquisition and Resettlement Policy Framework" which is under finalizing by the council. Those policy frameworks state to apply the WB OP 4.12.

The following legislations are related to the land acquisition and resettlement.

- Constitution of the Republic of Ghana, 1992
- State Lands Act, 1962 (Act 125)
- State Lands (Amendment) Act, 2000 (Act 586)
- The Lands (Statutory Wayleaves) Act, 1963 (Act 186)
- The Lands (Statutory Wayleaves) Regulations, 1964 (LI 334)
- State Lands Regulations, 1962 (LI 230)
- The Ghana Land Policy, 1999
- Framework for Environmental and Social Management of Bulk Transmission Line Projects in Ghana, 2009, GRIDCo
- Land Acquisition and Resettlement Policy Framework (Draft), 2012, GRIDCo

2) JICA policies on involuntary resettlement

The key principle of JICA policies on involuntary resettlement is summarized below.

I. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
II. When, population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.
III. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.
IV. Compensation must be based on the full replacement cost as much as possible.
V. Compensation and other kinds of assistance must be provided prior to displacement.
VI. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.
VII. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.
VIII. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.

IX. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

Above principles are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principle based on World Bank OP 4.12 is as follows.

X. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.

XI. Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.

XII. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.

XIII. Provide support for the transition period (between displacement and livelihood restoration.

XIV. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.

XV. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

In addition to the above core principles on the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and, detailed Financial Plan etc.

3) Gaps between JICA Guidelines/WB OP 4.12 and Legislation of Ghana

As Appendix-9 explains, two policy frameworks of GRIDCo, "Framework for Environmental and Social Management of Bulk Transmission Line Projects in Ghana" and "Draft Land Acquisition and Resettlement Policy Framework" mostly covers the JICA Guidelines and the WB OP 4.12, few gaps were identified between them.

4) Land acquisition and resettlement policies for the Project

As mentioned above, few gaps were identified and two policy frameworks of GRIDCo state that GRIDCo complies the WB OP4.12 to implement the land acquisition and resettlement. Besides, in the MD signed by the JICA preparatory survey team, Ministry of Energy and Petroleum, Ministry of Finance, GRIDCo and ECG, the Ghana side will comply with the JICA Guidelines. Therefore, two policy frameworks of GRIDCo can be the basis for the land

acquisition and resettlement policies of the Project.

1-3-2-3 Scale of Land Acquisition and Resettlement

1) Population

JICA Study Team planed the size of land for the 161 kV transmission towers to be replaced from the existing 33 kV sub-transmission towers as the maximum 15 meters square which secures appropriate space for the material yard, safety and access of working activities. Within the area of each tower, the population occupying the lands around the towers were surveyed by local consultant as shown in Table 1-3-2-3.1. Total 151 peoples in 23 households were identified within the areas and they can be resettled. They were aware of occupying the lands informally.

Table 1-3-2-3.1 Population around the Planned Towers

Tower No.	Household	Population
N1	0	0
N2	1	4
N3	0	0
N4	1	4
N5	0	0
N6	5	38
N7	0	0
N8	0	0
N9	9	71
N10	0	0
N11	0	0
N12	0	0
N13	0	0
N14	6	28
N15	1	6
N16	0	0
N17	0	0
N18	0	0
Total	23	151

【Source】JICA Study Team

2) Affected Assets

Total 77 structures were identified in the 15 meters square areas. The buildings are categorized for valuation purpose as "temporary", i.e., built only with ply wood or other wooden materials and corrugated iron roofs with wooden floor, "semi-permanent" with metal or wooden walls and corrugated iron roofs and concrete floor, and permanent (brick or concrete walls). All the affected buildings are either personally owned by the dwellers or rented from other people.

A typical family house has 2 rooms with a total surface of approximately $9m^2$ although there are some variations in the dimensions. Depending on the household's wealth, the floor may be wooden or concrete. Generally, houses have electricity but do not have running water, toilets, or kitchen. The construction technique of a typical wooden house includes building the frame of the building with strong wooden poles, putting the roof in place, erecting the walls with smaller vertical and horizontal wooden poles arranged into grids, and filling this grid with pieces of

plywood to fit the grids. The walls may eventually be painted with oil paint of individual choice of color. All materials are locally available at the local market. Labor for construction was hired through community carpenters and self-help labor. Such a construction requires two to three weeks of work for a team of three workers. They use common community water pipe, bathroom and toilet where they pay admission.

Table 1-3-2-3.2 Affected Buildings

No.	Type of Structure	Use of Building	Total
1	Wooden kiosk with wooden base & corrugated iron roofing sheet	Commercial and Residential	9
2	Metal kiosk with concrete base and corrugated iron roofing sheet	Commercial and Residential	10
3	Metal Container with concrete base and corrugated iron roofing sheet	Commercial Only	7
4	Shed for Livestock trading	Commercial Only	3
5	Wooden kiosk with wooden base & corrugated iron roofing sheet	Residential Only	6
6	Wooden kiosk with concrete base & corrugated iron roofing sheet	Residential Only	42
	Total		77

【Source】JICA Study Team

3) Living Conditions

According to the interviews to the 23 affected households, 40% of the occupation of the households, are engaged in the trading (Selling of second hand clothing, plastics, spare parts, shoe selling, provision shop), and the others were in carpenter, bar operator, drinking spot operator, food vendor, goat seller, hairdresser, kebab seller, mechanic, okada (motor) rider, worker, plastic waste recycler. The average household monthly income is estimated to be 1,158 Cedi (463US dollars), but there is a difference from the lowest of 72 Cedi (US 29 dollars) up to the highest of 3,360 Cedi (US 1,344 dollars). For the owners of commercial buildings which can be affected had the average household monthly incomes estimated at 8,840 Cedi (3,536 US dollars), and between 3,840 Cedi (US 1,536 dollars) to 14,400 Cedi (US 5,760dollars).

4) Socially Vulnerable

Based on the estimation of household incomes from interview to the occupants around the existing towers, 10 households can be under the WB poverty line (daily US$ 1.25 per headcount). No vulnerable households were identified in the PAPs. However, there were 14 socially vulnerable persons were identified in the affected household members.

Table 1-3-2-3.3 Affected Socially Vulnerable

No.	Type	Vulnerability	Total
1	Older Males of residential area	Highly dependent due to age or mental or physical disability	4
2	Older Females of residential area	Highly dependent due to age or mental or physical disability	3
3	Older Females of commercial area	Caretakers with no buildings of their own, or who are losing all the kiosk or stalls they work in.	2
4	Children in residential area	Highly dependent children due mental or physical disability	5
	Total		14

【Source】JICA Study Team

1-3-2-4 Measures of Compensation and Supports

GRIDCo/ECG will undertake measures to minimize or avoid land acquisition and resettlement, and are committed to ensuring the restoration of the livelihood of all people adversely affected by the Project. The following key policies are proposed based on the policy frameworks, Framework for Environmental and Social Management of Bulk Transmission Line Projects in Ghana, and Draft Land Acquisition and Resettlement Policy Framework, for the Project. As mentioned above, these policies mostly covers JICA's Guidelines for Environmental and Social Considerations and WB Operational Policies OP 4.12.

- All affected person are eligible regardless of legal or ownership titles;
- Affected person are compensated for the loses of structures, incomes and/or livelihoods;
- Resettlement or compensation payments are made on the basis of open market value or Replacement Cost of the property;
- Prior to the commencement of constructional activities, the PAPs should have been paid their compensation to enable them relocate;
- Cash compensation for the loss of income during the transition period;
- Vulnerable groups such as households headed by women or children, the aged, and the physically disabled etc. are cared to be provided to improve their socio-economic conditions rather than simply restoring then to their pre-project levels of vulnerability.

Table 1-3-2-4.1 Proposed Entitlement Matrix

Item No.	Type of loss	Entitled Persons	Entitlement (Compensation Package)	Implementation issues/Guidelines	Responsible Organization
1	Loss of structures (residential and commercial structures)	Owners of the structures	Cash payment at full market value for reconstruction of the structures	Assessment of compensation values and other alternative measures by Lands Valuation Division (LVD) and GRIDCo	GRIDCo, LVD
2	Loss of incomes due to dislocation of commercial structures	Owners of commercial structures	Cash payment for disruption allowance for 5 months		
3	Loss of Income and work days due to displacement	Household heads who reside	Cash payment for disruption allowance for 1 month transition period		
4	Loss of titles of commercial structures	Owners of commercial structures such as stalls, shelters, kiosks, containers with permit	Cash payment at full market value		
5	Displacement or damage of social infrastructure by construction activities	Owners/operators of social infrastructure services (telecommunication lines, water pipes, roads, or drainages)	Temporary relocation or rehabilitations	Coordination and negotiations with owners/operators of social infrastructure services	Supervising Consultant/ Contractor
6	Damages of community or public structures around the Project	Representatives, leaders or trustees of community or public structures	Rehabilitation, cash compensation or in-kind at replacement cost	Coordination and negotiations with representatives, leaders or trustees of	Supervising Consultant/ Contractor

	site by construction activities			community or public structures	

【Source】GRIDCo Framework for Environmental and Social Management of Bulk Transmission Line Projects in Ghana January 2009, Land Acquisition and Resettlement Policy Framework, JICA Study Team

1-3-2-5 Grievance Redress Mechanism

The grievance redress mechanism is officially studied in the RAP through the ESIA. The mechanism is expected as follows according to the "Framework for Environmental and Social Management of Bulk Transmission Line Projects in Ghana" and "Draft Land Acquisition and Resettlement Policy Framework" of GRIDCo.

- Grievance Redress Committee (GRC): The GRC is a main body to deal with grievance redress from the PAPs, which consists of representatives od communities, municipalities and GRIDCo
- Arbitration: Arbitration shall be an option for grievance redress where the parties involved in agree to resolve their dispute through arbitration. Aggrieved parties settle disputes out of court. In order to use arbitration in the settlement of disputes, the parties ought to make a written agreement to submit a present dispute, or future disputes to arbitration. The parties are at liberty whether or not to name an arbitrator in the agreement. Commission on Human Rights and Administrative Justice (CHRAJ), Department of Social Welfare in the Ministry of Employment and Social Welfare also mediate the disputes.
- Courts of Law: It should be noted that arbitration only works where the parties to a dispute agree to resolve a difference through arbitration. Where there is no consent, then a court of jurisdiction may be used to resolve a dispute.

1-3-2-6 Institutional Framework

1) GRIDCo Engineering Department

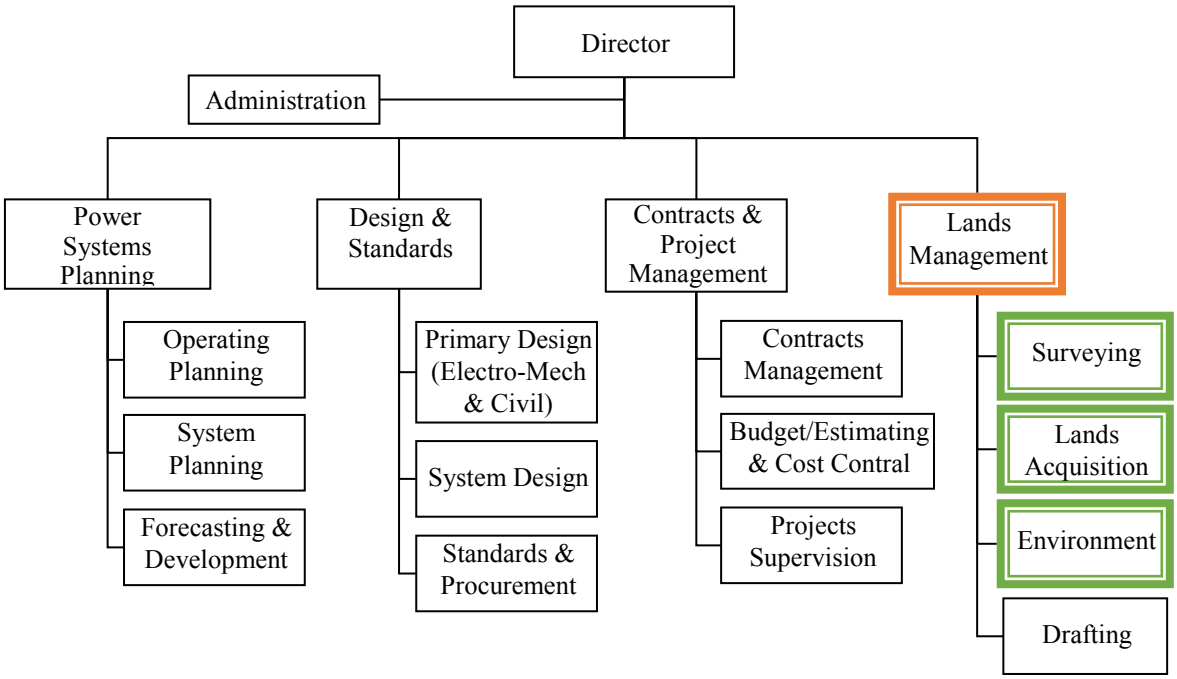
The project implementation body, GRIDCo Engineering Department whose structure is shown in Figure 1-3-2-6.1 is responsible to implement the land acquisition and resettlement. In the Engineering Department, the Lands Management Section takes main role for it. The other sections are involved as follows.

- Environment: implementation of ESIA, preparations of EIS/RAP, public consultations, grievance redress, monitoring & evaluation
- Lands Acquisition: implementation of ESIA, preparations of EIS/RAP, population census, inventory, valuation of lost assets and incomes, public consultations/negotiations, payment of compensation, grievance redress, monitoring & evaluation
- Surveying: population census, inventory

2) Other Related Organizations

The other parties except GRIDCo Engineering Department take following roles in the implementation of land acquisition and resettlement.

- GRIDCo Finance Department: budgetary provision
- Lands Valuation Division (LVD) of Lands Commission: Census and Inventory, valuation of lost assets and incomes, Negotiation and Consent, payment of compensation
- Independent Valuers (Private Valuation Consultants): valuation of lost assets and incomes
- Grievance Committee (GC): grievance redress
- Commission for Human Rights and Administrative Justice (CHRAJ): grievance redress (mediation)
- Department of Social Welfare: grievance redress (mediation)
- Court: grievance redress (mediation), final decision



【Source】GRIDCo

Figure 1-3-2-6.1 Organization Structure of GRIDCo Engineering Department

3) Lands Valuation Division (LVD) of Lands Commission

The Lands Valuation Division (LVD) of Lands Commission was established mainly to evaluate the assets related to land acquisition for public work projects as a Lands Valuation Board (LVB) in 1986. The LVD is a governmental agency responsible for the assessment of values to be paid on properties affected by involuntary acquisitions. The LVD undertakes valuation of immovable properties including land, buildings, furniture, fittings and fixtures, trade stock, plant and machinery and other effects, for any purpose, for Government agencies. Besides, the LVD advises all organs of Government on all matters of valuation of interest in immovable properties.

1-3-2-7 Implementation Schedule

The implementation schedule will be officially studied in the RAP through the ESIA. The implementation processes are expected as shown in Table 1-3-2-7.1 according to the “Framework for Environmental and Social Management of Bulk Transmission Line Projects in Ghana” and

"Draft Land Acquisition and Resettlement Policy Framework" of GRIDCo.

GRIDCo will start the Census and Inventory Census (cut-off date) after the Exchange of Notes (E/N) and Grant Agreement (G/A) for the Project, and 12 months are expected to complete the resettlement. Therefore, the implementation schedule of RAP would meet the Project implementation schedule as the process would be completed before the removal works of the existing towers are started.

- 6 months for Census and Inventory, Valuation of Lost Assets and Incomes, Compensation Entitlement
- 6 months for Negotiation and Consent, Budget Disbursement and Payment and Relocation including Grievance redress

Table 1-3-2-7.1 Expected Implementation Process

No.	Resettlement Steps	Responsible Organization	Expected schedule
A.	Pre-Resettlement Implementation Stage		
(1)	RAP Preparation	− GRIDCo Lands Management: Environmental Unit, Lands Acquisition Unit − Local Consultant	Through ESIA
(2)	Institutional Arrangements	− GRIDCo Engineering Department	
B.	Resettlement Implementation Stage		After EN/AG
(3)	Census and Inventory	− GRIDCo Lands Management: Surveying Unit, Lands Acquisition Unit − Lands Commission: Land Valuation Division − PAPs or PAP's representatives	About 6 months
(4)	Valuation of Lost Assets and Incomes	− GRIDCo Lands Management: Lands Acquisition Unit − Lands Commission: Land Valuation Division − Independent Valuers (Private Valuation Consultants)	
(5)	Compensation Entitlement	− GRIDCo Lands Management: Lands Acquisition Unit − Lands Commission: Land Valuation Division − Independent Valuers	
(6)	Negotiation and Consent	− GRIDCo Lands Management: Lands Acquisition Unit − Lands Commission: Land Valuation Division	About 6 months
(7)	Budget Disbursement	− GRIDCo Finance Department	
(8)	Payment and Relocation	− GRIDCo Lands Management: Lands Acquisition Unit − Lands Commission: Land Valuation Division − PAPs, Opinion leaders, an elder or chief	
C.	Cross-Culling Issues		
(9)	Public Consultation Meeting	− GRIDCo Lands Management: Environmental Unit, Lands Acquisition Unit	
(10)	Grievance Redress Mechanism (GRM)	− GRIDCo Lands Management: Environmental Unit, Lands Acquisition Unit − Grievance Redress Committee − Commission on Human Rights and Administrative Justice (CHRAJ) − Courts	
(11)	Monitoring and Evaluation	− GRIDCo Lands Management Environmental Unit, Lands Acquisition Unit	

【Source】GRIDCo Framework for Environmental and Social Management of Bulk Transmission Line Projects in Ghana January 2009, Land Acquisition and Resettlement Policy Framework, JICA Study Team

1-3-2-8 Cost and Finance

The necessary budgetary provisions to ensure that mitigation commitments stated (including compensation) and monitoring programs can be implemented effectively with the provisional estimate of one million, three hundred and eighty-five, seven hundred and eighty-eight Ghana Cedis only (GH¢ 1,385,788), approximately five hundred and fifty-four thousand, three hundred

and fifteen US dollars only (US$ 554,315) as shown in Table 1-3-2-8.1. (US$1= GH¢2.5). GRIDCo Finance Department will secure this budgetary provision.

The following were considered in the estimation of the cost of implementing the RAP.

1) Compensation for Structures

Total 77 structures can be removed and compensated. The compensation amount was calculated at the replacement cost for the replacement of affected structures. The cost is based on the market cost (at the time of valuation) of the materials to build a structure plus the cost of transporting materials to site, cost of labor and contractors' fees. (See Appendix-8.1.)

2) Titles to Commercial Structures

Total 10 commercial buildings were registered and those titles will be compensated. The District Assembly laws stated that it is a requirement for anyone who wants to establish a structure to acquire a permit. These are the current permit fees to be paid by the owners of the structures to the local government when establishing a new commercial structure. (See Appendix -8.1.)

3) Loss of income

Total 19 persons who have their businesses within the 15 meters square area would suffer from income loss as a result of displacement. It was estimated that it would take about four (4) months to get the businesses established plus transition period of estimated one (1) month. Therefore, income loss of 19 persons whose businesses would be affected is estimated by multiplying their monthly income by five (5) months. In addition, income loss for approximately one month income was calculated for 13 PAPs whose residents will be affected within 15 meters square area as period of transition. (See Appendix-8.2.)

4) Vulnerable Persons

It is the practice of GRIDCo to cater for vulnerable persons affected by the project even if they are not household heads. To estimate the compensation for vulnerable persons the monthly income of their respective households were divided by the household sizes to get income per household member per day. It has been estimated that the period of construction will last for about four (4) months (approximately 120 days). Hence, the income per vulnerable person per day was multiplied by 120 days for 14 vulnerable persons of different income levels were added as an estimated compensation. (See Appendix-8.3.)

5) Professional Fees and Permits

Under the Ghanaian laws, acquiring bodies are responsible for the payment of legal and surveyors fees incurred by PAPs when their properties are compulsorily acquired. The fee charged is normally 10% of the assessed value of the property. This is a statutory requirement for procuring the services of the Land Valuation Division.

6) Monitoring

A project with relatively limited resettlement impacts, an in-house monitoring system is commonly instituted within the project agency. With this project, GRIDCo will rely upon its staff in the Lands Management Section of the Engineering Department to keep track of ROW acquisition, compensation, and grievances. Three persons will be assigned as a team to monitor the implementation of RAP. The monitoring period is expected about 2.5 years until the construction works are completed, which has been estimated to last for 700 working days. A daily allowance for one GRIDCo staff will be GH¢120.00/day for three (3) staff was used as an estimate cost for the monitoring.

7) Contingency

An estimate of 10% of the total budget of the cost of implementation of resettlement action plan has been added to cater for other unforeseen cost that would arise in the course of the implementation.

Table 1-3-2-8.1 Estimated Costs of RAP Implementation

No.	Item	Amount	
		(GH¢)	(US$)
	Compensation for assets		
(1)	Wooden kiosk with wooden base & corrugated iron roofing sheet for Commercial/Residential	25,000	10,000
(2)	Metal kiosk with concrete base and corrugated iron roofing sheet for Commercial/Residential	120,000	48,000
(3)	Metal Container with concrete base and corrugated iron roofing sheet for Commercial only	136,500	54,600
(4)	Shed for Livestock trading for Commercial only	4,850	1,940
(5)	Wooden kiosk with wooden base & corrugated iron roofing sheet for Residential only	13,000	5,200
(6)	Wooden kiosk with concrete base & corrugated iron roofing sheet for Residential only	98,008	39,203
(7)	Titles to Commercial Structures	3,650	1,460
	Compensation for income loss		
(8)	Loss of income due to Commercial loss and transition period	502,800	201,120
(9)	Loss of income during transition period of residential PAP	5,624	2,250
	Other Costs		
(10)	Support for vulnerable persons	58,639	23,456
(11)	Professional fees and Permits (10% of the cost of structures (1)-(6))	39,736	15,894
(12)	Monitoring	252,000	100,800
	Total		
(13)	Sub-total	1,259,807	503,923
(14)	Contingency (10% of Sub-total)	125,981	50,392
(15)	GRAND TOTAL	1,385,788	554,315

Note: US$1= GH¢2.5

【Source】GRIDCo, JICA Study Team

1-3-2-9 Monitoring System

The monitoring system will be officially studied in the RAP through the ESIA. Based on the "Framework for Environmental and Social Management of Bulk Transmission Line Projects in Ghana" and "Draft Land Acquisition and Resettlement Policy Framework" of GRIDCo, Lands Management Section of Engineering Department is directly responsible for monitoring compliance with environmental performance. The Lands Management Section will monitor the

RAP implementation activities. The Section maintains a complete set of administrative records on asset inventories, payment receipts, and complaints. The LVD maintains a copy of the file for the legal agreements on physical assets.

Table 1-3-2-9.1 Monitoring Team of GRIDCo

Responsible Unit	Position	Task for Monitoring
Land Acquisition	Leader	1. Team leader responsible for organization and coordination. 2. Keeping administrative records, inventory, valuation, payment receipts, and complaint records. 3. Reporting 4. Any other duties that would be assigned
Land Acquisition	Staff	1. Resettlement procedures 2. Inventory, valuation, consent building, compensation execution, relocation, clearing 3. Grievances recording 4. Any other duties that would be assigned
Environment	Staff	1. Health and safety 2. General environmental issues 3. Sanitation issues 4. Any other duties that would be assigned

【Source】GRIDCo, JICA Study Team

1-3-2-10 Stakeholder Meeting

As explained in sub-section 1-3-1-9, GRIDCo preliminarily conducted the stakeholder meeting for the inhabitants around the existing towers, who can be the PAPs of the Projects. They were aware that they informally inhabited and indicated consent to remove for the Project implementation. However, the most concerned issues of the meeting was compensation for the properties and livelihoods of the PAPs. GRIDCo assured all the attendants that GRIDCo is mandated to mitigate the impact on the livelihood of individuals and communities displaced or affected by its operations in accordance with the environmental policy and corporate responsibility of GRIDCo.

1-3-3 Others

1-3-3-1 Draft Monitoring Form

Monitoring forms were drafted according to the monitoring plan as shown in Table 1-3-3-1.1.

Table 1-3-3-1.1 Draft Monitoring Form

Monitoring Item: 1. Consent buildings with the PAPs Planned Number: households					
No.	Date	Location	Number of Households	Special Instructions (Questions & Answers, Opinions)	Frequency
1					After E/N and A/G, Monthly
2					
3					
Monitoring Item: 2. Progress of compensation payment Planned Number: households					
No.	Date	Location	Number of Households	Special Instruction (Issues/Measures)	Frequency
1					Monthly
2					

3					

Monitoring Item: 3. Progress of PAP relocation
Planned Number: households

No.	Date	Location	Number of Households	Special Instruction (Issues/Measures)	Frequency
1					Monthly
2					
3					

Monitoring Item: 4. Progress of structure clearing
Planned Number: structures

No.	Date	Location	Number of Structures	Special Instruction (Issues/Measures)	Frequency
1					Monthly
2					
3					

Monitoring Item: 5. Process of grievance redress

No.	Date	Location	Number of petitioners	Special Instruction (Issues/Measures)	Frequency
1					Monthly
2					
3					

Monitoring Item: 6. Ambient noise level in dB(A)

No.	Date	Location	Noise level in dB(A)	Special Instruction (Issues/Measures)	Frequency
1		Accra Central BSP			Monthly (a half year after the operation starts)
2					
3					

【Source】JICA Study Team

1-3-3-2 Environmental Check List

Based on the JICA's Guidelines for Environmental and Social Considerations (April, 2010 Version), the Study Team conducted an environmental review of the Project using the Environmental Checklist: Power Transmission and Distribution Lines with GRIDCo as shown in Table 1-3-3-2.1.

Table 1-3-3-2.1 Environmental Checklist: Power Transmission and Distribution Lines

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons for Yes/No, Mitigation Measures)
1. Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied?	(a) N	(a) The Environmental Assessment Regulations in Ghana demand an EIA for construction of a transmission line. Besides, the EPA's Environmental Guidelines for the Energy Sector demand ESIA (EIA) involving high voltage transmission lines either overhead or underground, equal or exceeding 70 kV class. Therefore, ESIA will be required for the Project. GRIDCo registered the Project to EPA in October

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons for Yes/No, Mitigation Measures)
		(d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(b) N (c) Y (d) N	2013 and was required the ESIA by EPA in December 2013. (b) GRIDCo has started ESIA since February and will obtain an Environmental Permit (EP). (c) EP will include conditions especially for construction works. GRIDCo and contractors will satisfy the imposed conditions. (d) GRIDCo will make consents with related authorities as stakeholders through the implementation of ESIA.
	(2) Explanation to Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) GRIDCo conducted a stakeholder meeting in February 2014 and obtain general consents from representatives of residents to the Project. GRIDCo will conduct other stakeholder meetings in the ESIA. (b) GRIDCo will reflect the comments in ESIA especially for mitigation measures.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) As the project site is located in urbanized area, three alternatives including the zero option (the case without the Project) were examined to minimize the impacts on resettlement. The alternatives were formulated with types of towers and the appropriate alternative was studied from a technical perspective, cost and required land space for the construction.
2. Pollution Control	(1) Water Quality	(a) Is there any possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? If the water quality degradation is anticipated, are adequate measures considered?	(a) N	(a) The project activities will not involve any major alteration of the local topography or large-scale civil engineering work. Consequently, there will be no soil runoff to the extent of worsening the water quality. Moreover, the management of soil runoff will be stated in environmental management plans in ESIA and contract term that GRIDCo requires a contractor.
3. Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) As the project site is located in Accra urbanized area, it is not located in protected areas.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate measures taken to prevent disruption of migration routes and habitat fragmentation of wildlife and livestock? (e) Is there any possibility that the project will cause the negative impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystem due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts	(a)-(f)N	(a)-(f) As the project site is located in Accra urbanized area, there is no special ecosystem.

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons for Yes/No, Mitigation Measures)
		considered? (f) In cases where the project site is located in undeveloped areas, is there any possibility that the new development will result in extensive loss of natural environments?		
	(3) Topography and Geology	(a) Is there any soft ground on the route of power transmission and distribution lines that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? (b) Is there any possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(a)(b)N (c) N	(a)(b) The land is mostly flat at about 10 meters above sea level. No major alterations of the local topography or large-scale civil engineering work will occur under the Project, making slope failures, landslides or soil runoff highly unlikely. (c) The foundation works of control room of Accra Central BSP can cause soil runoff but it will be within limited time and immediately compacted. Besides, the management of soil runoff will be stated in environmental management plans in ESIA and contract term that GRIDCo requires a contractor.
4. Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) Y (b) Y (c) Y (d) Y (e) Y (f) Y (g) Y (h) Y (i) Y (j) Y	(a) Involuntary resettlement is caused around the 161 kV towers by the constructions. However, the alternatives were studied with types of the towers and those designs were technically studied to minimize the impacts of resettlement. As a result, 151 persons in 22 households were identified around the towers for resettlement. (b) GRIDCo will conduct public consultations for the PAPs to explain resettlement policies and make consents in the ESIA and evaluation of compensation amount. (c) In accordance with GRIDCo Framework for Environmental and Social Management of Bulk Transmission Line Projects in Ghana and Deaft Land Acquisition and Resettlement Policy Framework, RAP will be made in the ESIA. The frameworks state compensation with market prices or full replacement costs, restoration of livelihoods and living standards. (d) The compensations will be paid prior to the resettlement according to the frameworks of GRIDCo. (e) GRIDCo will make the RAP including the compensation policies in the ESIA. (f) The RAP will pay particular attention to vulnerable groups or people according to the frameworks of GRIDCo. (g) GRIDCo will make consents with the PAPs through the public consultations in the ESIA. (h) GRIDCo Land Management Section of Engineering Department will establish implementation unit and GRIDCo will secure the budget. (i) GRIDCo will make the monitoring plan according to the frameworks of GRIDCo. (j) GRIDCo will establish the grievance redress mechanism according to the frameworks of GRIDCo.
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures	(a) Y	(a) The project will adversely affect the living conditions of the PAPs with resettlement or temporary relocation. The RAP including the

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons for Yes/No, Mitigation Measures)
		considered to reduce the impacts, if necessary? (b) Is there a possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (c) Is there any possibility that installation of structures, such as power line towers will cause a radio interference? If any significant radio interference is anticipated, are adequate measures considered? (d) Are the compensations for transmission wires given in accordance with the domestic law?	(b) N (c) N (d) N	mitigation measures will be made in the ESIA and it will be implemented by GRIDCo. The traffic of residents and vehicles will be affected by the construction works. However, the impact is limited within construction period and it is because most construction works will be manually done. Traffic management during the construction period will be done according to the according to the environmental management plan that a contractor is required to prepare. (b) No significant adverse impact is expected on hazards and infectious diseases because no massive influx of workers is expected as most labours can be supplied locally for the small-scale project and construction works by humans. However, a contractor will sensitize workers and communities to reduce the risks of HIV infections according to the environmental management plan that a contractor is required to prepare. (c) As the existing route of 33 kV sub-transmission line is used for the Project, the 161 kV towers will not cause any radio interference which will negatively affect local people. (d) As the existing route of 33 kV sub-transmission line is used for the Project, the compensations for transmission wires will not be given. If any compensations are necessary through the ESIA, GRIDCo will provide it according to the RAP.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There are no prominent archaeological, historical, cultural or religious sites to consider at the Project sites. However, simple worships are located although they are near the project site. GRIDCo will conduct consultation with them.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) No significant impact is expected on landscape because there are no special natural and cultural landscapes around the project sites. 161 kV towers are higher than the existing 33 kV sub-transmission towers, however, they will not significantly change the existing landscape.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a)-(b) N	(a)-(b) There are no settlements of ethnic minorities or indigenous peoples at the Project site.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and	(a)-(d) Y	(a)-(d) Japanese supervising consultant and contractor take responsible to ensure management for safety and health in working conditions in accordance with contractor's construction manuals which are required in the contract in order to prevent accidents at work and to the local residents during construction period. Personal protective wear will be provided for all the workers during construction.

Category	Environmental Item	Main Check Items	Yes:Y No:N	Confirmation of Environmental Considerations (Reasons for Yes/No, Mitigation Measures)
		public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?		
5. Others	(1) Impacts During Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a) Y (b) N (c) Y	(a) An environmental management plan that GRIDCo requires a contractor designates mitigation measures for pollution during construction. (b) As the project site is located in Accra urbanized area, the construction activities do not adversely affect the natural environment. (c) The construction works can affect traffic of resident and vehicles, commercial and business activities although no particular heavy machinery is required. The traffic management during the construction will be designated in the environmental management plan that GRIDCo requires a contractor in the contract.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a)-(b) Y (c) Y (d) Y	(a)-(b) An Environmental Management & Monitoring Plan will be prepared in the ESIA and implemented by GRIDCo. (c) GRIDCo will formulate the monitoring system and GRIDCo and a contractor shall make budgetary allocations towards all environmental programs. (d) A contractor will submit GRIDCo weekly reports. The EP will designate that GRIDCo should submit EPA monitoring reports.
6. Note	Reference to Checklist for Other Sectors	(a) Where necessary, pertinent items described in the Road checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities).	(a) N	(a) The Project is irrelevant as it only involves the project components consist of the construction of a building for a control room, the installation of transformers and gas insulated switchgears in the existing BSP, and the installation of 161kV transmission line only at 3.4 ㎞.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed, (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N	(a) The Project is irrelevant as it only involves the project components consist of the construction of a building for a control room, the installation of transformers and gas insulated switchgears in the existing BSP, and the installation of 161kV transmission line only at 3.4 ㎞.

【Source】JICA Study Team

Chapter 2 Contents of the Project

2-1 Outline of the Project

2-1-1 Overall objectives and Project purpose

The Ghana Grid Company (GRIDCo) completed the Transmission System Master Plan for Ghana in February 2011, formulating a distribution facility plan to cover all of Ghana by 2020. With support from the United States Trade and Development Agency (USTDA), GRIDCo also finished revising this master plan in December 2012, setting 2026 as the target year. The revised master plan is the upper level plan to this project.

However, the power development projects based on this upper level plan have been stalled, particularly by power distribution facilities in the Accra area. The Ghana government has thus requested grant aid from Japan to achieve self-reliant, sustainable socioeconomic growth with the Power Supply to Accra Central project.

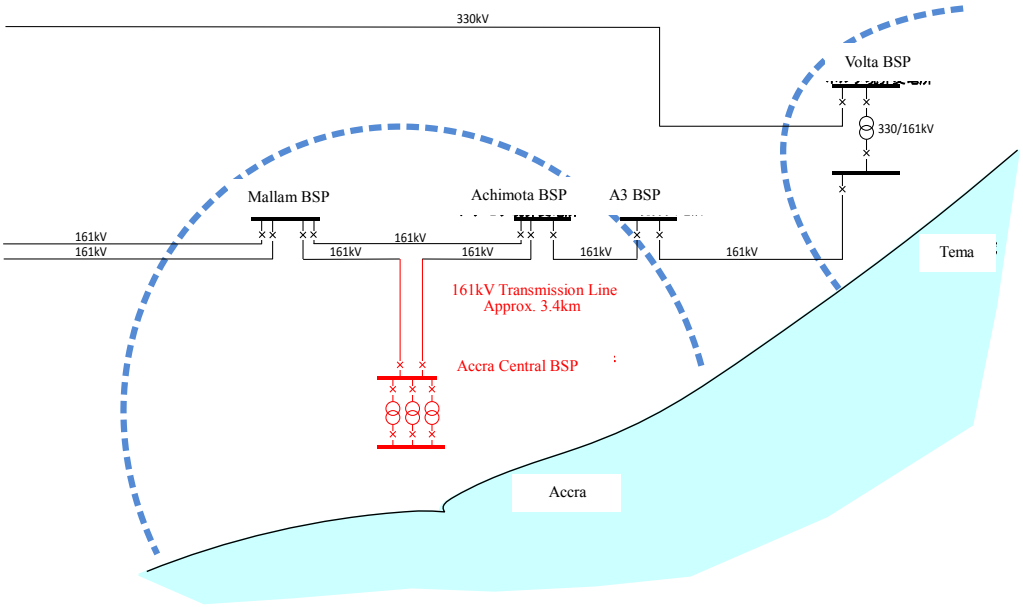
2-1-2 Outline of the Project

This project is meant to help to enhance distribution facilities in the Accra area to improve the serious damage done to economic activity in the area by insufficient supply capacity from power distribution facilities and aging facilities. Table 2-1-2-1 gives an outline of the project, while Figure 2-1-2.1 shows the location of the project system.

Table 2-1-2.1 Outline of the components of the Project

Components		Quantity
Procurement and Installation Work		
1. Accra Central BSP		
(1) 161 / 34.5 kV Transformers (ODAF, Outdoor, Metal Enclosure Type)		125 MVA × 3units
(2) 170 kV Gas Insulated Switchgears (GIS) (Double Bus Type)		
1) Incoming Feeders	(Outdoor Type)	2 sets
2) Transformers Feeders	(Outdoor Type)	3 sets
3) Bus Coupler	(Outdoor Type)	1 set
4) Voltage Transformers	(Outdoor Type)	2 sets
(3) 33 kV GIS (Double Bus Type)		
1) 161/34.5 kV Transformer bays	(Indoor Type)	3 sets
2) 33/11 kV Transformer bays	(Indoor Type)	3 sets
3) 33 kV Feeder bays	(Indoor Type)	14 sets
4) Bus Coupler bay	(Indoor Type)	2 sets
5) Bus Section bays	(Indoor Type)	1 set
6) Station Transformer bays	(Indoor Type)	3 sets
7) Earthing Transformer bays	(Indoor Type)	2 sets
(4) SCADA Interface Panel		1 set
2. 161kV Transmission Line from the Avenor Branch Point to Accra Central BSP (1 Circuit for Achimota Line and 1 circuit for Mallam Line)		
(1) 161 kV Overhead Line (ACSR, TERN, twin bundle or equivalent)		Approx. 3 km
(2) 161 kV Underground Cable (XLPE Cable, Copper, 1,600 mm^2)		Approx. 0.4 km
Procurement Work		
3. Testing Equipment and Maintenance Tools for the Equipment of the Project		1 lot
4. Spare Parts for the Equipment of the Project		1 lot
Construction Work		
5. Foundation for the Equipment of the Project (Gas Insulated Switchgears, Transformers, Towers for 161 kV Transmission Line)		1 lot
6. Building for a control room of Accra Central BSP		1 building

[Source] Preparatory Survey Team



[Source] Preparatory Survey Team

Figure 2-1-2.1 Location of the requested components

2-2 Outline Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

This project primarily targets higher level power distribution facilities in the Ghana power system. Still, in the absence of medium-to-long-term system plans, there are concerns that operation of lower level power facilities and even supply stability may also be impacted as the development plan targets an Accra area experiencing significant growth.

Along with being an urgent grant aid project, in light of the above point, this project must avoid equipment being replaced before the facilities reach their service life once in service. Thus, the target years for project evaluation and facility planning are to be set carefully.

Also, given that this is a development project in a region with an active socioeconomy, environmental and social concerns are to be properly accounted for in the planning phase.

2-2-1-2 Plan for Natural Conditions

(1) Temperature Conditions

The rainy seasons in the Accra area for the project are from March to July, with dry seasons in other periods. Weather in the Accra area is clearly delineated between rainy and dry seasons. High temperatures reach 38°C in the dry season, while low temperatures reach 15°C and average humidity is 97% in the rainy season. Substation facilities used in the project will account for the above temperatures and humidity. Care will be taken such that the equipment will operate properly with no obstacles to O&M in the external air temperatures, temporary temperature increases from direct sunlight and high humidity. Space heaters will also be used for electrical enclosures in order to prevent condensation from temperature differences.

(2) Climate Conditions

Maximum monthly rainfall in the Accra area for the project during rainy season is around 180 millimeters, but there are squalls in certain areas. As such, foundations for substation facilities will be raised 1.5 meters, along with other flood measures. Also, given the lightning during the rainy season in the project area, shielding for overhead ground wires on transmission line towers will be installed at the GRIDCo standard angle of 15 degrees to keep a 95% shielding rate. Given the danger of a lightning strike during steel tower construction and overhead line work, safety precautions are to be taken, such as temporarily halting work when thunder is heard in the distance. Also, a lightning rod will be installed on the rooftops of control building in this project to prevent lightning from directly striking the substation facilities within the Accra Central BSP.

(3) Other considerations

Given the project site is located approximately 2.5 kilometers from the coast, there are concerns of salt damage. In order to ensure a stable power supply, the number of suspension and tension insulators are to be noted carefully, along with surface leakage distances for insulators used with 161 kV transmission lines.

2-2-1-3 Plan for Socioeconomic Conditions

The project site is in the Accra area in a light industrial zone along major roads with much traffic. Some of the phone, water, sewage and other infrastructural facilities are also buried where the transmission line towers will be constructed. Thus, to the extent possible, work should not interfere with local residents and traffic or obstruct existing structures and buried objects. Transmission line design will also maintain safe separation distances from nearby structures along road boundaries.

2-2-1-4 Plan for Construction Conditions

The project area in Accra generally has good construction conditions. There is much construction activity for various large commercial facilities and office buildings, and multiple

contractors which handle such construction work, including electrical contractors. With multiple contractors that can handle work on the ultra-high voltage substation and transmission facilities for the project, project policy will be to assume that the contractors in Accra will be used as sub-contractors.

2-2-1-5 Plan for Using Local Contractors, Equipment and Materials

Given the limitations on attainable easements for the project, it is essential to use gas-insulated switchgears and forced oil, air-cooled transformers, along with other equipment being introduced to Ghana for the first time. As such, supervision by Japanese engineers with sufficient skill in substation and power transmission planning will be essential in system integration and installation work management, and this will be kept in mind when building the construction team.

Still, market research on local Ghana contractors and past work order materials from the implementing agency suggest that construction workers, work vehicles, construction equipment and materials can be procured in Ghana with relative ease. As the skilled labor and regular workers for the construction and work for substation facilities, civil works, buildings and transmission lines in the project can be ordered from local contractors, the project implementation plan will use local sub-contractors.

Also note that as the aggregate, cement, rebar and other materials used in the civil works and construction for the substation and foundation work for the transmission towers can be purchased locally, equipment and materials are to be purchased locally to the extent possible in this project.

2-2-1-6 Plan for O&M Capacity of Implementing Agency

Despite its struggles with large-scale capital investments such as the current project, GRIDCo does have a certain level of technical capacity in system operations and has steadily handled O&M for the national power transmission network. This project includes gas-insulated switchgears and other equipment being introduced into Ghana for the first time. Such equipment may differ from traditional switchgears and equipment in interior structure, but as far as operation methods, system protection functionality and other O&M issues, the required skills do not greatly exceed the technical levels for equipment used in Ghana to date.

Accordingly, this project will not include any transfer of power technology or other soft component involving consultants focused on system operation and protections. Manufacturer technicians will be used for O&M technology transfers, offering guidance on initial and standard operation based on the characteristics, features and specifications of the equipment.

2-2-1-7 Planned Scopes for Facilities and Equipment and Setting Grades

In light of the conditions described above, materials and equipment to be purchased for the project, as well as installation scope and technical standards will be determined based upon the following policies.

(1) Planned Scope for Facilities and Equipment

Project scope will include the facilities and equipment needed to help stabilize the socioeconomic activity of the Accra area based on the estimated power demands in the target year of the equipment plan, that being the tenth year following the start of service. In terms of the division between the Japanese side project and Ghana side work, the Japanese side will plan on consulting with the Ghana side to decide which items the Ghana side can reasonably handle without exceeding Ghana side abilities.

In order to keep the designs economical, equipment specifications will use standard products conforming to international standards when possible, selecting the minimum required equipment configurations and specifications.

(2) Plan for Setting Grades

Care will be taken not to deviate from the technical levels of GRIDCo when designing the power distribution facilities built, procured and installed in the project, conforming to existing facility configurations, GRIDCo technical standards and work manuals.

2-2-1-8 Plan for Construction and Procurement Methods and Work Period

As this project will be performed based on the Japan grant aid scheme, installation must be completed within the time limits as given in the Exchange of Notes (E/N) and Grant Agreement (G/A). In order to complete the work within the specified construction period and achieve the results expected from substation construction, the process plan decided must effectively coordinate Japanese and Ghana work schedules and work to streamline importing and other various procedures.

With concurrent construction of the substation and 161 kV transmission lines, care must be taken to keep scheduling efficient. Work teams need to be formed appropriately, the construction methods used need to be well known to local contractors and engineers, and the implementation system must be structured so that work progresses safely and swiftly.

2-2-2 Basic Plan

2-2-2-1 Prerequisites of the Project

1) Purpose of Power demand forecate for the Project

The main project components are construction of an Accra Central BSP and upgrading the transmission lines to the substation to 161 kV lines to improve power distribution within the Accra area. The substation includes three 161/34.5 kV voltage class transformers with 125 MVAx3 capacity and two transmission lines: one bound for Achimota and another bound for Mallam.
The purpose of the preparatory study will be to clarify project prerequisites by estimating power demand in the Accra area. It will act as base data to verify project relevance and effectiveness in light of the power distribution facility plan, including flow analysis and evaluations on how well the project coordinates with other development projects.

2) Target year for the Project

Relevance and effectiveness of the project as a grant aid project, including its urgency and benefit, will be confirmed through the preparatory study. This project primarily targets higher level power distribution facilities in the Ghana power system. Still, in the absence of medium-to-long-term system plans, there are concerns that operation of lower level power facilities and even supply stability may also be impacted as the project targets an Accra area experiencing significant growth.

The target year for facility planning will be ten years after service starts. This project must avoid equipment being replaced before the facilities reach their service life once in service, and the ten year figure is consistent with recent projects for enhancing upper level system power distribution in metropolitan areas and cities, as well as other similar grant aid projects. Meanwhile, as this project is a grant aid project of urgent need, the target year for evaluating the project and its benefits will be three years after service start.

Start of service:	2018 (Planning year)
Target year for project evaluation:	2021 (Three years from start of service)
Target year for facility plan:	2028 (Ten years from start of service)

3) Conditions of power facilities, power demand, and system load factor

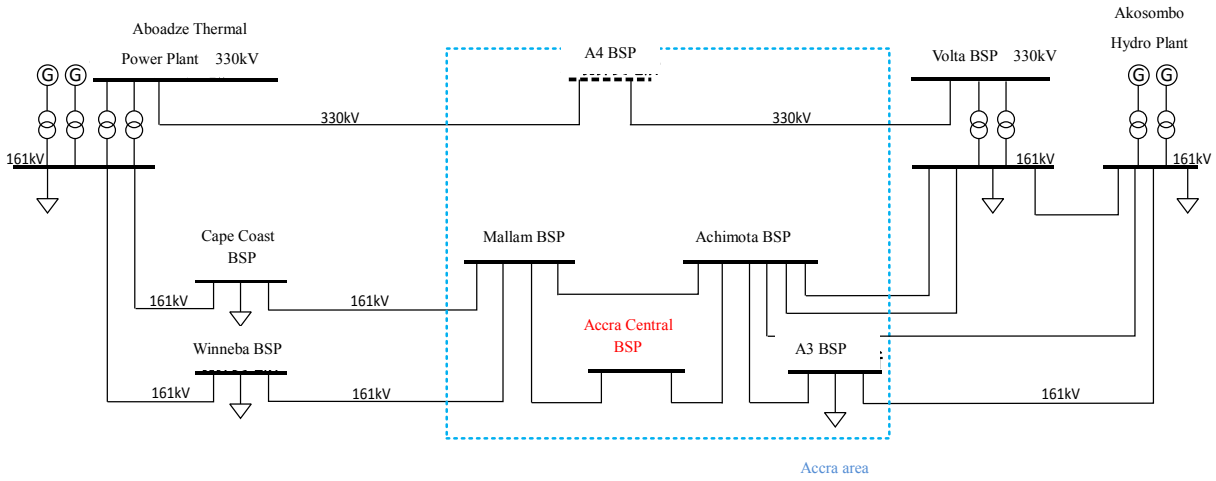
1) Power facilities Conditions

Figure 2-2-2-1.1 gives an outline of the power distribution facilities for the Accra area. The Achimota, Mallam and A3 BSPs are currently responsible for supplying power to the metropolitan area. Power is supplied mainly by the Akosombo Hydro Plant in eastern Ghana and supplemented by the Aboadze Thermal Power Plant in the west.

Table 2-2-2-1.2 gives the facility capacities for each of the BSPs in the Accra area. As shown in the table, total capacity for the current BSPs is 726 MVA, but supply capacity to the Accra area is insufficient. As such, inefficient measures are being used to supply

the Accra area with power with large power losses, diverting 161 kV power from the Winneba BSP to Accra and using 33 kV sub-transmission lines.

In light of the circumstances, GRIDCo is working on an enhancement project to add two 66 MVA capacitor banks to the substation facilities in the A3 BSP for a total improvement of 132 MVA, aiming to commence operation at the end of 2014. Since Ghana started exporting oil in 2010, the Ghana economy has shown dramatic growth, bringing with it rapidly growing power demands in the capital. As shown in Figure 2-2-2-1.1, the central area of Accra has an urgent need for the Accra Central BSP to be developed in this project, as well as an A4 BSP in the northern Accra, which has gradually developed as Accra has expanded.



[Source] Preparatory Survey Team

Figure 2-2-2-1.1 Outline of Power faicilities in Accra Central

Table 2-2-2-1.1 Existing BSP located in Accra Central

Substation	System Voltage	Transformer	Capacity	Status
Achimota BSP	161 / 34.5 kV	5T1	66 MVA	Operation
	161 / 34.5 kV	5T2	66 MVA	Operation
	161 / 34.5 kV	5T3	66 MVA	Operation
	161 / 34.5 kV	5T4	66 MVA	Operation
	161 / 34.5 kV	5T5	66 MVA	Operation
	Total		**330 MVA**	—
Mallam BSP	161 / 34.5 kV	37T1	66 MVA	Operation
	161 / 34.5 kV	37T2	66 MVA	Operation
	161 / 34.5 kV	37T2	66 MVA	Operation
	161 / 34.5 kV	37T2	66 MVA	Operation
	Total		**264 MVA**	—
A3BSP	161 / 34.5 kV	A3T1	66 MVA	Operation
	161 / 34.5 kV	A3T2	66 MVA	Operation
	Total		**132 MVA**	—
Total Capacity			**726 MVA**	

[Source] Preparatory Survey Team

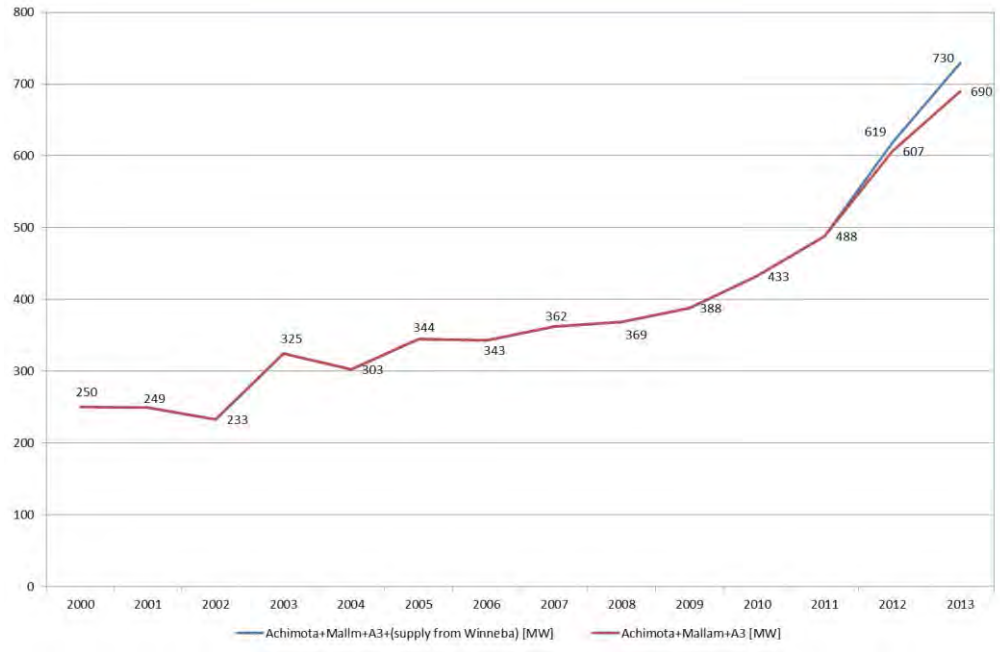
2) Power Demand Conditionsin Accra Central

The annual peak totals for the 161 kV buses at each of the Accra area BSPs between 2000

and 2013 are given in Figure 2-2-2-1.2. Power demands in Ghana have increased significantly together with the rapid socioeconomic progress made since 2010, reaching 690 MW in 2013. Also, as mentioned above, the capacity of Accra area BSPs is a bottleneck preventing power supply within the Accra area. Taking into account the power supplied to the Accra area from the Winneba BSP via 33 kV sub-transmission lines, power demand was 730 MW in 2013, as shown in the figure.

It should also be noted here that a simultaneous utilization rate must be applied to the simplified total above to calculate actual loads in the Accra area. The average simultaneous utilization rate for Ghana power demand was 92% from 2003 to 2011.

Next, Table 2-2-2-1.2 shows the annual energy consumption levels for 161 kV bus loads of each BSP in the Accra area in gigawatts per hour (GWh). This table confirms that the Mallam BSP went online in 2001 and the A3 BSP when online in 2012.



[Source] GRIDCo

Figure 2-2-2-1.2 Change of Total value of the yearly peak loads of 161 kV Bus in Accra area

Table 2-2-2-1.2 161 kV Bus load on each BSP in Accra area

Unit: GWh/year

BSP	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Achimota	1524	1398	1265	1423	1508	1607	1564	1572	1748	1787	1975	2117	2025	1850
Mallam	-	208	415	339	371	410	502	449	612	667	774	844	1044	1184
A3	-	-	-	-	-	-	-	-	-	-	-	-	0.21	396

[Source] GRIDCo

3) System load factor in Ghana

Table 2-2-2-1.3 shows the annual average loads, annual peak loads and load rates for Ghana as given in the Technical Assessment Report compiled in December 2012 with support from the USTDA. The average load rates (domestic demand) for power systems were calculated at 64% from 2000 to 2011. These values have been used to convert energy consumption into peak loads for the power demand estimates for this project.

Table 2-2-2-1.3 Annual average load, annual peak load and load factor in Ghana

	Annual average load (MW)	Annual peak load (MW)	Load factor
2003	640	1,007	64%
2004	685	1,064	64%
2005	732	1,169	63%
2006	769	1,277	60%
2007	732	1,299	56%
2008	845	1,345	63%
2009	914	1,432	64%
2010	1,005	1,615	62%
2011	1,076	1,668	65%
Average	**764**	**1,202**	**64%**

[Source] Technical Assessment Report, USTDA, 2012

4) Upper level plan for the Project and Exisisting deman forecasts

1) Upper level plan for the Project

As shown in Table 2-2-2-1.4, GRIDCo formulated a Transmission Master Plan in November 2011 and a Generation Master Plan in February 2012, and is in the process of developing a national power system. This project must maintain consistency with the technical reports from these master plans, which were reviewed in December 2012 with support from the USTDA. However, these upper level plans target Ghana on the national level. Projects such as this one for development in the Accra area and other regions must reconfirm the system structure, facility capacities, demand distributions and other regional details and break the upper level plans down while adapting them to local features.

Note here that the target years of these master plans fall between 2020 and 2030, making them consistent with the target years for project evaluation (three years from start of service: 2020 if service starts in 2017) and facility planning (ten years from start of service: 2027 if service starts in 2017). This allows for effective evaluation of project relevance and effectiveness through cross-validation.

Table 2-2-2-1.4 Existing Master Plan Studies

Studies	Target year
Transmission System Master Plan for Ghana (November 2011)	2020
Generation Master Plan Study for Ghana (February 2012)	2026
Technical Assessment Report by USTDA (Feasibility Study for the Eastern Transmission Line)	2026

[Source] Preparatory Survey Team

2) Overall Objectives

In the upper level plans described above, national power demands were calculated based on econometric methods and broken down into bus demand for each BSP with GRIDCo heuristics to determine future power transmission and generation plans using flow analysis. The base case estimates for power demands in the Accra area as shown in the Transmission Master Plan have been extracted as Table 2-2-2-1.5. In this table, the total values for the bus loads of the Achimota, Mallam, A3 and A4 BSPs give the total demand for the Accra area, with demand increasing at an average rate of 6.30% per year.

In Table 2-2-2-1.5, demand for the A3 BSP, which is slightly removed from the center of Accra between Accra and Tema, is evaluated as increasing. In reality though, demand in the center of Accra is greatly increased and has lead to the current request for the Accra Central BSP. This also shows that development in the Accra area and other regions must reconfirm the system structure, facility capacities, demand distributions and other regional details and break the upper level plans down while adapting them to local features.

For this project, Accra area power demand estimates will be reviewed based on the latest 161 kV bus load data for the Accra area, also accounting for power supplied to the area from surrounding areas with 33 kV sub-transmission lines and other power flow which cannot be confirmed from national level demand trends. Meanwhile, figures will be cross-compared with the rates of increase in average demand and other national statistics to prevent any large discrepancies with the power demand estimates given in the upper level plans or inconsistency with the overall plan.

Table 2-2-2-1.5 Power demand forecast for Accra area

BSP	Items	Unit	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Achimota	Bus Load	MVA	288.4	324.7	285.0	285.0	285.0	285.0	285.0	285.0	285.0	285.0	285.0	285.0
Mallam	Bus Load	MVA	91.8	86.3	159.5	62.0	71.5	80.0	90.5	101.7	113.5	126.0	139.2	153.3
A3	Bus Load	MVA	0.0	0.0	0.0	124.1	142.9	160.1	181.1	203.3	226.9	252.0	278.5	306.6
A4	Bus Load	MVA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**Total Demand**	**MVA**	**380.2**	**411.0**	**444.5**	**471.1**	**499.4**	**525.1**	**556.6**	**590.0**	**625.4**	**663.0**	**702.7**	**744.9**

[Source] Technical Assessment Report by USTDA, 2012 and Preparatory Survey Team

5) Methods and Modeling of Power Demand Forecast for the Project

1) Power Demand Forecast Methods for the Project

Methodology for power demand forecasts will be divided into the two methods given in Table 2-2-2-1.6. As with the master plans mentioned above, forecasts will use econometric approaches to build models and estimate power demand by gathering GDP, population and other macroeconomic indicators.

Table 2-2-2-1.6 Methods and characteristics of Power demand forecast

Method	Data	Advantage	Disadvantage
Engineering approach	Details of facilities specification Facilities Efficiency Facilities Operation Data (Load factor, Demand factor, etc.)	Easy interpretation of the result's background because it is based on numerous data and documents	Necessary of numerous data such as Facilities conditions, Facilities planning, Operarion Planning, etc.
Econometric approah	Time series data such as GDP and Electricity Tariff, etc.	Easy forecast by collecting Explanatory variable (exogonous variable)	・Complicate interpretation of the result's background because of forecast based on Explanatory variable (exogonous variable) ・Necessary for data on reasonable period

[Source] Preparatory Survey Team

2) Power Demand Forecast Model

The aforementioned USTDA Technical Assessment Report (USTDA report) reviews the power demand estimates in the Generation Master Plan and Transmission Master Plan. In the master plans, Ghana power demand was evaluated as being strongly correlated to real GDP, population and real GDP per capita, and when reviewed in the USTDA report, real GDP was shown to have the strongest correlation. Thus, the conclusion is that there is a high correlation factor.

The project area of Accra is home to government agencies and head offices for private sector firms, making it the location which most strongly reflects the socioeconomic conditions in Ghana. Based on this, power demand estimates in this project will confirm the correlation in past trends between real GDP and Accra area power demands. If as a result the correlation between real GDP and Ghana power demands is confirmed to be as strong as it is in the USTDA report, the following approximation formula given in the USTDA report will be used to estimate future demand, with ***a1***, ***a2*** and ***a3*** as constants.

$$\boldsymbol{Ln}\ (\text{annual energy consumption}_{i}) =$$

$$\boldsymbol{a1} + \boldsymbol{a2} \times \boldsymbol{Ln}\ (\text{real GDP}_{i}) + \boldsymbol{a3} \times \boldsymbol{Ln}\ (\text{annual energy consumption}_{i-1})$$

6) Socio-economic Conditions and Economic Growth Scenario

1) Socio-economic Conditions for demand forecast in Accra Area

The Ghana socioeconomic indicators which apply to project power demand estimates are given in Table 2-2-2-1.7. As arranged in the USTDA report, this table takes 2005 as the standard year for real GDP (population data courtesy of the US Internal Revenue Service, GDP data courtesy of the World Bank)

Table 2-2-2-1.7 Ghana's Population and Real GDP

Year	Population	Real GDP GDP (constant 2005 US$)
1992	15,655,847	6,018,522,257
1993	16,141,178	6,310,420,587
1994	16,610,887	6,518,664,466
1995	16,992,937	6,786,739,258
1996	17,354,886	7,099,096,283
1997	17,722,810	7,396,999,769
1998	18,116,256	7,744,687,665
1999	18,520,249	8,085,453,654
2000	18,935,103	8,384,615,439
2001	19,357,355	8,720,000,057
2002	19,798,703	9,112,400,059
2003	20,250,113	9,586,244,863
2004	20,689,541	10,123,074,575
2005	21,126,090	10,720,336,364
2006	21,563,400	11,406,437,892
2007	21,996,825	12,143,084,616
2008	22,427,962	13,166,950,385
2009	22,858,579	13,780,416,117
2010	23,286,035	14,692,687,226
2011	23,714,498	16,690,892,880

[Source] Technical Assessment Report by USTDA, 2012

2) Ghana Economic Growth Scenario

In order to maintain consistentcy with the upper level plans, the USTDA Technical Assessment Report will also be referenced for Ghana economic growth scenarios. The Ghana economic growth scenarios given in the USTDA report are shown in Table 2-2-2-1.8.

As calculated from Table 2-2-2-1.7, population is following a relatively gentle increasing trend. Based on average growth rates of approximately 2% during the table period, high and low cases of ±0.2% will be used, respectively.

In Table 2-2-2-1.7, real GDP grew the most in 2008 and 2011 at approximately 8% and the least in 1994 and 2000 at approximately 4.0%. The five-year average growth rate (2005 to 2010) was 6.5%. Based on these figures, the economic growth scenarios are estimated as given in Table 2-2-2-1.8.

Table 2-2-2-1.8 Ghana Economic Growth Scenario

Items	General growth	High growth	Low growth
Real GDP growth rate	+ 8.0%	+ 6.5%	+ 4.0%
Population growth rate	+ 2.2%	+ 2.0%	+ 1.8%

[Source] Technical Assessment Report by USTDA, 2012

7) Modeling Test of Power Demand Forecast

The econometric model used in power demand forecasts was built with Simple E (Ver. 2008, Expanded), economic forecasting simulation software developed by the Institute of Energy Economics, Japan (IEEJ) and used in power demand forecasting in ASEAN countries. As econometric models are generally built as aggregates of many estimation and definition formulae, relevance of the model must be tested. The relevance of the power demand forecasting model for this preparatory study will be verified using the following indicators. As the the USTDA report maintained a coefficient of determination (R^2) in excess of 0.97 for correlation between real GDP and Ghana power demand, power demand estimates in this project will also aim to maintain the same level of correlation. Targets will be as follows:

- Coefficient of determination (R^2): 0.95 or higher
- Durbin-Watson statistic: 1.00 – 3.00
- Coefficient sign test: checked as correlation with economic principle

8) Accra Area Power Demand Forecast

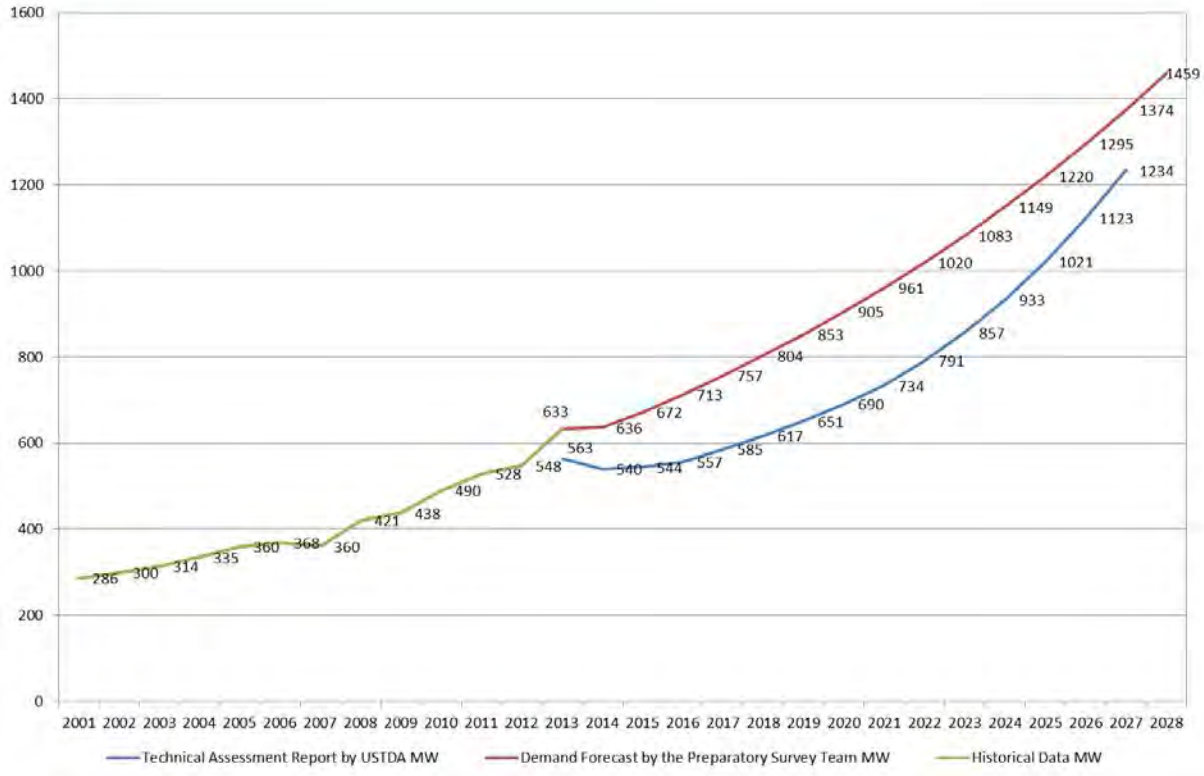
The approximation formula for power demand estimations obtained using the aforementioned software based on the above policies is as follows here. The approximation formula maintained an R^2 of 0.974, confirming that the correlation between real GDP and Accra area power demand is roughly as strong as that between real GDP and Ghana power demand as analyzed in the USTDA report. Also, a value of 2.01 was reached for the Durbin-Watson statistic. Given the extreme proximity of this value to 2, this confirms that there are no serial correlations between disturbances in the built model.

From the above verification results, approximation model relevance was confirmed as shown in the following approximation formula:

$$\boldsymbol{Ln}(\text{annual energy consumption}_i) =$$

$$-13.082 + 0.86707 \times \boldsymbol{Ln}(\text{real GDP}_i) + 0.84191 \times \boldsymbol{Ln}(\text{annual energy consumption}_{i-1})$$

Calculating from this approximation formula based on the economic growth scenario in Table 2-2-2-1.8, Accra area power demands were estimated as shown in Figure 2-2-2-1.3 for a load ratio of 64%. Accra area power demand estimates as shown in the aforementioned USTDA report are shown together with the figure, calculated with a load ratio of 64% from the total of 161 kV bus loads for BSPs in Accra area.



[Source] Preparatory Survey Team

Figure 2-2-2-1.3 Demand Forecast in Accra area

The project power demand estimates are slightly higher than the USTDA report estimates as the project estimates also account for power supplied to the Accra area from the Winneba BSP with 33 kV sub-transmission lines, in line with actual circumstances.

Also, as the project power demand estimates more faithfully reflect the regional characteristics of the Accra area, a model is built correlating 15-year Accra area power demand estimates with their macroeconomic indicators. This allows the project model to improve on forecasts of situations which are difficult to estimate from actual Accra area status, such as the drop in demand for 2014 seen in the USTDA report model.

The average rate of increase in demand for the project power demand estimates is between 6 and 6.5%, which maintains consistency with the rates of increase for the Accra area as estimated in the technical report.

In the project, the estimated Accra area power demand is taken as the base data for evaluating project relevance and effectiveness through flow analysis and evaluations on how well the project coordinates with other development projects. In the project estimates, power demand in the project evaluation target year (2021) is calculated as 949 MW, and that in the facility planning target year is calculated at 1,459 MW.

9) Demand Forecast in Accra area

The BSP construction projects in the Accra area through the project facility planning target year as confirmed through the preparatory study are given in Table 2-2-2-1.9. Accra area load distributions must be estimated as base data for the flow analysis. In addition to the existing Achimota, Mallam and A3 BSPs, Accra area load distributions will be estimated based on power demand as estimated in the project, accounting for the BSPs given in Table 2-2-2-1.9.

Table 2-2-2-1.9 Construction Plan of BSP in Accea area

Facilities planning	Capacity	Commission year	Feasibility
Accra Central BSP	375 MVA (125 MVA×3)	2018	The Project
A4 BSP	375 MVA (125 MVA×3)	2020	Plan
A3 BSP (Reinforcement)	132 MVA (66 MVA×2)	2014	Contract Conclusion

[Source] Preparatory Survey Team

Given the shortage in substation facility supply capacity, power supply will not be stable unless the system is operated by distributing loads from the BSPs to primary substations according to BSP capacities. As such, the power loads obtained in Figure 2-2-2-1.3 are proportionately distributed according to the capacities of each BSP to estimate load distributions for the Accra area. Table 2-2-2-1.10 gives the results of the load distribution calculations, which form the base data for the flow analysis.

Futhermore, the load distributions in Table 2-2-2-1.10 for outside the Accra area (refer to Figure 2-2-2-1.1) use figures estimated from the aforementioned USTDA report.

Developing the Accra Central BSP in downtown Accra for the project will also allow 161 kV transmission lines to be used to supply power to the area, previously the terminus of a 33 kV sub-transmission line network. Thus, developing an Accra Central substation will help to reduce distribution loss and voltage drops in addition to enhancing power supply capacity.

In order to evaluate the effect of these changes, a flow analysis of the Accra area is to be performed upon extending the Accra area power demand to the 33 kV bus load. However, determining characteristics and future plans for distribution facilities comprised of expanding components will not be easy during the limited preparatory study period. Thus, to keep things simple, the primary substation construction plans currently being finalized will be considered in addition to the existing primary substations to distribute facility capacity proportionately and extend bus loads for each primary substation. The results are shown in Attachment A-7.

Table 2-2-2-1.10 Accra Area Power Demand

Start of service (without Project) (with Project) | Three years from start of service (without Project) (with Project) | Ten years from start of service (with Project)

Case Study				Cace 0	Case1	Case2	Case3	Case4	Case5	Case6	Case7	Case8	Case9	Case10	Case11	Case12	Case13	Case14	Case15	Case16
Year				2013	2016	2017	2018	2018	2019	2020	2021	2021	2022	2023	2024	2024	2025	2026	2027	2028
Operation Year				-5	-2	-1	0	0	1	2	3	3	4	5	6	6	7	8	9	10
EVENT	the Request (Accra Central BSP)							●	●	●		●	●	●	●	●	●	●	●	●
(●: Operation)	New 330 kV line between Aboadze and Cape Coast					●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	A4BSP									●	●	●	●	●	●	●	●	●	●	●
	Volta - Achimota lines upgrade (LILAC => TERN)															●	●	●	●	●
power factor				0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Load	Accra area	(1)	MW	643.4	725.8	771.8	820.1	813.9	863.8	921.1	987.4	978.4	1040.6	1105.8	1174.2	1175.3	1250.7	1328.8	1410.9	1500.6
	Demand	(2)	MW	632.8	713.3	757.1	803.6	803.6	853.0	905.4	949.4	961.0	1020.1	1082.7	1149.3	1149.3	1219.9	1294.8	1374.4	1459.0
	33kV Distribution Loss	(3)	MW	10.6	12.5	14.7	16.5	10.3	10.8	15.7	37.9	17.4	20.5	23.1	24.9	26.0	30.8	34.0	36.5	41.6
	(4)=(3)/(1)x100	(4)	%	1.6%	1.7%	1.9%	2.0%	1.3%	1.3%	1.7%	3.8%	1.8%	2.0%	2.1%	2.1%	2.2%	2.5%	2.6%	2.6%	2.8%
	Achimota	(5)	MW	290.60	277.10	294.40	312.60	217.10	230.50	187.40	271.30	198.90	211.30	224.40	238.40	238.40	253.40	268.90	285.70	303.50
	Demand	(6)	MW	287.63	274.35	291.20	309.09	215.08	228.30	185.81	269.09	197.22	209.34	222.20	235.85	235.85	250.34	265.72	282.05	299.42
	33kV Distribution Loss	(7)	MW	2.97	2.75	3.20	3.51	2.02	2.20	1.59	2.21	1.68	1.96	2.20	2.55	2.55	3.06	3.18	3.65	4.08
	(8)=(7)/(5)x100	(8)	%	1.0%	1.0%	1.1%	1.1%	0.9%	1.0%	0.8%	0.8%	0.8%	0.9%	1.0%	1.1%	1.1%	1.2%	1.2%	1.3%	1.3%
	Mallam	(9)	MW	236.60	225.20	239.80	255.00	177.00	187.50	149.80	200.47	159.00	168.90	179.50	190.50	190.50	202.80	215.00	228.40	242.60
	Demand	(10)	MW	230.11	219.48	232.96	247.27	172.07	182.64	148.65	188.87	157.78	167.47	177.76	188.68	188.68	200.28	212.58	225.64	239.54
	33kV Distribution Loss	(11)	MW	6.49	5.72	6.84	7.73	4.93	4.86	1.15	11.60	1.22	1.43	1.74	1.82	1.82	2.52	2.42	2.76	3.06
	(12)=(11)/(9)x100	(12)	%	2.7%	2.5%	2.9%	3.0%	2.8%	2.6%	0.8%	5.8%	0.8%	0.8%	1.0%	1.0%	1.0%	1.2%	1.1%	1.2%	1.3%
	A3BSP	(13)	MW	116.20	223.50	237.60	252.50	174.80	185.70	152.00	207.00	161.50	171.80	182.80	194.20	194.20	206.40	219.70	233.30	247.90
	Demand	(14)	MW	115.05	219.48	232.96	247.27	172.07	182.64	148.65	201.61	157.78	167.47	177.76	188.68	188.68	200.28	212.58	225.64	239.54
	33kV Distribution Loss	(15)	MW	1.15	4.02	4.64	5.23	2.73	3.06	3.35	5.39	3.72	4.33	5.04	5.52	5.52	6.12	7.12	7.66	8.36
	(16)=(15)/(13)x100	(16)	%	1.0%	1.8%	2.0%	2.1%	1.6%	1.6%	2.2%	2.6%	2.3%	2.5%	2.8%	2.8%	2.8%	3.0%	3.2%	3.3%	3.4%
	Accra Central	(17)	MW					245.00	260.10	211.50		224.50	238.40	253.00	268.70	268.70	285.20	302.80	321.40	341.20
	Demand	(18)	MW					244.41	259.43	211.15		224.12	237.89	252.50	268.02	268.02	284.48	301.96	320.51	340.25
	33kV Distribution Loss	(19)	MW					0.59	0.67	0.35		0.38	0.51	0.50	0.68	0.68	0.72	0.84	0.89	0.95
	(20)=(19)/(17)x100	(20)	%					0.2%	0.3%	0.2%		0.2%	0.2%	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
	A4BSP	(21)	MW							220.40	308.60	234.50	250.20	266.10	282.40	283.50	302.90	322.40	342.10	365.40
	Demand	(22)	MW							211.15	289.86	224.12	237.89	252.50	268.02	268.02	284.48	301.96	320.51	340.25
	33kV Distribution Loss	(23)	MW							9.25	18.74	10.38	12.31	13.60	14.38	15.48	18.42	20.44	21.59	25.15
	(24)=(23)/(21)x100	(24)	%							4.2%	6.1%	4.4%	4.9%	5.1%	5.1%	5.5%	6.1%	6.3%	6.3%	6.9%
	Cape Coast		MW	36.91	46.29	49.99	54.61	54.61	59.66	65.18	71.21	71.21	79.22	88.14	98.05	98.05	109.08	91.01	96.06	96.06
	Old Kpong		MW	25.57	32.06	34.63	37.83	37.83	41.33	45.16	49.33	49.33	54.88	61.06	67.92	67.92	75.57	84.07	88.73	88.73
	New Tema		MW	227.24	258.11	258.11	258.11	258.11	258.11	258.11	258.11	258.11	258.11	258.11	258.11	258.11	258.11	258.11	272.42	272.42
	Winneba		MW	15.96	20.02	21.62	23.62	23.62	25.80	28.19	30.80	30.80	34.26	38.12	42.41	42.41	47.18	52.48	55.39	55.39
	Kpong GS		MW	0.52	0.48	0.49	0.50	0.50	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.52	0.52
	Akosombo		MW	6.48	6.48	6.48	6.48	6.48	6.48	6.48	6.48	6.48	6.48	6.48	6.48	6.48	6.48	6.48	6.84	6.84
	Smelter 2		MW	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00
	sub total	A	MW	1022.1	1155.2	1209.1	1267.3	1261.1	1321.7	1390.7	1469.8	1460.8	1540.1	1624.2	1713.7	1714.8	1813.6	1887.5	1996.9	2086.6
System Loss	Transmission between Akosombo and Aboadze	B	MW	20.05	25.34	25.35	29.34	27.66	30.71	28.55	32.90	32.29	38.00	37.80	43.68	38.65	45.00	51.35	54.30	65.16
	33kV Distribution in Accra area	C	MW	10.61	12.49	14.69	16.48	10.28	10.81	15.70	37.94	17.38	20.53	23.07	24.95	26.05	30.84	34.00	36.55	41.60
	Total System Loss (B+C)	D	MW	30.66	37.82	40.04	45.81	37.94	41.52	44.25	70.84	49.67	58.53	60.87	68.63	64.70	75.84	85.35	90.85	106.76
	Loss rate above (D/F x 100)	E	%	2.9%	3.2%	3.2%	3.5%	2.9%	3.1%	3.1%	4.7%	3.3%	3.7%	3.7%	3.9%	3.7%	4.1%	4.4%	4.4%	5.0%
Total (A+D)		F	MW	1042.15	1180.58	1234.47	1296.59	1288.72	1352.40	1419.26	1502.70	1493.12	1578.05	1662.00	1757.35	1753.41	1858.61	1938.80	2051.16	2151.72
Remarks						↑ (a)		↑ (b)			↑ (c)				↑ (d)	↑ (d)				↑ (e)

(a) Overload of the 161/34.5 kV transformers that supply electricity in Accra area.
(b) The Request items assumed to be in service.
(c) The assumed loss for the case of not implementing the Project to confirm the system loss reduction effect of the Project.
(d) Overload of the transmission lines between Volta and Achimota. The transmission lines should be upgraded by 2024.
(e) Overload of the 161/34.5 kV transformers that supply electricity in Accra area.

Note: 1) Analysis results based on assumed demands at each primary substation shown on the Attachment A-8. The 33 kV distribution loss may vary depending on the assumed demands.

2) Table 2-2-2-2.7 above shows a part of losses such as transmission lines, transformers and 33 kV distribution lines in the modeling area and do not represent losses for the entire Ghana

2-2-2-2 Load Flow Analysis

A load flow analysis was performed for the first ten years from the start of service (2018-2028) in order to confirm the project's relevance and effectiveness. (To evaluate the project results, an analysis of current status starting from 2016 was also performed.) This analysis has been confirmed that the Accra Central BSP for this project is essential for supplying power to fulfill significant growth in future demand in the Accra area.

(1) Basic Plan for Load Flow Analysis

The objective of the load flow analysis within the preparatory study is to confirm the relevance and effectiveness of this project as a Japanese grant aid project. In order to do so, a load flow analysis was performed from 2018 to 2028, covering ten years of operation from the start of service.

The basic objectives of the load flow analysis are given in Table 2-2-2-2.1. From the objective above, the load flow analysis was performed with a model centered on the project area of Accra, not Ghana as a whole. The model included transmission facilities from Akosombo Hydro Plant and the area from the Volta substation and Tema Thermal Power Complex east of Accra to the Aboadze Thermal Power Plant west of Accra, as well as Accra area 33 kV distribution facilities. Figure 2-2-2-2.1 shows the scope of the system model built.

Table 2-2-2-2.1 Basic Plan for Load Flow Analysis

Area	- Transmission system between Akosombo and Aboadze as shown on Figure 2-2-2-2.1
Voltage	- 161 kV or higher of the transmission system in the Area - 33 kV Primary substations and 33 kV distribution lines in Accra area
Demand	- Demand forecast is aforementioned section 2-2-2-1 - Power factor 87% (see Table 2-2-2-2.5)
Major aspects of analysis	- Assumed commission year (2018) - Target year for the evaluation of effectiveness of the Project (2021) - Target year for the design of the Project (2028)
Evaluation	- Power flow is within each nominal capacities of the equipment like transformers, transmission lines conductors and so on - Voltage limit of bus bars is within ±5%[1] of the nominal voltage - The three-phase short circuit current is within the nominal capacity of circuit breakers

[1] Voltage limit is "within ±5% of the noinal voltage at all times under Normal State" regulated at Art 12.10 in "NATIONAL ELECTRICITY GRID CODE (October 2009)"

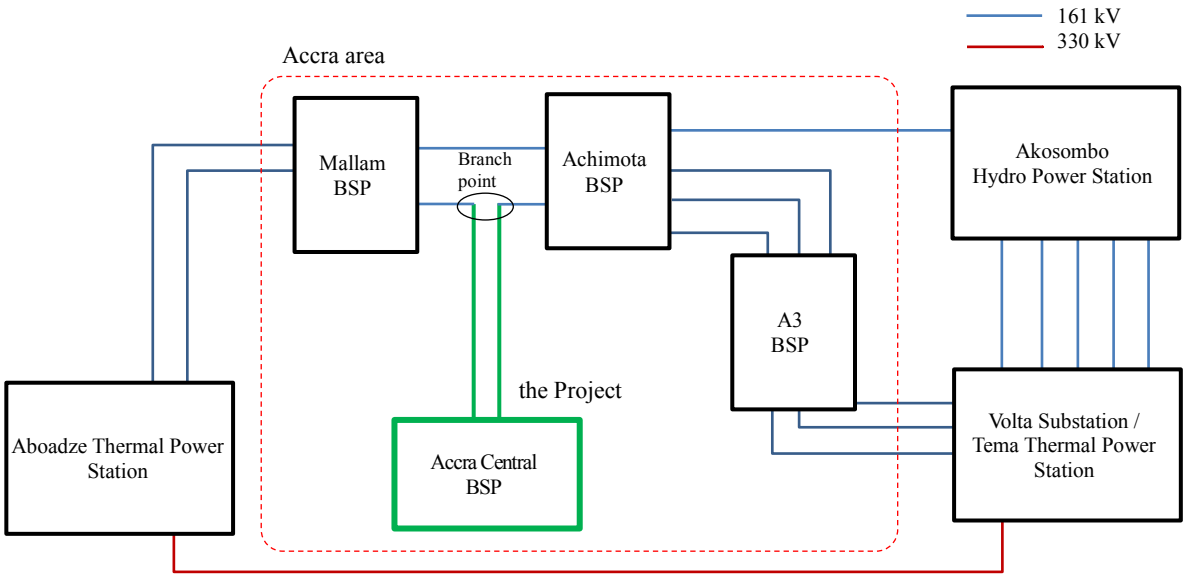


Figure 2-2-2-2.1　System Model Area for Load Flow Analysis (2018)

(2)　System Data

The major system data collected through the preparatory study in performing the load flow analysis is given in Tables 2-2-2-2.2 through 2-2-2-2.4. The detail data is given in attachment A-8.

(3)　Power System Model

The power system model centered on Accra Central was built based on the aforementioned system data using ETAP system analysis software from Eltecs Engineering & Consulting. Load flow analysis results on May 7, 2013 are given in Figure 2-2-2-2.2.

The actual load flow and bus voltage status have been verified against the load flow analysis results, and the relevance of the load flow analysis model built in the preparatory study has been confirmed.　Thus, the model will be expanded to the estimated Accra area system plan to verify project relevance and effectiveness.

Table 2-2-2-2.2 Generator

Power Station	Generator	Type	Commission year (plan)	Capacity
Akosombo	Akosombo G1	Hydro	1965	170.525 MW
	Akosombo G2	Hydro	1965	170.525 MW
	Akosombo G3	Hydro	1965	170.525 MW
	Akosombo G4	Hydro	1965	170.525 MW
	Akosombo G5	Hydro	1972	170.525 MW
	Akosombo G6	Hydro	1972	170.525 MW
Aboadze T1	TAPCo GT1	Gas Turbine	1998	120.4 MW
	TAPCo GT2	Gas Turbine	1998	120.4 MW
	TAPCo HRSG	Steam Turbine	1998	123.5 MW
Aboadze T2	TICo GT1	Gas Turbine	2001	120.4 MW
	TICo GT2	Gas Turbine	2001	120.4 MW
	TICo HRSG	Steam Turbine	(2015)	123.5 MW
Aboadze T3	T1-G1	Gas Turbine	2013	31 MW
	T1-G2	Gas Turbine	2013	31 MW
	T1-G3	Gas Turbine	2013	31 MW
	T1-G4	Gas Turbine	2013	31 MW
	T1-G5 (HRSG)	Steam Turbine	2013	31 MW
Aboadze T3 expansion	T2-G	Gas Turbine	(2015)	120 MW
	T2-HRSG	Steam Turbine	(2015)	60 MW
Aboadze T4	T4-G1	Gas Turbine	(2018)	133.3 MW
	T4-G2	Gas Turbine	(2018)	133.3 MW
	T4-HRSG	Steam Turbine	(2018)	133.3 MW
Kpong	Kpong G1	Hydro	1982	45.9 MW
	Kpong G2	Hydro	1982	45.9 MW
	Kpong G3	Hydro	1982	45.9 MW
	Kpong G4	Hydro	1982	45.9 MW
Pone	Kpone GT1	Gas Turbine	(2014)	120.5 MW
	Kpone GT2	Gas Turbine	(2014)	120.5 MW
	Kpone HRSG	Steam Turbine	(2016)	123.5 MW
Asogli	Asogri(1) GT1	Gas Turbine	2010	29.0 MW
	Asogri(1) GT2	Gas Turbine	2010	29.0 MW
	Asogri(1) HRSG	Gas Turbine	2010	29.0 MW
	Asogri(2) GT1	Gas Turbine	2010	29.0 MW
	Asogri(2) GT2	Gas Turbine	2010	29.0 MW
	Asogri(2) HRSG	Steam Turbine	2010	29.0 MW
	Asogri(3) GT1	Gas Turbine	(2016)	60 MW
	Asogri(3) GT2	Gas Turbine	(2016)	60 MW
	Asogri(3) HRSG	Steam Turbine	(2016)	60 MW
	Asogri(4) GT1	Gas Turbine	(2016)	60 MW
	Asogri(4) GT2	Gas Turbine	(2016)	60 MW
	Asogri(4) HRSG	Steam Turbine	(2016)	60 MW
Tema TT1PP	TT1PP GT1	Gas Turbine	2009	113.4 MW
	CENIT GT	Gas Turbine	2012	113.4 MW
	TT1PP HRSG	Steam Turbine	(2017)	113.4 MW
Tema MRP	MRP GT1	Gas Turbine	2007	47.3 MW
	MRP GT2	Gas Turbine	2007	20 MW
	MRP HRSG	Steam Turbine	2007	15 MW
Tema TT2PP	TT2PP GT1	Gas Turbine	2010	7.8 MW
	TT2PP GT2	Gas Turbine	2010	7.8 MW
	TT2PP GT3	Gas Turbine	2010	7.8 MW
	TT2PP GT5	Gas Turbine	2010	13.1 MW
	TT2PP HRSG	Steam Turbine	2010	13.1 MW
Bonyere 1	GT1	Gas Turbine	(2016)	150 MW
	GT2	Gas Turbine	(2016)	150 MW
	HRSG	Steam Turbine	(2016)	150 MW
Bonyere 2	GT1	Gas Turbine	(2017)	150 MW
	GT2	Gas Turbine	(2017)	150 MW
	HRSG	Steam Turbine	(2017)	150 MW
Bui	Bui1	Hydro	2013	133 MW
	Bui2	Hydro	2013	133 MW
	Bui3	Hydro	2013	133 MW
Pwalugu	Pwalugu 1	Hydro	(2026)	24 MW
	Pwalugu 2	Hydro	(2026)	24 MW
Hemang	Heman 1	Hydro	(2020)	46.5 MW
	Heman 2	hydro	(2020)	46.5 MW
Juale	Juale 1	Hydro	(2020)	41.5 MW
	Juale 2	Hydro	(2020)	41.5 MW

[Source] GRIDCo

Table 2-2-2-2.3 Major Substations in Accra Area (2018)

Substation	Voltage	Capacity	Total
A3 BSP	161/34.5 kV	66 MVA×4 units (Out of which, 66 MVA × 2 units are to be commissioned in 2014)	264 MVA
Achimota BSP	161/34.5 kV	66 MVA × 5 units	330 MVA
Mallam BSP	161/34.5 kV	66 MVA × 4 units	264 MVA
Accra Central BSP	161/34.5 kV	125 MVA × 3 units	375 MVA
Volta Substation	330/161 kV	200 MVA × 2 units	400 MVA
Aboadze Substation	330/161 kV	200 MVA × 2 units	400 MVA

[Source] GRIDCo

Table 2-2-2-2.4 Major Transmission Lines in Accra Area (2018)

Location	Voltage	Length	Conductor	Capacity
Akosombo Hydro Power Station - Volta Substation	161 kV	68 km×5 lines	LILAC (403mm^2)	213 MVA×5 lines
Akosombo Hydro Power Station - Achimota BSP	161 kV	93 km×1 line	LILAC (403mm^2)	213 MVA×1 line
Volta Substation - A3 BSP	161 kV	15 km×3 lines	LILAC (403mm^2)	213 MVA×3 lines
A3 BSP - Achimota BSP	161 kV	11 km×3 lines	LILAC (403mm^2)	213 MVA×3 lines
Achimota BSP - Mallam BSP	161 kV	12 km×2 lines	TERN (430mm^2)×2 bundles	488 MVA×2 lines
Accra Central BSP - Branch Point	161 kV	about 3 km×2 lines	TERN (430mm^2)×2 bundles	488 MVA×2 lines
Mallam BSP - Aboadze Substation	161 kV	173 km×1 line 190 km×1 line	MISTLETOE (282 mm^2)	170 MVA×2 lines
Aboadze Substation - Volta Substation	330 kV	220 km×1 line	TERN (430mm^2)×2 boundles	1000 MVA×1 line

[Source] GRIDCo and Preparatory Survey Team

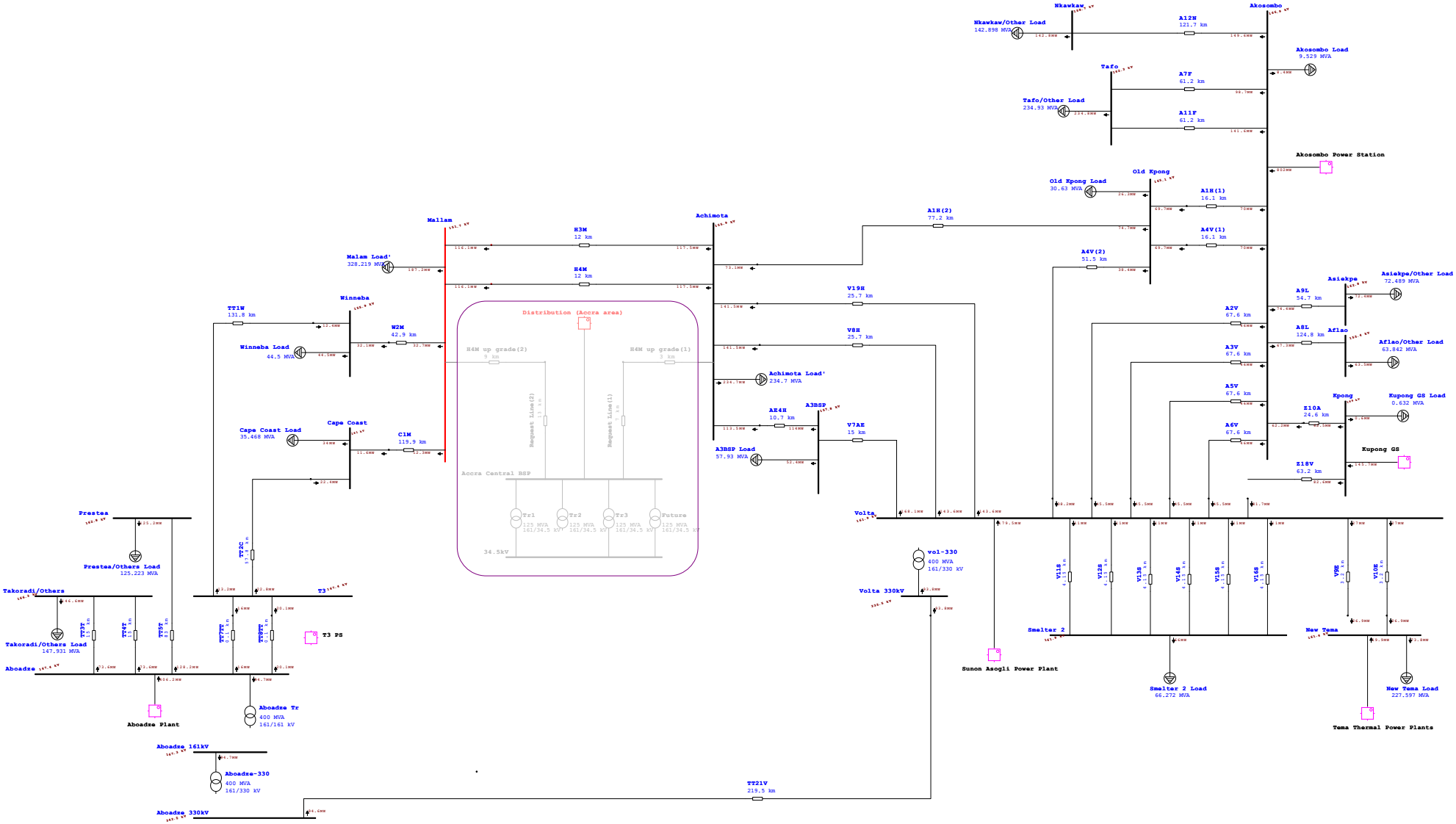


Figure 2-2-2-2.2 Power System Model and the Results of Load Flow Analysis (May 7, 2013)

(4) Case Studies and the Results

In order to verify project implementation results, a load flow analysis was performed from 2018 to 2028 ten years after start of service.

1) Development plan and demand

The main transmission and substation facility enhancements currently planned by GRIDCo are given in Table 2-2-2-2.5.

Table 2-2-2-2.5 Transmission System Development Plan

Location / Section	Description	Start of Operation
Accra Central BSP	- The Project. - Installation of 161/34.5 kV 125 MVA transformer × 3 units.	2018
A3 BSP	- Addition of 161/34.5 kV 66 MVA transformer × 2 units. - Three 161 kV transmission lines between Volta and Achimota to be led in to A3 BSP.	2014
Aboadze – Cape Coast transmission line	- Extension of the 330 kV transmission lines.	2017
A4 BSP	- Installation plan for the BSP at an around 30 km location from Volta along the 330 kV transmission line between Volta substation and Aboadze thermal power station. - Supply power to the Accra area (northern part).	2020 (planned)
Volta – Achimota transmission line	- Upgrade plan for the 161 kV transmission lines between Volta substation and Achimota BSP.	(planned)

[Source] Preparatory Survey Team

The data given in Section 2-2-2-1 is applied to the the power demands for each substation bus. Detailed demand data by substation is given in Attachment A-8.

Further, based on the USTDA Technical Assessment Report compiling reviews of the existing master plans, an average power factor of 0.87 will be used for the Accra area. Power factors for each region as given in the USTDA report are shown in Table 2-2-2-2.6.

Table 2-2-2-2.6 Power Factor at BSPs

BSP	Power Factor
Achimota	0.87
Mallam	0.87
New Tema	0.87
Kenyase	0.92
Kumasi	0.87
Techiman	0.92
Tamale	0.92
Sawla	0.92
Others	0.90

[Source] “Transmission System Master Plan for Ghana”, GRIDCo, 2011

2) Confirming analysis results and project effects

Results of the load flow analysis performed based on the above preconditions are arranged in Table 2-2-2-2.7. A chart of analysis results for each year is given in Attachment A-8.

[1] 2016: Two years before the start of service for the project

Case 1 (Figure 2-2-2-2.3)

- Transformer capacity will exceed 95% of rated capacity as shown in the figure, but can meet the power supply demands of the Accra area.

[2] 2017: One year before the start of service for the project

Case 2 (Figure 2-2-2-2.4)

- If the project is not implemented, there is a possibility that the transformers in the figure will be overloaded and limiting power supply to the Accra area. The project substation is expected to start operation at earliest.

[3] 2018: The start of service and effects of the project

Case 3 (Figure 2-2-2-2.5)

- If the project is not implemented, the transformers in the figure will be overloaded, limiting power supply to the Accra area.

Case 4 (Figure 2-2-2-2.6)

- Implementing the project will eliminate limitations to power supply to the Accra area.
- The project will reduce power losses of 7.87 MW within the system model scope.

[4] 2021: Target year for project evaluation

Case 8 (Figure 2-2-2-2.7)

- No system problems, and power can be supplied to the Accra area.
- Compared to Case 7, which supposes that existing facilities can operate while overloaded without construction of a new BSP, Case 8 reduces losses of 21.17 MW by starting operation of the planned BSP.

[5] 2024: Planned enhancement of transmission lines necessary

Case 11 (Figure 2-2-2-2.8)

- In 2024, additional demand will limit Accra area power supplies due to overloading of the three transmission lines between the Volta substation and A3 BSP which supply power to the area.

Case 12 (Figure 2-2-2-2.9)

- GRIDCo is scheduled to upgrade LILAC transmission lines to TERN lines. If the upgrade for the three transmission lines between the Volta substation and A3 BSP is completed, then the lines will not limit power supply to the Accra area.

[6] 2028: Target year for evaluating the facility plan

Case 16 (Figure 2-2-2-2.11)

- As Case 15 (Figure 2-2-2-2.10) is shown, evaluating the facility plan of one year before the target year (2027) will have no system problems. (however, the transmission line upgrades in [5] will be needed)
- BSPs supplying the Accra area with its power are expected to be over capacity, limiting

power supply. Additional transformers in Accra area will be necessary till 2028.

3) Confirming short circuit current

Three-phase short circut currents were calculated for all of the power generation facilties in Ghana when set in parallel as shown in Table 2-2-2-2.2 (in 2028). The results are shown in Table 2-2-2-2.7.

Table 2-2-2-2.7 Short Circuit

Substation	Bus Voltage	Short Circuit
Accra Central BSP	161 kV	17.2 kA
	34.5 kV (Bus Separated)	25.5 kA/14.3 kA
	34.5 kV (Bus Tied)	32.6 kA

Power supply possible to Accra area without causing system problems

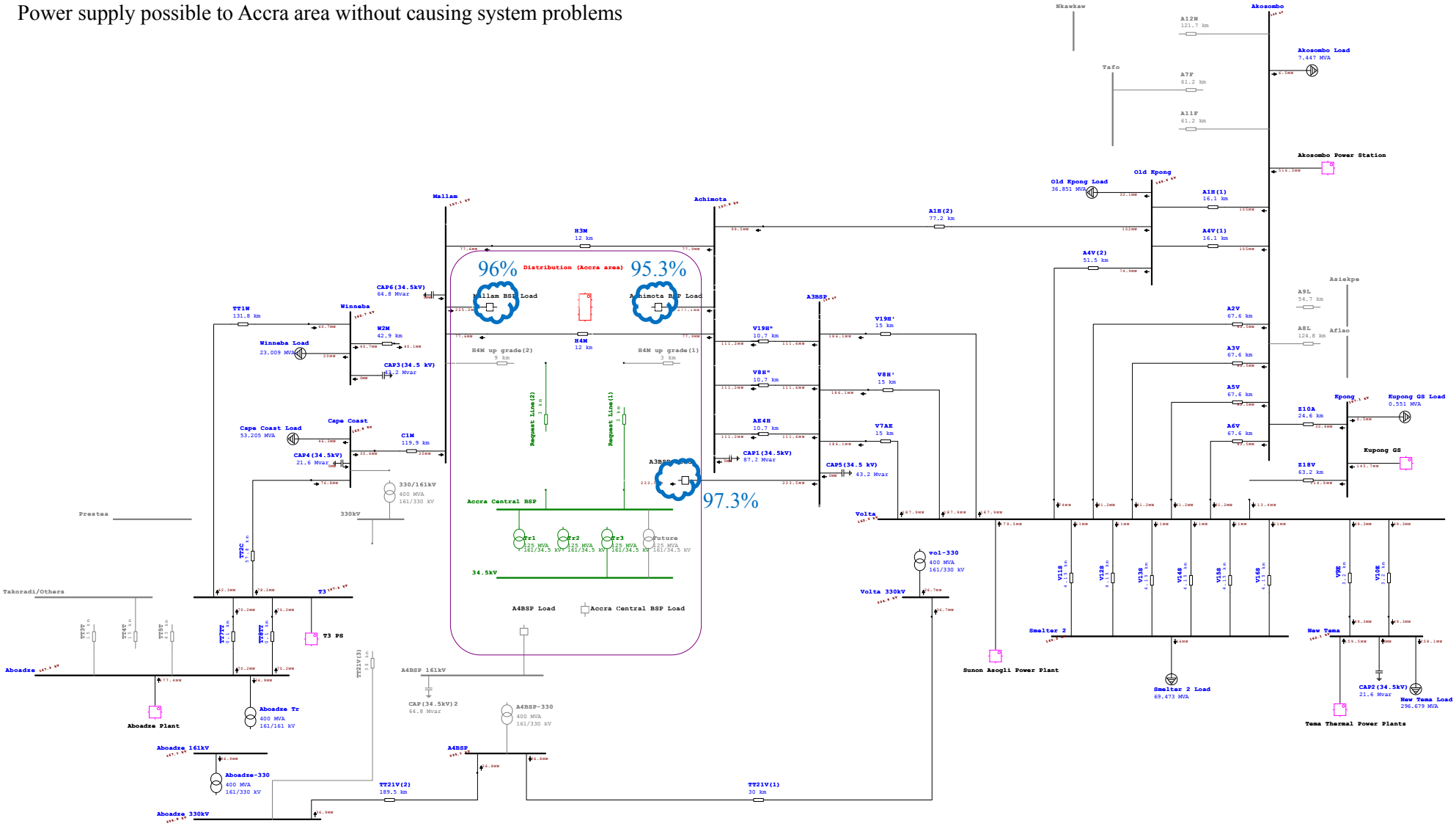


Figure 2-2-2-2.3 Case 1 (2016, without the Project)

There is a possibility that the transformers in the figure will be overloaded and limiting power supply to the Accra area

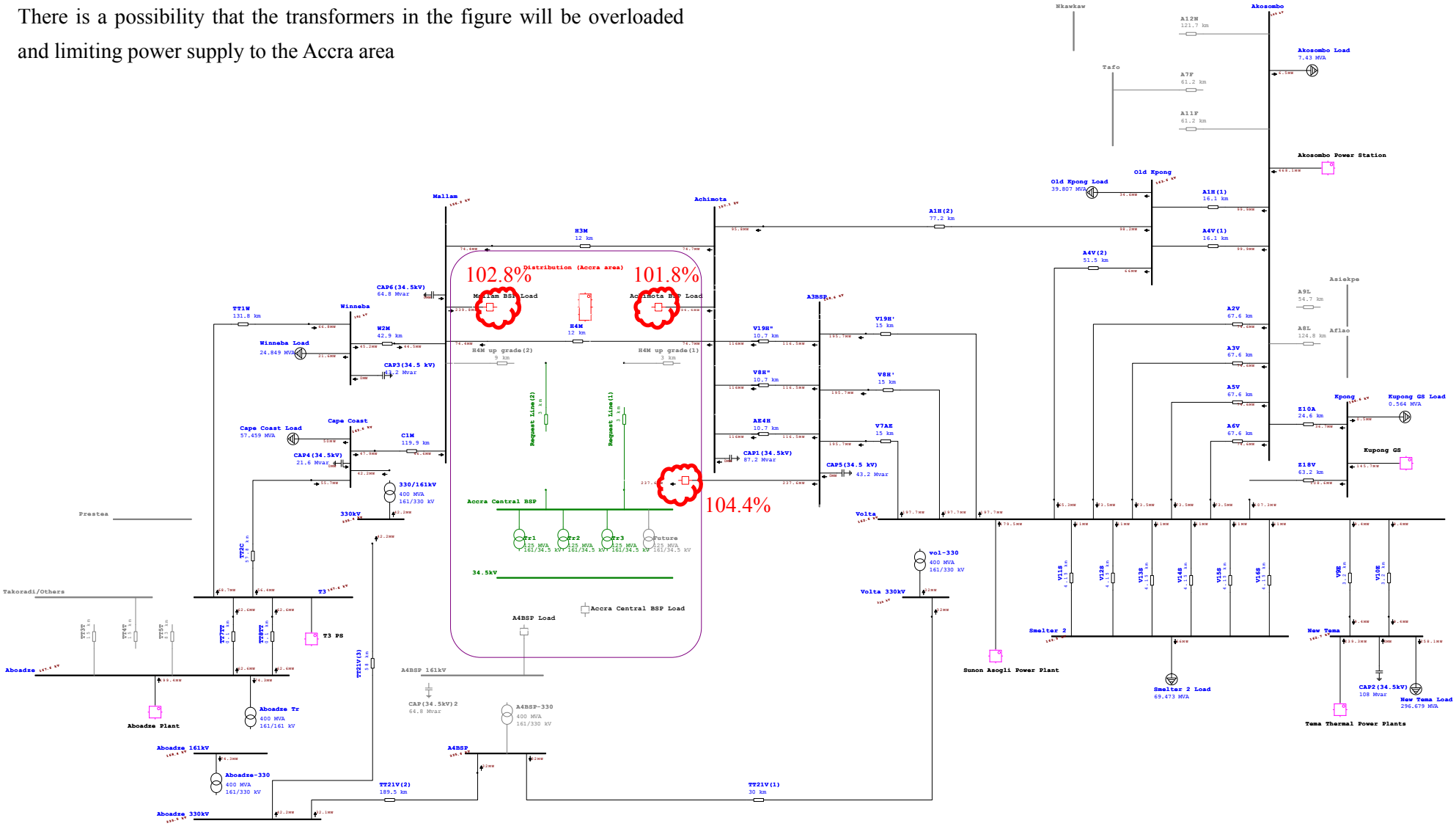


Figure 2-2-2-2.4 Case 2 (2017, without the Project)

There is a possibility that the transformers in the figure will be overloaded and limiting power supply to the Accra area

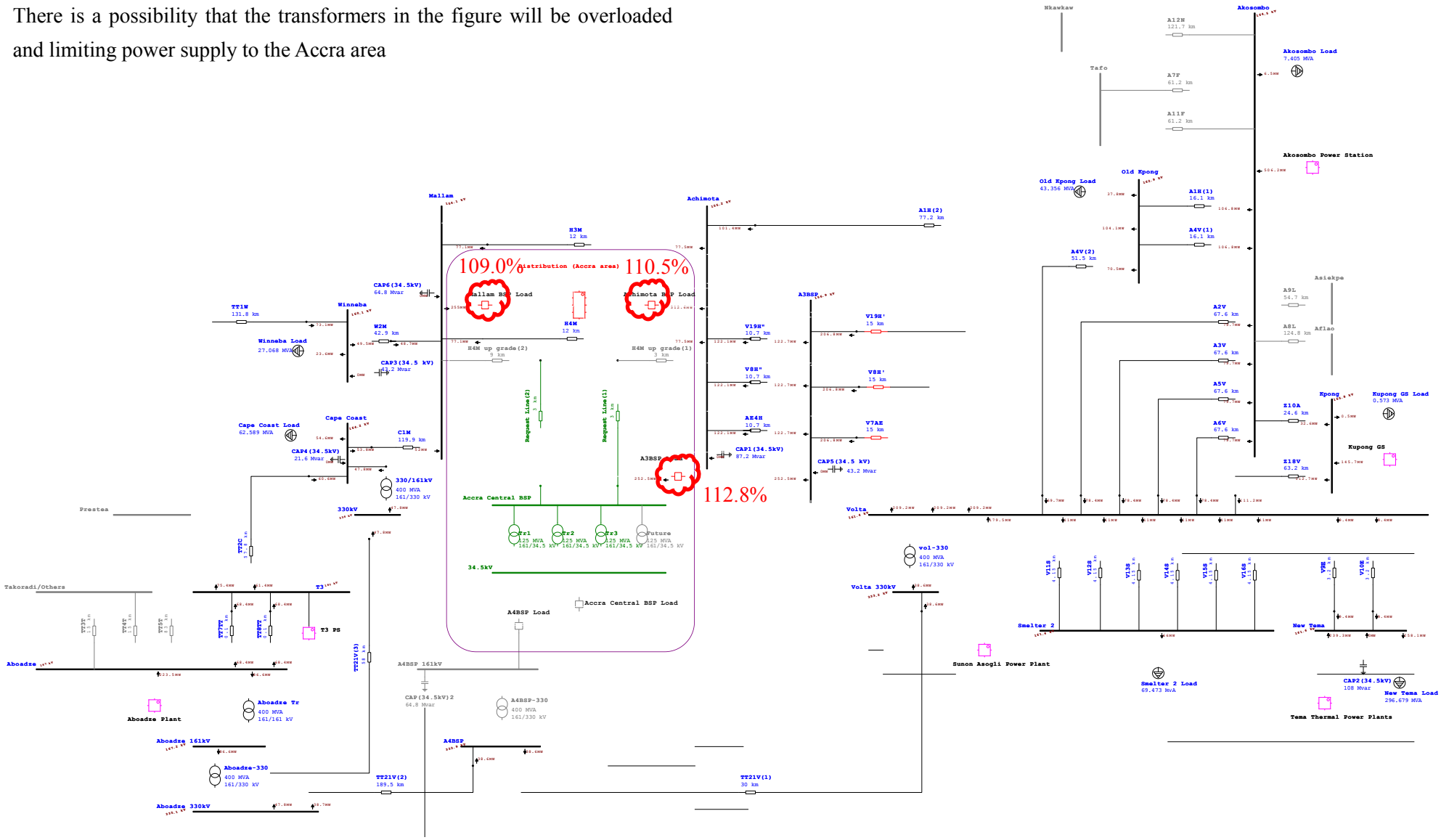


Figure 2-2-2-2.5 Case 3 (2018, with the Project)

Power supply possible to Accra area without causing system problems

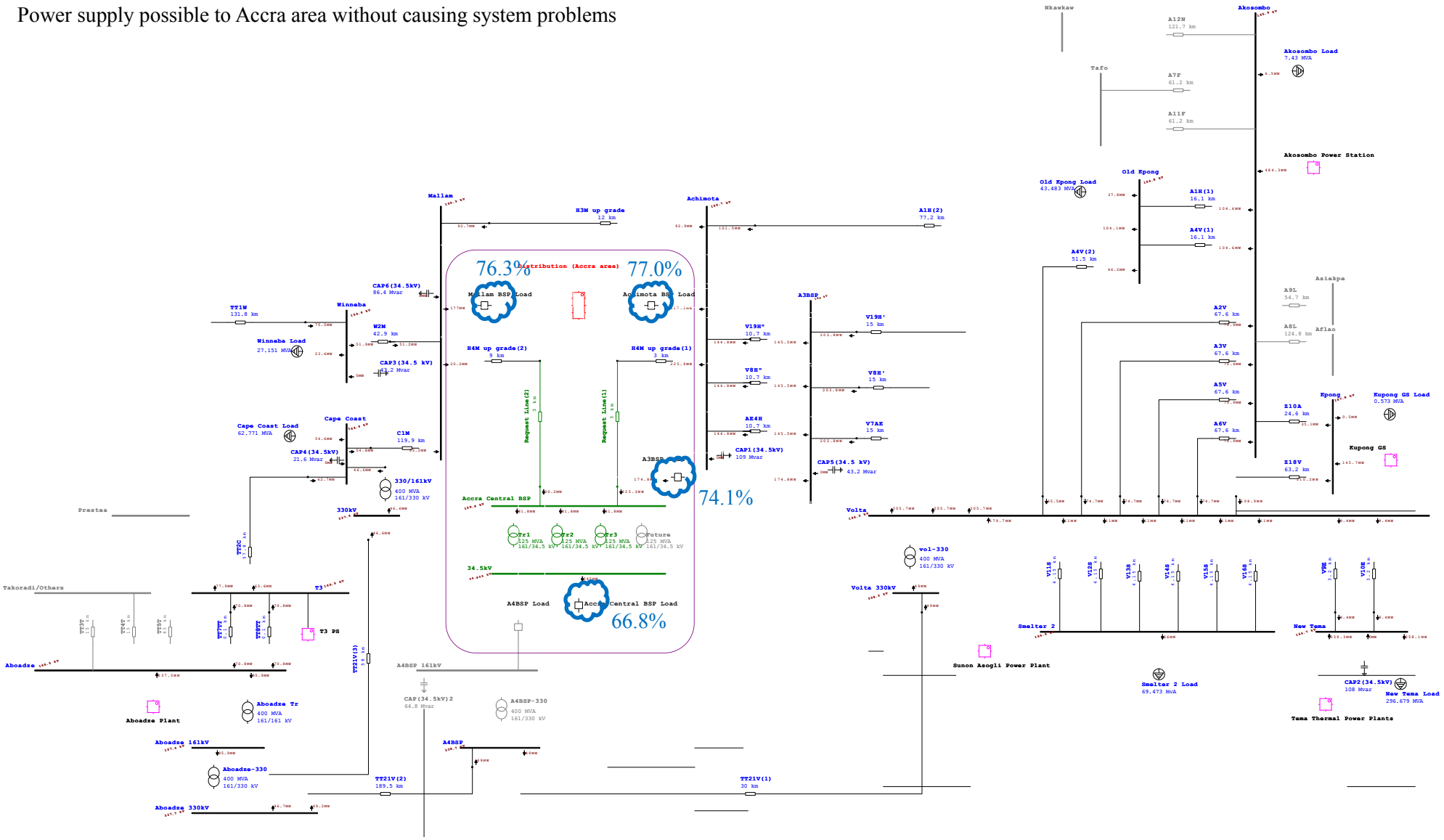


Figure 2-2-2-2.6 Case 4 (2018, with the Project)

Power supply possible to Accra area without causing system problems

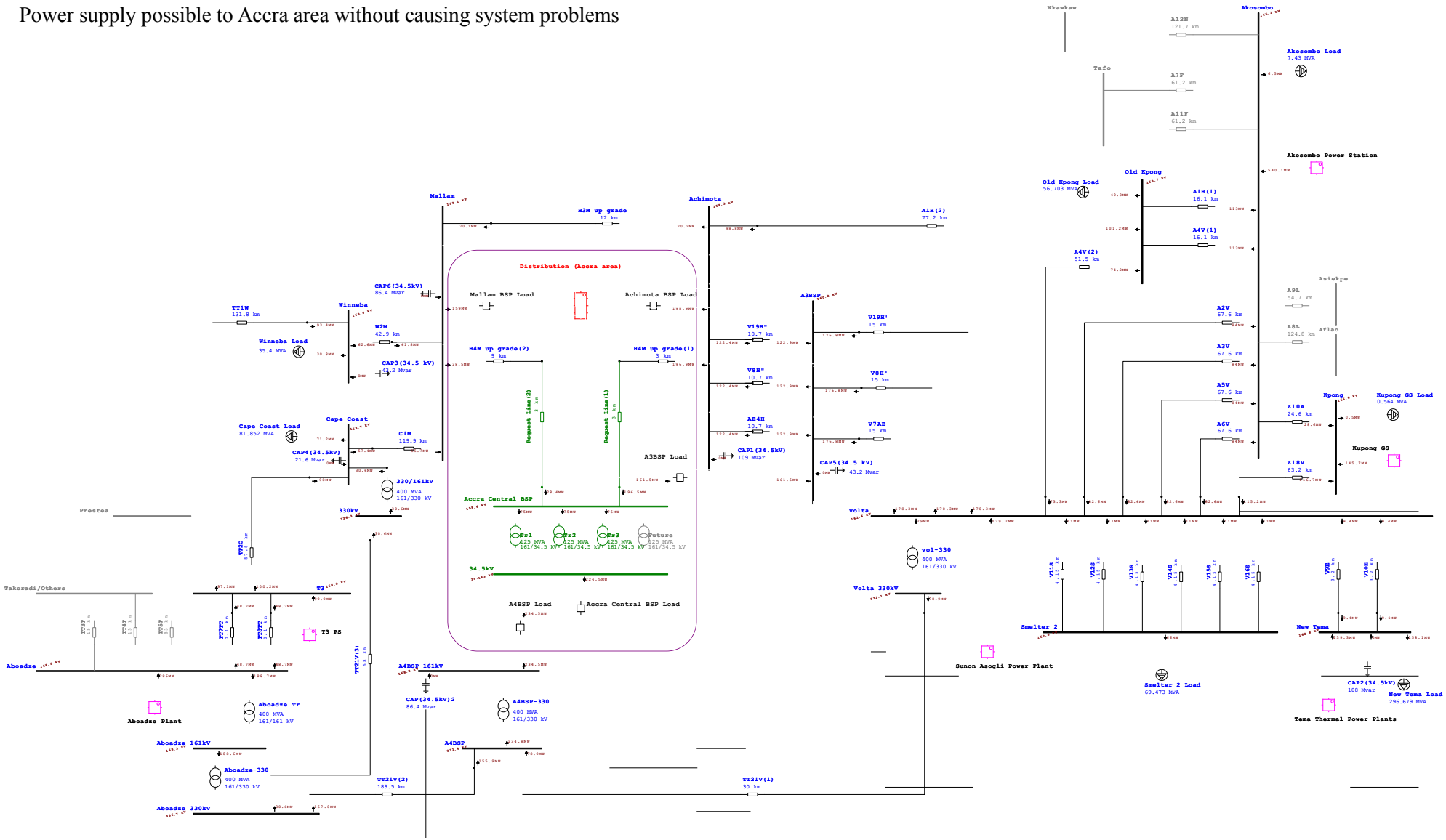


Figure 2-2-2-2.7 Case 8 (2021, with the Project)

There is a possibility that the transformers in the figure will be overloaded and limiting power supply to the Accra area

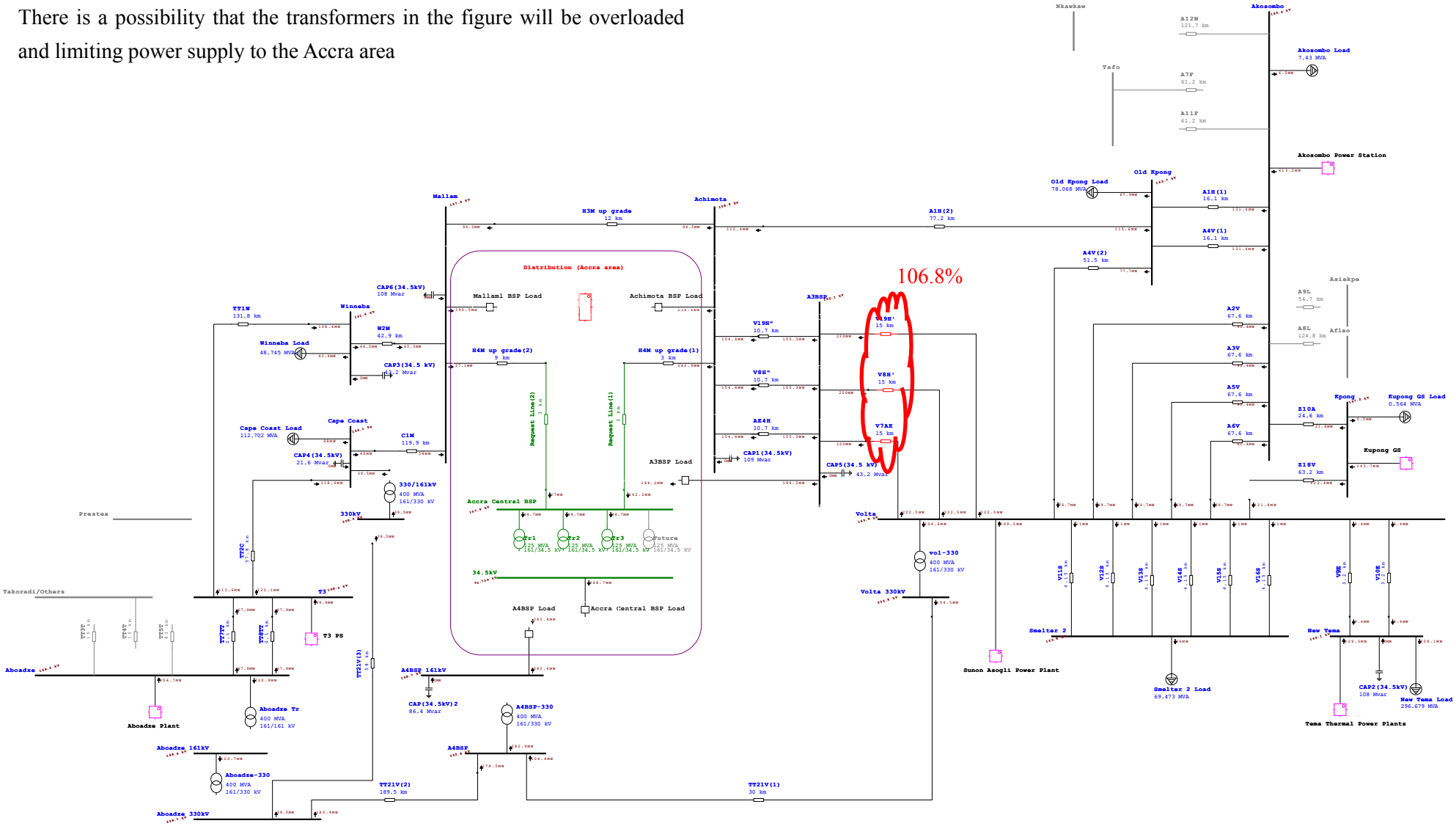


Figure 2-2-2-2.8 Case 11 (2024, with the Project, without transmission lines upgrade)

Power supply possible to Accra area without causing system problems

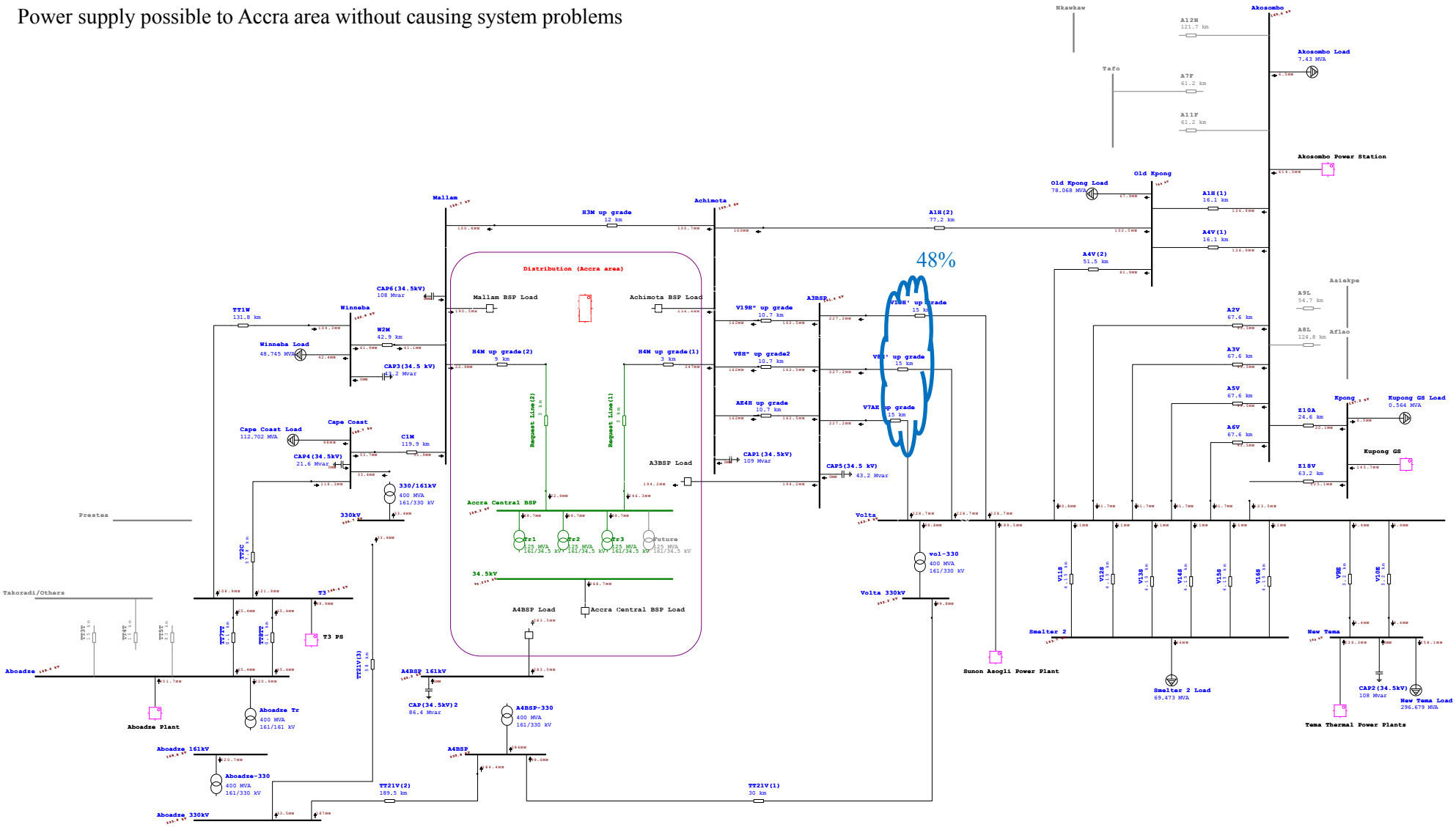


Figure 2-2-2-2.9 Case 12 (2024, with the Project and transmission lines upgrade)

Power supply possible to Accra area without causing system problems

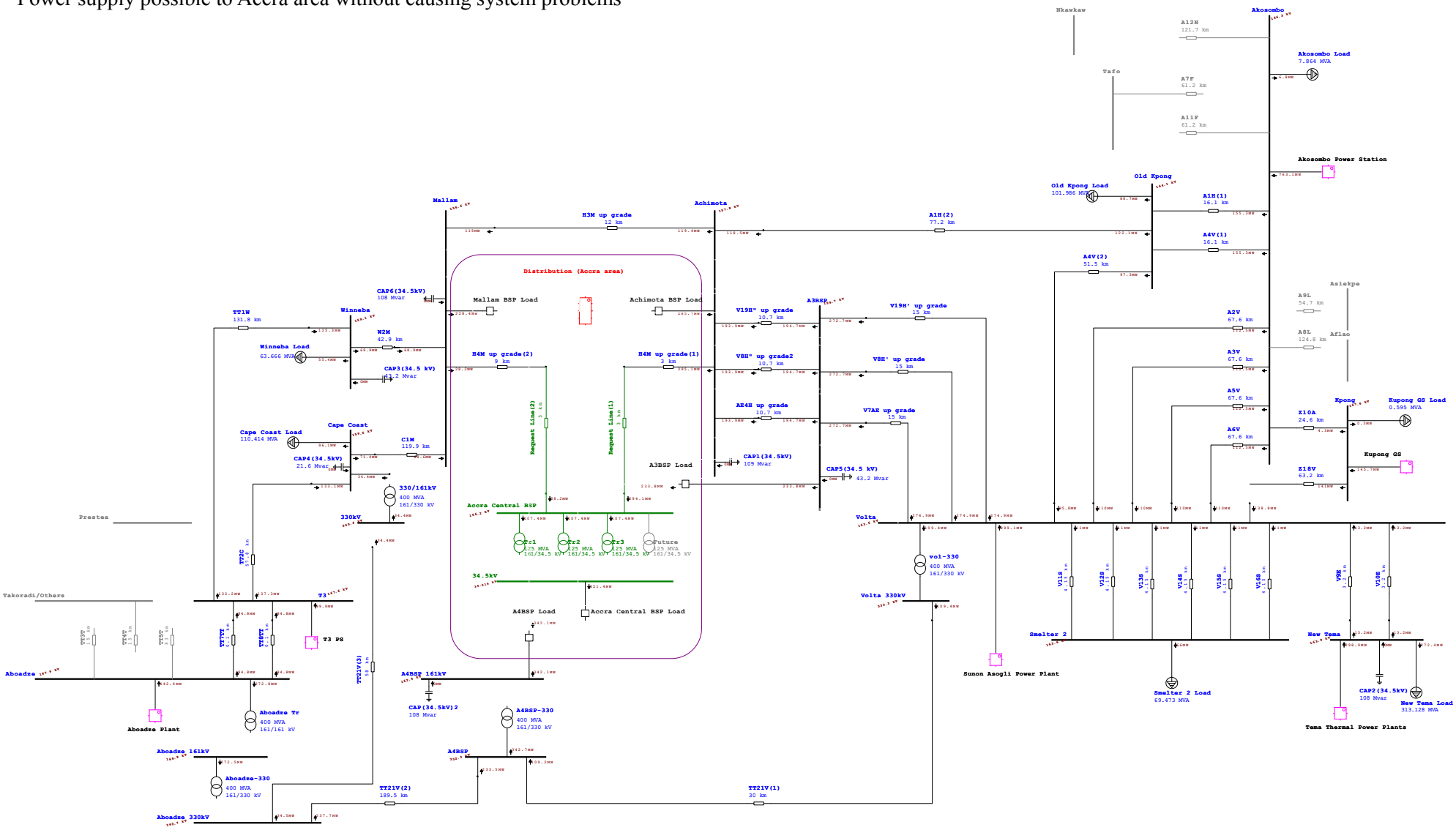


Figure 2-2-2-2.10 Case 15 (2027, with the Project and transmission lines upgrade)

There is a possibility that the transformers in the figure will be overloaded and limiting power supply to the Accra area

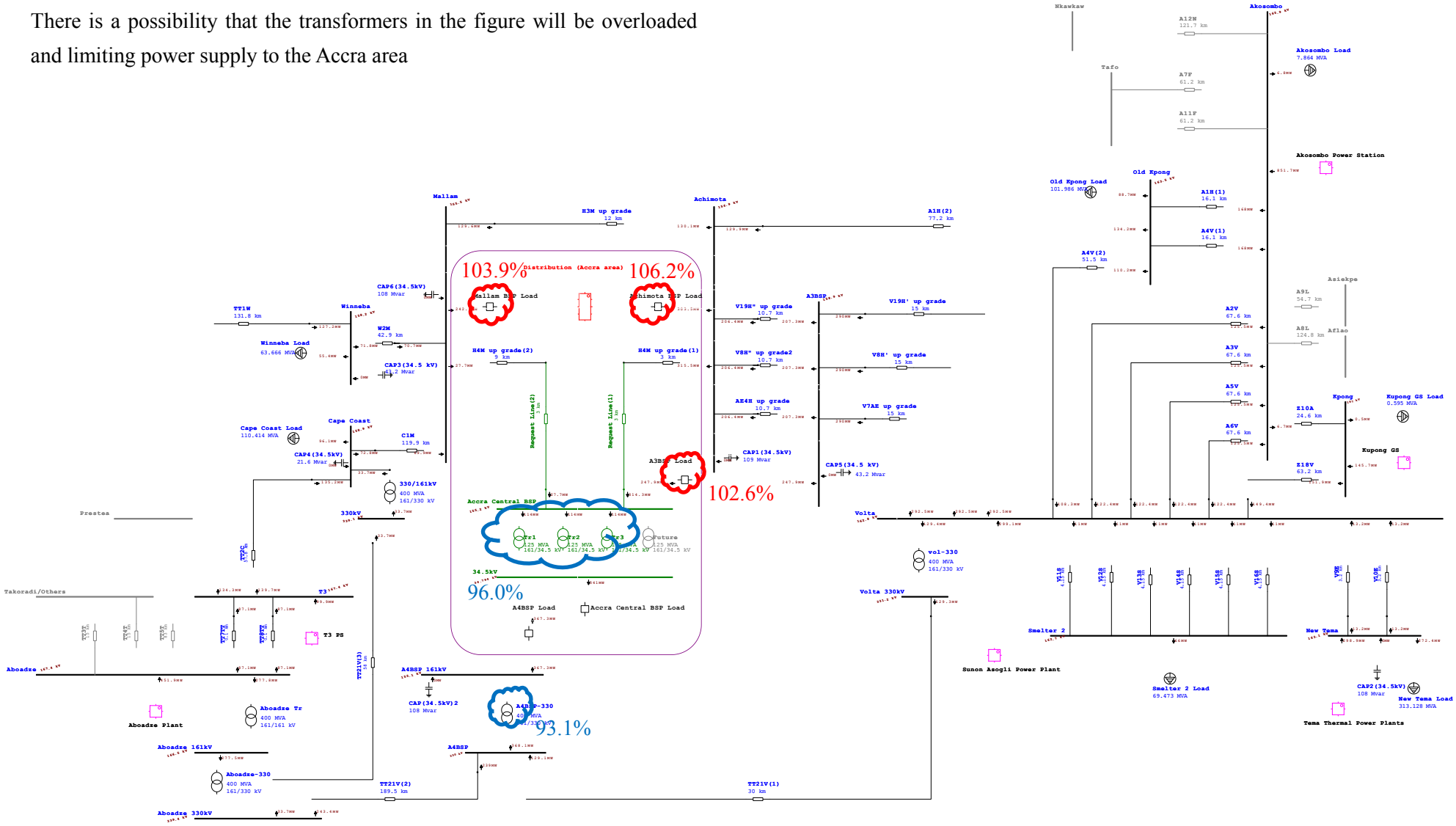


Figure 2-2-2-2.11 Case 16 (2028, with the Project and transmission lines upgrade)

(5) Project Relevance and Recommendations

1) Project relevance

- In 2017, the Achimota, Mallam and A3 BSPs supplying the Accra area with its power are expected to be over capacity, limiting power supply. This makes the project relevant due to its urgency.
- The project's sustainability also makes it relevant given that it will supply power to the Accra area, though additional transformers are necessary by 2028.
- Building a new BSP in the demand area is expected to reduce power loss. The project will reduce power losses of 21.17 MW from its original system in 2021.

2) Recommendations

- With the current power transmission system, additional demand may impede power supply to the Accra area in the future (the study addressed 2024) due to overloading of the three transmission lines between the Volta substation and A3 BSP which supply area power. GRIDCo is scheduled to upgrade their Lilac transmission lines to Tern lines, which will be absolutely necessary to prevent failure of power supply to the Accra area.
- Three stable 161 kV transmission lines must be connected to the A3 BSP from the Volta substation, from which power currently gets drawn occasionally. If even one of the three lines goes unconnected, the aforementioned transmission lines between the Volta substation and A3 BSP will overload years earlier and may impede power supply to the Accra area unless the lines are upgraded before they overload.
- Figure. 2-2-2-2.12 shows Primary substation system in Accra area. As shown in Figure. 2-2-2-2.12, Graphic Road primary substation (33kV E substation) is supplied with 33kV sub-transmission lines from Achimota BSP though Avenor primary substation. In normal operation, 33kV sub-transmission lines between Graphic Road primary substation and Avenor primary substation are used as a backup for 33kV sub-transmission lines between Achimota BSP and the Avenor primary substation. However, Avenor primary substation shall be supplied from Accra Central BSP because Achimota BSP is expected to be over capacity. In the case, 33kV sub-transmission lines between Achimota BSP and Avenor primary substation is used as a backup for 33kV sub-transmission lines between Accra Central BSP and Avenor primary substation. Therefore, connection with Avenor primary substation is necessary in terms of power quality, supply reliability and redundancy on the system operation. In the case, it is necessary to confirm the resettlement and land acquisitions, etc.

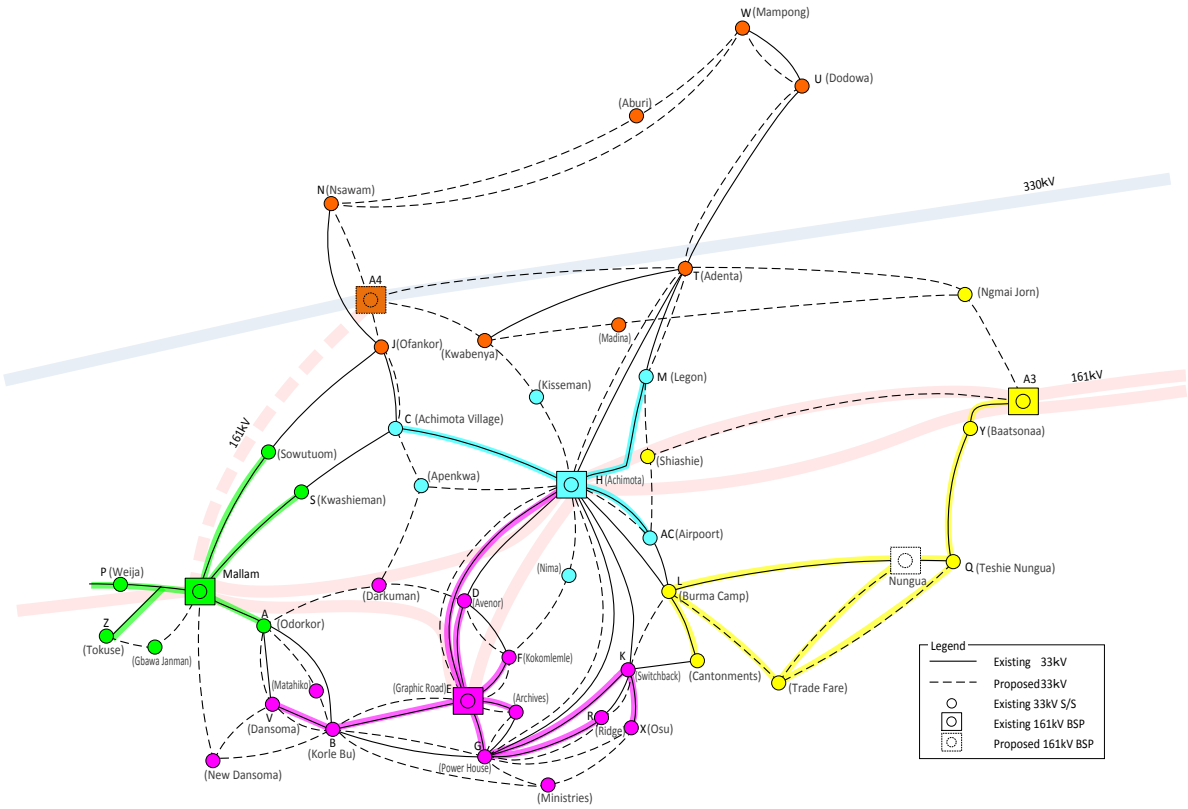


Figure 2-2-2-2.12 Primary substation system in Accra area

2-2-2-3 Overall Plan

1) Design Conditions

Project design conditions are as follows:

1) Weather conditions

Weather conditions applicable to designs for substation facilities, buildings, and foundations are as shown in Table 2-2-2-3.1.

Table 2-2-2-3.1 Weather Conditions

Area		Accra city
Altitude		5.3 to 6.8 m
Ambient temperature	Maximum	38 degree C
	Minimum	15 degree C
	Average	25.2 degree C
Maximum humidity		97%
Wind speed	Maximum	26 m/s
	Usual speed	1 to 8 m/s
Rainfall (Maximum in a month)		178 mm
Soil bearing capacity		7 to 8 ton/m^2 (depend on boring survey)

[Source] BBC Weather Report、Kotoka International Airport Weather Station

2) Design Conditions

① System voltage

161 kV system : 161 kV +/- 5%

33 kV system : 33 kV +/- 5%

② System frequency : 50 Hz +/- 0.2 Hz

③ System earthing

161 kV system : Solidly earthing system

33 kV system : Grounding transformer

2) Applicable Standards and Units Used

Substation systems and transmission facilities are generally designed in accordance with IEC standards, JEC standards or equivalent standards.

2-2-2-4 Basic Plan Overview

As mentioned previously, this project is meant to help to enhance distribution facilities in the Accra area to improve the serious damage done to economic activity in the area by insufficient supply capacity from power distribution facilities and aging facilities. An overview of the project was previously given in Table 2.1.2-1.

(1) Accra Central BSP (New Substation)

1) Basic plan

Upon request from the Ghana side, outdoor type gas-insulated switchgears (GIS) will be used for the 170 kV switchgears given the small site. In this project, two sets of incoming feeders, three sets of transformer feeders, one set of busbar coupler feeder and two sets of voltage transformers on buses will be installed, with space for future extensions of each one set of the incoming feeder and the transformer feeder.

Three 125 MVA transformers will be installed for the step down from 161 kV to 34.5 kV, with space for one additional transformer in the future.

GRIDCo has explained that the land for the Graphic Road primary substation is classified as a light industrial area with the following standard values for environmental noise in the area:

Noise limitation at light industrial area;

Time	Noise Level
Daytime (06:00 – 22:00)	65 dB
Nighttime (22:00 – 06:00)	60 dB

[Note] According to NEMA guideline for reference, the standard noise of this capacity size of transformers is around 85 dB.

In order to comply with the above noise standards of 60 dB, the transformers will be enclosed in additional steel enclosures. As the steel enclosures fulfill the role of a firewall, the standalone firewall have been eliminated. And further, using the steel enclosures and no firewalls, the transformers are connected by power cables through elephant-type cable boxes for both 161 kV and 34.5 kV cable connections instead of outdoor bushings.

Compact cubicle-type gas-insulated switchgears (C-GIS) will be newly purchased and installed for the 33 kV switchgear once the existing 33 kV switchgear is removed. In order to minimize the outage of power supply, the procedures given in Figure 2-2-2-4.1 will be followed for removal of the existing 33 kV switchgear.

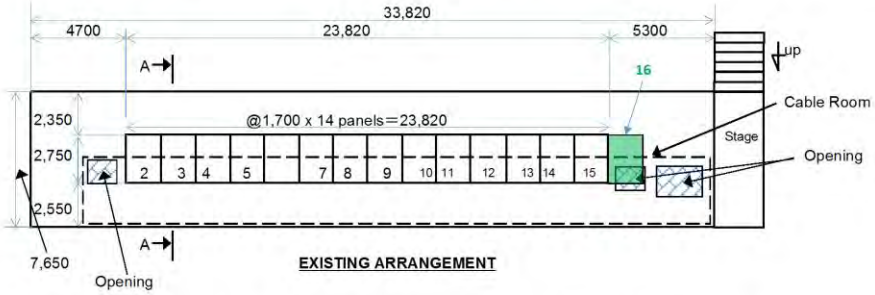
The Japanese side will supply and install 33 kV power cables for the following sections, excluding the power cables for outgoing feeders outside the substation:

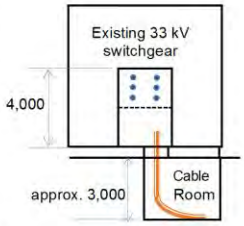
- Between three 125 MVA transformers (161/34.5 kV)
- Between two Station service transformers (33/0.4 kV)
- Between the two earthing transformers (33 kV)

Note here that the earthing transformers will be installed outside on the west of the existing buildings as designated by ECG, and that cables will be routed through one of the dormer windows in the existing building.

With electricity sales to be measured at the secondary circuits on the 33 kV side of the 125 MVA transformers and both GRIDCo and ECG needing their own electricity meters, six meters will be needed in total. GRIDCo and ECG will supply three meters each to be mounted on the Energy meter panels by the Japanese side. The Energy meter panels are to be manufactured and installed by the Japanese side in the new and existing control buildings with three meters and spare space for an additional meter.

Procedure for Replacement work of 33 kV switchgear panels at Graphic Road S/S (Preliminary)

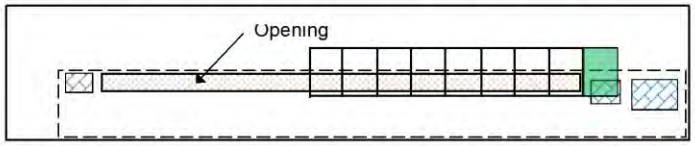




Section A-A

Stage 0
ECG installs "Additional panel (called No.16)" for temporary power supply, before commencement of JICA Project.
ECG requires the three (3) month notice before the commencement of JICA Project.

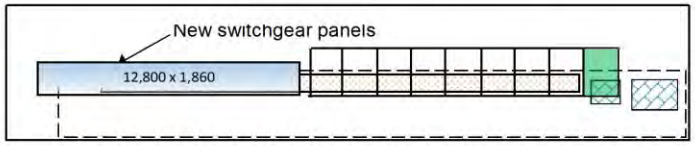
Stage 1
Panel No. 2 to 7 should be removed by ECG. Continuous power supply for removed panels should be done by ECG, using temporary power supply panel, and/or temporary bypass circuit by the other substations.
Additional floor openings are made by ECG, in accordance with information by Japanese side.



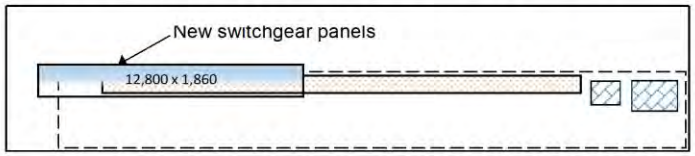
Existing Panel Name

No.	NAME
2	OKASHIE-2
3	OKASHIE-1
4	AVENOR-II
5	(Not in use)
6	(None)
7	Measuring
8	Bus Coupler
9	TR. T31
10	ADABRAKA
11	CATHADRAL
12	TR. T32
13	KOTOBABI
14	AVENOR-I
15	LARTEBIOKOSHIE

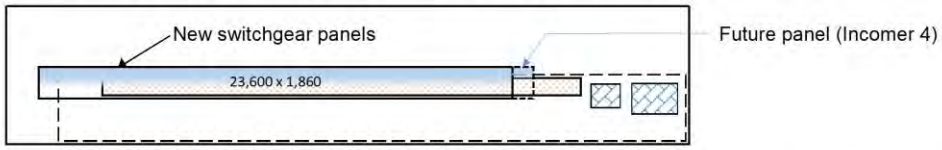
Stage 2
15 panels of New 33 kV Switchgear should be installed by Japanese side, and energized after the installation and testing. (Number of new panels is subject to change.)
The foundation of the new switchgear might be raised from the floor level, due to the location of the existing floor openings.



Stage 3
Remaining existing panel No. 8 to 16 should be removed by ECG. Temporary power supply for removed panels are conducted by ECG, as same as Stage 1 above.
Additional floor openings are made by ECG, in accordance with information by Japanese side.



Stage 4
Remaining new switchgears should be installed and tested by Japanese side, then completed.



Note;
1) Since the above work may continue for several months, ECG is required to supply power to his customers during the works.
2) The size of the new 33 kV switchgear panels may be changed, depending on different manufacturers.
3) The detailed schedule such as duration of the works should be discussed at the implementation stage.

Figure 2-2-2-4.1 Procedure for Replacement work of 33 kV switchgear panels at Graphic Road S/S

SCADA interface panels will be prepared and installed to transfer signals with the SCADA system. As seen in Figure 2-2-2-4.2, the Ghana side will be responsible for connections with the panels.

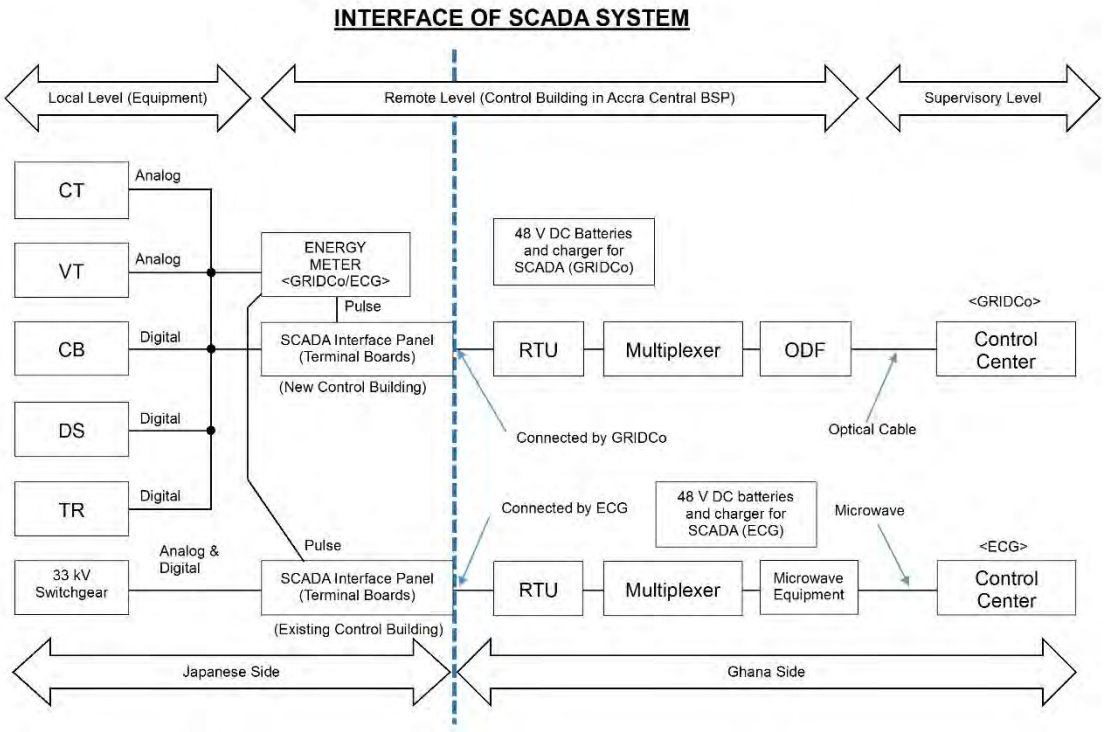


Figure 2-2-2-4.2 Interface of SCADA System

A new grounding system will be installed, accounting for connections to the existing grounding system. Installation of lightning rods and other safety facilities will also be considered.

The Ghana side will be responsible for the following items.

- Removal of existing 33 kV switchgear panels
- Work on new floor openings in the existing 33 kV switchgear room
- The following items for the SCADA system:
  1) All new communications equipment to be installed in the Accra Central BSP, including RTUs, multiplexers, optical terminal devices, microwave equipment and optical cables.
  2) Modification of necessary equipment for receiving and sending signals from additional equipment required for monitoring and controls in the GRIDCo and ECG control centers.
  3) 48 V DC storage batteries and chargers for RTUs and other communication equipment.

2) Planned details for substation equipment

Equipment and materials to be supplied by the Japanese side for Accra Central BSP and

Graphic Road primary substation are given in Tables 2-2-2-4.1 and 2-2-2-4.2, respectively and Single Line Diagram for Accra Central BSP and Equipment Layout of Graphic Road primary substation are shown in DWG No. E-01 and E-02, respectively. (See Appendix-5)

Table 2-2-2-4.1 Equipment List for Accra Central BSP Substation

No.	Description	Specifications
AC1	161/34.5 kV Transformer	
	➢ Standards	IEC, JEC or equivalent
	➢ Capacity	125 MVA
	➢ Rated frequency	50 Hz
	➢ Primary voltage	161 kV
	➢ Voltage regulating range	161 kV +/- 10%
	➢ Steps (taps)	+/- 8 steps (17 taps)
	➢ Secondary voltage	34.5 kV
	➢ Cooling	ODAF (Oil Directed Air Forced Cooling)
	➢ Vector group	YNd11
	➢ % impedance	Approximately 13%
	➢ Rated basic impulse withstand voltage	161 kV: 650 kV 34.5 kV: 170 kV
	➢ Rated power frequency withstand voltage (1 min.)	161 kV: 325 kV 34.5 kV: 70 kV
	➢ Bushing CT	161 kV line: 3 CTs 161 kV neutral: 1CT 34.5 kV line: 3 CTs
	➢ Neutral earthing	161 kV : Solidly earthing system 34.5 kV: Grounding Transformers
	➢ Connection	161 kV side: Cable connection (1 x 400 mm^2/phase) 34.5 kV side: Cable connection (3 x 800 mm^2/phase)
	➢ Noise	Less than 60 dB (Special design for low noise)
	➢ Others	Future space for No.4 Transformer is considered.
AC2	170 kV Switchgears	
	➢ Standards	IEC, JEC or equivalent
	➢ Type	SF_6 gas insulated, three phase type
	➢ Rated frequency	50 Hz
	➢ Busbar configuration	Double Busbar system
	➢ Quantity	Feeder bays : 2 bays Transformer bays : 3 bays Bus Coupler bay : 1 bay VT bay : 1 bay
	➢ Rated voltage	170 kV
	➢ Rated current	Busbar: more than 3,150 A Bus coupler: more than 3,150 A Feeder: more than 2,000 A Transformer: more than 800 A
	➢ Rated interrupting current	31.5 kA
	➢ Rated short-time withstand current (short time)	31.5 kA (3 sec.)
	➢ Rated basic impulse withstand voltage	750 kV
	➢ Rated power frequency withstand	325 kV

No.	Description	Specifications
	voltage (1 min.) ➢ Circuit Breaker - Auto-reclosing - Operating sequence ➢ Current Transformer - Feeder bays - Transformer bays - Coupler bay - Secondary current ➢ Voltage Transformer ➢ Others - Lightning Arresters (LA) for Transformer bays - Spare bays for 161 kV feeders	 Yes O-0.3 sec.-CO-3 min.-CO (Three phase) 4 CTs None 2 CTs 1 A 161/√3 kV / 115/√3 V - LAs are supplied for Transformer bays. - Space for 1 x spare feeder bay and 1 x spare transformer feeder bay is considered.
AC3	161 kV XLPE Cable ➢ Circuit ➢ Type ➢ No. of core ➢ Cross section	 Primary circuit of 125 MVA Transformer XLPE Single core 400 mm^2
AC4 -1	Control and Protection Control and Protection Panel ➢ Type of Control and Protection panel ➢ Panel arrangement ➢ Standard Protection system (scheme) - 161 kV Transmission line protection - 161/34.5 kV Transformer protection - 161 kV Busbar protection - Other 161 kV protection system	 Duplex type panel Front of panel: 161 kV Switchgear Control and 125 MVA Transformer voltage regulating control Rear of panel: 161 kV Protection relays Main: Phase Comparison Relay Back-up: Distance Relay (Over reach/Under reach) Intertripping scheme should be applied. Transformer Differential Relay/Overcurrent Relay Current Differential Relay Breaker Failure Protection shall be applied.
-2	Energy Meter Panel	A panel with three (3) sets of Energy meters (plus one (1) set for future space) is provided at new Control building. [Note] - Two (2) Energy meters shall be equipped with one Transformer secondary circuit for each GRIDCo and ECG. - Independent 2 x CT with accuracy class 0.2 shall be supplied and VT secondary shall be of double windings with accuracy class 0.2 on 125 MVA Transformer secondary circuit. These

No.	Description	Specifications
		CTs are installed at cable room under the switchgear room with supporting structures. - Two (2) panels of Energy meter panel with three (3) meters (plus one (1) for future space) are provided and each one (1) panel is installed at each building. - Energy meters are provided by ECG and GRIDCo (three (3) each) and mounted on the panel by Japanese side.
-3	Interface Panel for SCADA System of GRIDCo	Interface terminals for Digital I/O, Analog I/O and Pulse signals are provided for RTU of SCADA system in the Control building.
AC5	Others	
-1	DC Power Supply System	
	➢ DC Voltage	125 V DC
	➢ Battery Capacity	More than 700 Ah
-2	AC Power Supply System	
	➢ AC Voltage	415/240 V AC (Three phases and four wires)
	➢ Station Service Transformer	Capacity: 500 kVA AC distribution panel is included.
-3	Substation Earthing	Earthing conductors, terminals and other necessary materials are provided.

Table 2-2-2-4.2 Equipment List for Graphic Road Primary Substation

No.	Description	Specifications
GR1	34.5 kV Switchgears	
	➢ Standards	IEC, JEC or equivalent
	➢ Type	SF_6 gas insulated, metal-clad type
	➢ Rated voltage	36 kV
	➢ Rated frequency	50 Hz
	➢ Bus configuration	Double Busbar system
	➢ Quantity	- 125 MVA Incomer : 3 panels - 33/11 kV Transformer : 3 panels - 33 kV Feeder : 14 panels - Bus Coupler : 2 panels - Bus Section : 1 panels - Station Service Transformer : 3 panels - Earthing Transformer : 2 panels Note) Meters, Protection relays, and other devices are mounted on switchgear panels. The space for No. 4 unit of 125 MVA Transformer should be secured at existing 33 kV switchgear room.
	➢ Rated current	- Busbar : 2,500 A - Bus coupler : 2,500 A - Bus Section : 2,500 A - Feeder : 1,250 A - 125 MVA Transformer : 2,500 A - 33/11 kV Transformer : 630 A
	➢ Rated interrupting current	40 kA
	➢ Rated short-time withstand current (short time)	40 kA (3 sec.)
	➢ Rated basic impulse withstand voltage	170 kV
	➢ Rated power frequency withstand voltage (1 min.)	70 kV
	➢ Circuit Breaker - Auto-reclosing - Operating sequence	 Yes O-0.3 sec.-CO-3 min.-CO (Three phase)
	➢ Current Transformer - Secondary current	 5 A
	➢ Voltage Transformer	33/√3 kV / 110/√3 V / 110/3 V and 33/√3 kV / 110/√3 V
	➢ Protection relays	Numerical relays should be applied.
	➢ Standard Protection system (scheme) - 33 kV Incomer (161/34.5 kV Transformer) protection - 33 kV Feeder Protection - 33 kV Bus Coupler Protection - 33/11 kV Transformer Protection - 33/0.4 kV Station Service Transformer & Earthing Transformer Protection	 50/51, 50/51N, 27DC, 86, 95 21, 67/50/51, 67/50/51N, 27DC, 79, 86, 95 21, 50/51, 50/51N, 27DC, 86, 95 50/51, 50/51N, 87, 27DC, 86, 95 50/51, 50/51N, 86, 95 【Device No.】

No.	Description	Specifications
		21 : Distance Relay 27DC : Undervoltage Supervision Relay 50/51 : Overcurrent Relay (Instantaneous and Inverse-time) 64 : Earth-fault Overvoltage Relay 67 : AC Power Directional Relay 79 : Reclosing Relay 86 : Lockout Relay 87B : Bus Differential Relay 87L : Feeder Differential Relay 87T : Transformer Differential Relay 95 : Trip Circuit Supervision Relay
	➢ Foundation for new switchgears	Since some cable connections for new switchgears might be interfered by floor beams of the existing 33 kV switchgear room, the foundation for new switchgears should be raised by means of supporting steel structures.
GR2	33 kV XLPE Cable	
-1	Secondary circuits of 125 MVA Transformer	
	➢ Type	XLPE
	➢ No. of core	Single core
	➢ Cross section	800 mm^2
	➢ No. per phase	3 cables per phase
-2	Station Service Transformer	
	➢ Type	XLPE
	➢ No. of core	Three core
	➢ Cross section	240 mm^2
	➢ No. per phase	1 cable per phase
-3	Earthing Transformer	
	➢ Type	XLPE
	➢ No. of core	Single core
	➢ Cross section	500 mm^2
	➢ No. per phase	1 cable per phase
GR3	Control	
-1	Energy Meter Panel	A panel with three (3) sets of Energy meters (plus one (1) set for future space) is provided in existing building. [Note] See AC4-2
-2	Interface Panel for SCADA System of ECG	Interface panel is provided for SCADA system in existing building.
GR4	Others	
-1	DC Supply System	
	➢ DC Voltage	110 V DC
	➢ Battery Capacity	More than 500 Ah
-2	Earthing Transformer	
	➢ Standard	IEC, JEC or equivalent
	➢ Rated Voltage	33,000 V

No.	Description	Specifications
	➢ Continuous rated current ➢ Rated short-time current ➢ Duration ➢ Zero-sequence impedance ➢ Connection ➢ Cooling	0 A 1,060 A/phase 10 sec. 19.1 ohm ZN ONAN

3) Substation building and ancillary facility construction plans

The Accra Central BSP will be constructed within the grounds of the Graphic Road primary substation. The facilities to be built are: 1) foundations for three 125 MVA transformers with space for one future extension (28.8 meters by 15.3 meters with underground pipings and cabling culverts); 2) foundations for seven sets of 170 kV gas-insulated switchgear (GIS) bays with future space for two additional bays (22.4 meters by 9.3 meters with underground cabling pit); 3) control building for accommodating control equipment for main equipment (three stories with basement); 4) underground culverts connecting these facilities and existing buildings (Graphic Road primary substation control building); and 5) ancillary facilities for these facilities. The site is a 1,300-square meter triangle shape with a 48.1-meter lower base and 46.1-meter height, which makes it extremely small compared to other BSPs. Given the space constraints, Oil directed air forced cooling (ODAF) type transformer and 170 kV GIS will be used. Also, the control building is a multi-story construction to reduce contruction area, and Station service transformers will be installed on the roof of the control building. Further, cabling culverts (2) and (3) are housed within the transformer foundations to reduce construction area. An overview of the main facilities follows below.

Main facilitie

Control building: 3-story with basement, reinforced concrete rigid-framed structure, contruction area approx. 110 square meters, floor area approx. 340 square meters

Transformer foundation: Basement, reinforced concrete wall construction, contruction area approx. 432 square meters, floor area approx. 373 square meters

GIS foundation: Basement, reinforced concrete wall construction, contruction area approx. 188 square meters, floor area approx. 146 square meters

Wiring culverts (1), (4) and (5): basement, reinforced concrete box structure

The main features and construction plans of the facilities are as follows:

Table 2-2-2-4.3 TR Platform Foundation

Room	Area	Equipment/Specification
Cable Culvert (2)		Light Fittings, Ventilation, Cable Rack, Drainage, Floor panel
Cable Culvert (3)		Light Fittings, Ventilation, Cable Rack, Drainage, Floor panel

Mechanical Pit		Light Fittings, Ventilation, Pipe Rack
Oil Pit		Wall, Floor: Waterproofing, Oil resistant Mortar Steel Trowel Finish
Total	373 ㎡	

Table 2-2-2-4.4 GIS Platform Foundation

Room	Area	Equipment/Specification
Cable Pit		Light Fittings, Ventilation, Cable Rack, Drainage
Staircase		Wall, Floor: Waterproofing Mortar Steel Trowel Finish
Total	187 ㎡	

Table 2-2-2-4.5 Cable Culvert (1)

Room	Area	Equipment/Specification
Cable Culvert (1)		Light Fittings, Ventilation, Cable Rack, Drainage
Total	30 ㎡	

Table 2-2-2-4.6 Cable Culvert (4)

Room	Area	Equipment/Specification
Cable Culvert (4)		Light Fittings, Ventilation, Cable Rack, Drainage
Cable Culvert (5)		Light Fittings, Ventilation, Cable Rack, Drainage
Total	112 ㎡	

Table 2-2-2-4.7 Control Building

FL	Room	Area	Equipment/Specification
BF	Cable Pit		Light Fittings, Ventilation, Cable Rack, Drainage
	Water Tank		Light Fittings, Ventilation, Cable Rack, Drainage
	Electrical Duct (1)		Light Fittings, Electrical Panel
	Staircase		Light Fittings, Emergency Light
	Sub Total	110 ㎡	
GF	Control Panel Room（1）		Light Fittings, Ventilation, Air-condition, Cable Pit
	Control Room（1）		Light Fittings, Ventilation, Air-condition, Cable Pit
	Entrance, Staircase		Light Fittings, Emergency Light
	Toilet		Light Fittings, Ventilation, Faucet, Wash basin, Sink
	Electrical Duct (2)		Light Fittings, Electrical Panel
	Sub Total	110 ㎡	
1F	Control Panel Room（2）		Free Access Floor H=300, Light Fittings, Ventilation, Air-condition
	Battery Room		Free Access Floor H=300, Light Fittings, Ventilation, Air-condition
	Staircase		Light Fittings, Emergency Light
	Shower Room		Light Fittings, Ventilation, Shower set, Wash basin, Sink
	Electrical Duct (3)		Light Fittings, Electrical Panel
	Sub Total	110 ㎡	
2F	Control Panel Room（3）		Free Access Floor H=300, Light Fittings, Ventilation, Air-condition
	Control Room（2）		Free Access Floor H=300, Light Fittings, Ventilation, Air-condition
	Staircase		Light Fittings, Emergency Light
	Toilet		Light Fittings, Ventilation, Shower set, Wash basin, Sink
	Electrical Duct (4)		Light Fittings, Electrical Panel
	Sub Total	110 ㎡	
RF	Staircase		Light Fittings, Emergency Light
	Electrical Duct (5)		Light Fittings, Electrical Panel

FL	Room	Area	Equipment/Specification
	Sub Total	18 ㎡	
	Total	458 ㎡	

Main external finishing details for the facilities are as follows:

Table 2-2-2-4.8 Exterior Finishing Schedule

Facility	Item	Specification
TR Platform Foundation	Floor	Waterproofing Concrete Steel Trowel (Slope 1/100）, Waterproofing Mortar Steel Trowel Finish
	Oil Pan	Waterproofing Concrete Steel Trowel (Slope 1/100）, Waterproofing Mortar Steel Trowel Finish
	Wall	Exposed Waterproofing Concrete, Exterior Paint Finish
GIS Platform Foundation	Floor	Waterproofing Concrete Steel Trowel (Slope 1/100）, Waterproofing Mortar Steel Trowel Finish
	Steps	Waterproofing Mortar Steel Trowel Finish with SUS Non-slip
	Wall	Exposed Waterproofing Concrete, Exterior Paint Finish
Cable Culvert	Floor	Waterproofing Concrete Steel Trowel Finish (Slope 1/100)
Control Building	Roof (1)	Asphalt Membrane Waterproofing (3 Layer), Styroform t=50, Concrete t=80 with expansion plastic joint @2000
	Roof (2)	Concrete Steel Trowel (Slope 1/50）Urethane Waterproofing
	Wall	Exposed Waterproofing Concrete, Exterior Paint Finish
	Balcony Floor	Concrete Steel Trowel (Slope 1/50）Urethane Waterproofing
	Windows	Readymade Aluminum Window
	Entrance Doors	Readymade Aluminum Door
	Delivery Doors	Steel Door
	Down spout	VP 100φ
	Roof Drain	Cast Iron

Main internal finishing details for the facilities are as follows:

Table 2-2-2-4.9 Interior Finishing Schedule

Facility	Room	Item	Specification
TR Platform Foundation	Cable Culvert (2), (3)	Under floor	Waterproofing Concrete Steel Trowel (Slope 1/100）, Waterproofing Mortar Steel Trowel Finish
		Floor	Floor Panel
		Wall	Exposed Waterproofing Concrete
		Ceiling	Exposed Waterproofing Concrete
	Mechanical Pit	Floor	Waterproofing Concrete Steel Trowel (Slope 1/100)
		Wall	Exposed Waterproofing Concrete
		Ceiling	Waterproofing Concrete Steel Trowel (Slope 1/100)
	Oil Pit	Floor	Waterproofing Concrete Steel Trowel (Slope 1/100)
		Wall	Exposed Waterproofing Concrete
		Ceiling	Exposed Waterproofing Concrete
GIS Platform Foundation	Cable Pit	Floor	Waterproofing Concrete Steel Trowel (Slope 1/100)
		Wall	Exposed Waterproofing Concrete
		Ceiling	Exposed Waterproofing Concrete
Cable Culvert (1), (4), (5)	Cable Culvert	Under Floor	Waterproofing Concrete Steel Trowel (Slope 1/100)
		Floor	Floor Panel
		Wall	Exposed Waterproofing Concrete
		Ceiling	Exposed Waterproofing Concrete

Table 2-2-2-4.10 Control Building Interior Finishing Schedule

FL	Room	Floor	Wall	Ceiling
BF	Cable Pit	Waterproofing Concrete Steel Trowel (Slope 1/100)	Exposed Waterproofing Concrete	Exposed Waterproofing Concrete
	Water Tank	Waterproofing Concrete Steel Trowel (Slope 1/100)	Exposed Waterproofing Concrete	Exposed Waterproofing Concrete
	Electrical Duct (1)	Waterproofing Concrete Steel Trowel (Slope 1/100)	Exposed Waterproofing Concrete	Exposed Waterproofing Concrete
	Staircase	Mortar Steel Trowel	Mortar Steel Trowel	Mortar Steel Trowel EP
GF	Control Panel Room (1)	Ceramic Tile 300*300	Mortar Steel Trowel EP	Light Gauge Steel Frame PB12mmEP
	Control Room (1)	Ceramic Tile 300*300	Mortar Steel Trowel EP	Same with above
	Entrance, Staircase	Ceramic Tile 300*300	Mortar Steel Trowel EP	Mortar Steel Trowel EP
	Toilet	Ceramic Tile 300*300	Ceramic Tile 100*100	Light Gauge Steel Frame Flexible B 6mmEP
	Electrical Duct (2)	Mortar Trowel	Exposed Concrete	Exposed Concrete
1F	Control Panel Room (2)	Free Access Floor H=300	Mortar Steel Trowel EP	Light Gauge Steel Frame PB12mmEP
	Battery Room	Free Access Floor H=300	Mortar Steel Trowel EP	Light Gauge Steel Frame PB12mmEP
	Staircase	Ceramic Tile 300*300	Mortar Steel Trowel EP	Mortar Steel Trowel EP
	Shower Room	Ceramic Tile 300*300	Ceramic Tile 100*100	Light Gauge Steel Frame Flexible B 6mmEP
	Electrical Duct (3)	Mortar Trowel	Exposed Concrete	Exposed Concrete
2F	Control Panel Room (3)	Free Access Floor H=300	Mortar Steel Trowel EP	Light Gauge Steel Frame PB12mmEP
	Control Room (2)	Free Access Floor H=300	Mortar Steel Trowel EP	Light Gauge Steel Frame PB12mmEP
	Staircase	Ceramic Tile 300*300	Mortar Steel Trowel EP	Mortar Steel Trowel EP
	Toilet	Ceramic Tile 300*300	Ceramic Tile 100*100	Light Gauge Steel Frame Flexible B 6mmEP
	Electrical Duct (4)	Mortar Trowel	Exposed Concrete	Exposed Concrete
RF	Staircase	Ceramic Tile 300*300	Mortar Steel Trowel EP	Mortar Steel Trowel EP
	Electrical Duct (5)	Mortar Trowel	Exposed Concrete	Exposed Concrete

(2) Basic Plan for 161 kV Transmission Line

1) Planning

Plans for 161 kV transmission lines are to procure and build an Achimota line and Mallam line in the nearly four kilometers between the Avenor branch point and Accra Central BSP.

The 161 kV transmission lines include overhead lines from towers N0 to N18 and ground cable from cable dead-end tower N18 to the 161 kV gas-insulated switchgear installation within the

Accra Central BSP.

2) Design conditions for 161 kV transmission lines

a) Natural Conditions

Items	Design Values
Altitude	Less than 50 m
Conductor temperature	-
Mminimum temperature	10 degree C
Everyday temperature	28 degree C
Maximum temperature	80 degree C
Wind speed	31.1 m/s
Seismic force	Horizontal 0.12G
Soil bearing capacity	10 ton/m^2 (depend on boring survey)

b) Electrical Conditions

Items	Design Values
Minimum clearance of conductor	-
Phase to ground	1,500 mm
Phase to phase	3,000 mm
Height of conductor (see Note 1)	-
General area (m)	7.5 m
Waterway (m)	7.5 m
Road crossing (m)	8.5 m
Shield angle (OPGW and conductor)	15 degree
Minimum creepage distance of insulator (See Note 2)	25 mm/kV
Equivalent salt deposit density	0.25 mg/cm^2

[Notes]

1. The minimum clearance of conductor shall be designed at conductor temperature of 65 degree C.
2. The minimum creepage distance shall be designed ‘’Pollution Level III Heavy’’ in IEC.

3) 161 kV transmission line equipment plan

161 kV transmission lines will be installed within an exclusive range on the existing 33 kV sub-transmission line route.

a) Supports (towers)

In terms of budget and construction (cranes and other heavy machinery are not necessary due to the small land area), a lattice design will be used for the steel towers.

Steel towers will be built in the location of the existing 33 kV sub-transmission line towers.

Towers will be designed strong enough for multiple aluminum-conductor steel-reinforced (ACSR) cables or a single ACSR cable and single optical ground wire (OPGW) to withstand burnout.

Design safety factor will be 1.1 times for suspended cables and 1.2 times for tensioned cables with the conductors at maximum tension.

Ground resistance values for steel towers will be 10 ohms or less.

The following three types of steel towers will be used:

- Suspension tower (0-2° angles)
- Tension tower (tensioned; 0-20° angles)
- Termination tower (0-20° angles)

b) Overhead lines (conductor cables)

For conductor cables, multiple GRIDCo standard ACSR TERN conductor cables will be used (Aluminum: 402.8 mm^2; total: 430 mm^2). Detailed design quantities and procurement quantities are given in Table 2-2-2-4.11.

Table 2-2-2-4.11 Length of 161 kV Transmission Line

Items	Q'ty
① 161 kV Transmission line distance (Tower N0 – Tower N18)	3,000 m
② Sag (3%) ①x0.03	90 m
③ Design Quantity (①+②) x2 conductor x3 pahses x2 circuits	37,080 m
④ Jumper lines	Including in spare quatity
⑤ Spare quantity (10 %) ③x0.1	3,708 m
⑥ Procurement quntity ③+⑤	40 km

c) Insulators

Insulators equivalent to IEC60383-1 specifications will be used.

d) Overhead ground wires and optical cables

For overhead ground wires, GRIDCo standard OPGW will be used (48-core; model: G655). Detailed design quantities and procurement quantities are given in Table 2-2-2-4.12.

Table 2-2-2-4.12 Length of OPGW Line

Items	Q'ty
① 161 kV Transmission line distance (Tower N0 – Tower N18)	3,000 m
② Sag (3%) ①x0.03	90 m
③ Design Quantity (①+②) x2 conductor	6,180 m
④ Spare quantity (10 %) ③x0.1	618 m
⑤ Procurement quantity ③+④	6.8 km

Shielding angles will be 15 degrees or less, in line with GRIDCo standards.

Optical cable will be spread for the 650 meters from cable dead-end tower N18 to an optical cable distribution frame (ODF) within the control room in the Accra Central BSP to be provided by the Ghana side.

e) 161 kV underground cable

The 161 kV underground cable will be spread for the approximately 580 meters from

cable dead-end tower N18 to the 161 kV gas-insulated switchgear installation within the Accra Central BSP.

This cable will be directly buried at a depth of 1.3 meters. Cable will be protected in conduits for road and railroad crossings.

Table 2-2-2-4.13 Specifications for 161 kV Transmission Line

No.	Items	Specifications	Q'ty
TL1	Tower		
	1) Style of tower	Steel lattice type	
	2) Type of tower	Suspension type (Angle: 0-2 degree)	7 towers
		Tension type (Angle: 0-20 degree)	10 towers
		Termination type (Angle: 0-20 degree)	1 tower
	3) Safety factor	1.1 for suspension towers 1.2 for tension towers	
	4) Grounding resistance	less than 10 ohms	
TL2	Overhead Line (Conductor)		40 km
	1) Type	ACSR	
	2) Size	TERN(Aluminum: 402.8 mm^2, total: 430 mm^2)	
TL3	Insulator		1 lot
	1) Standards	IEC60383-1 or equivalent	
	2) Size	254 mm suspension insulators	
	3) Creepage distance	320 mm	
	4) Material	Porcelain	
	5) Color	Brown	
	6) Ball and socket coupling	16mm	
	7) Dry lightning impulse withstand voltage	110 kV per unit	
	8) Wet power-frequency withstand voltage	40 kV per unit	
	9) Electro-mechanical failing load	120 kN per unit	
	10) Number of insulators	17 units/phase	
TL4	Shield Wire and Optical Cable		6.8 km (OPGW)
	1) Type	OPGW	1.4 km (Optical fiber cable)
	2) Number of Core	48 cores	
	3) Type of optical fiber cable	G655 or equivalent	
TL5	161 kV Underground Cable		3.8 km (0.58 km x 3 phases x 2 circuits x 110 %)
	1) Type	XLPE	
	2) Size	1,600 mm^2	
	3) Conductor	Copper	
	4) Number of Core	Single Core	
	5) Type of sheath	PVC with anti-termite protection	
	6) Color of sheath	Black	
	7) Armor	Aluminum armor for direct buried in the ground	

4) Ghana side work

The main details for the Ghana side work on the 161 kV transmission lines is as follows:

a) Construction of an intermediate tower for 161 kV lines (Tower N0)

b) Connection of conductor cable (multiple ACSR TERN 430 mm^2 cables) to Tower N1

c) Connection of OPGW to Tower N1

d) Connection of optical cable to the ODF within the control room in the Accra Central BSP

e) Construction of a temporary road along the railway for construction vehicles carrying the 161 kV lines

f) Obtaining of permissions from related agencies for 161 kV lines (cables) to cross roads and railways

2-2-3 Overall objectives and Project purpose

The project outline design drawings are given in Appendix-5.

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

As the project will be implemented based on the Japan grant aid cooperative framework, it will be approved by the Japanese Government and commence after an Exchange of Notes (E/N) between the two countries and a Grant Agreement (G/A) between JICA and Ghana are exchanged. Basic policy and special considerations needed if the project is implemented are given below.

(1) Project Implementing Body

The supervisory responsible agency for implementing the project on the Ghana side is the MoP. The project implementing body responsible for O&M after the facilities go into service is GRIDCo. So that the project will progress smoothly, MoP and GRIDCo must appoint project representatives to stay in close contact and negotiate with the Japanese consultant and contractor.

The appointed GRIDCo project representative must explain project details sufficiently to MoP and GRIDCo project staff and project area residents so that they will cooperate with project implementation.

(2) Consultant

Japanese consultants will enter a design and supervision agreement with GRIDCo to procure and install equipment for the project, and produce detailed design and supervise construction work related to the project. Along with drafting tender documents, consultants will handle bidding on behalf of GRIDCo, the project implementing body.

(3) Contractor

In accordance with Japan grant aid framework, independent Japanese contractors selected by Ghana through open bidding will build, procure and install equipment for the project.

Contractors will need to continue supplying spare parts, support for failures, and other services after the project is completed, and as such must give due consideration to a post-delivery communication and coordination for equipment and facilities.

(4) Need for Dispatching Engineers

This project is complex, combining construction of substations with civil engineering, construction and installation of substation facilities within the existing Graphic Road substation, as well as construction work on approximately four kilometers of 161 kV transmission lines. Construction will also require coordination with ECG, which manages the 33 kV distribution facilities which need to be linked. With the majority of the work being done concurrently, it is essential that foremen familiar with the Japanese grant aid system be dispatched from Japan to keep management and site guidance for the whole works consistent in terms of scheduling, quality, finished forms and safety management.

2-2-4-2 Implementation Conditions

(1) Ghana Construction Conditions and Technology Transfers

As explained in Section 2-2-1-4 above, there are multiple general construction and electrical contractors in the Accra and Kumasi areas which can accept orders for laborers, transportation vehicles and construction equipment within Ghana, as well as facility and transmission line construction work for the project. However, dispatching Japanese engineers is essential in terms of schedule management, quality control and safety management. This will help in keeping the project strictly on schedule, as well as because this will be the first use of 161 kV gas-insulated switchgears in Ghana and involve construction work on 161 kV transmission lines in the plant and crowded residential areas.

(2) Using Local Equipment and Materials

While aggregate, cement, rebar and other materials for use in foundation work must be managed for quality and timely delivery, there is much precedent showing that these materials can be procured locally, as well as examples of locally procured material. Thus, in the interest of developing local industries, equipment than can be procured locally is to be used to the extent possible when formulating the construction plan. However, as Ghana relies on imports for the substation facilities and power transmission equipment needed for the project, such equipment will be procured in Japan or another country.

(3) Safety Measures

With Ghana having relatively few safety problems and the project being in an urban area, the area has good access and will be easy to monitor. Still, work after sunset is to be avoided, and sufficient care must be taken to prevent equipment theft and ensure the safety of construction staff.

(4) Tax Exemption

1) Ghana tax exemption procedures

As a rule, Ghana does not refund taxes, but rather uses a total exemption system in which parties apply in advance to receive exemption before paying. The following documentation is to be submitted by the responsible ministry to the Tax Policy Unit (TPU) of the Ministry of Finance (MOF) to perform the exemption procedure.

- Letters from the responsible ministry to the MOF regarding the request for exemption
- Letters from the implementing body to the responsible ministry regarding the application for exemption
- Equipment list (with CIF prices listed)
- Copies of the Exchange of Notes (E/N) and Grant Agreement (G/A)
- Copy of the contractor contract (with JICA authentication)

As tax exemption requires parliamentary approval, the process will require two to three months following submission of the above application. As seen above, the documents required for application may be submitted once the contractor contract is authenticated by JICA. As such, it is preferable that tax exemption be applied for quickly once the contractor contract is authenticated.

2) Interim waiver procedures

As mentioned above, tax exemption is approved by parliament and takes time, making an interim waiver absolutely essential in terms of schedule management. Documentation needed for the interim waiver procedure is as follows. As the bill of lading and packing list are required, waivers must be applied for each shipment.

- Bill of Lading
- Comercial Invoice
- Packing List

Given that the above documents are required for interim waivers, equipment must be delivered as free on board (FOB) at the port of loading so that the documents can be prepared. As such, the implementing body must complete the interim waiver procedure within the short time from loading on the ship until the cargo enters the port of discharge in the recipient country.

While tax exemption is a precondition for grant aid projects, the Ghana government regulates application of exemptions strictly due to worsening government financial conditions. In past grant aid projects in Ghana, contractors have looked for exceptions to temporarily pay the taxes and then accept refunds afterward in order to expedite the slow customs process, but given the exceptional nature of such measures, they require more time.

3) Other tax system procedures

Import and customs duties (10-20% of the CIF price depending on the HS code), consumption taxes (17.5% of the CIF price for imported goods) and other taxes come to approximately 40% of the FOB price. The implementing body must collect and submit the documents needed to properly calculate the tax amount to the Ghana Revenue Authority to confirm the amount of exemption.

Also, as Ghana is a member state of the Economic Community of West African States (ECOWAS), an exemption must also be acquired for taxes on goods imported into ECOWAS in addition to Ghana import duties. Thus, in addition to exemption procedures for Ghana import duties, the implementing body must also apply for ECOWAS duty exemption with the Ministry of Trade and Industry (MOTI).

Note that Ghana has developed an online system called the Ghana Community Net, or GC Net, to simplify the customs process, but feels totaling 0.46% of FOB price must be paid for its use. As exemption is repealed for these fees, they must be paid by the Ghana side.

In addition, this project involves procurement of paint for buildings, insulating oil for transformers and other hazardous materials and will require an environmental permit upon import into Ghana. The implementing body must obtain a product data sheet of the materials in question and other necessary documents from the contractor and handle the permit quickly.

2-2-4-3 Scope of Works

The Japanese side will procure, install, test and adjust the 161 kV substation and 161 kV transmission lines for the project within the existing Graphic Road substation in the Japanese and Ghana construction scopes and perform the necessary civil engineering work. The Ghana side will be responsible for site leveling at the existing Graphic Road substation, removal of the 33 kV sub-transmission lines and laying of 33 kV ground cables. Detailed scopes for the Japanese and Ghana sides are as shown in Table 2-2-4-3.1.

Table 2-2-4-3.1 Work Demarcation for the Project

No.	Item	Work Demarcation		Notes
		Japan	Ghana	
1*	(1) To secure [a lot] /[lots] of land necessary for the implementation of the Project and to clear the [site]/[sites] (New substation and 161 kV Transmission facilities)		○	
	(2) To clear the [site]/[sites]		○	Including the shifting of the temporary markets on the 161 kV transmission line route
2*	To construct the following facilities			
	(1) Control building, TR foundations, GIS foundations, cable pit	○		Reinforced concrete structure
	(2) The gates and fences	○	○	The GIS fire wall is worked by Japanese side
	(3) The parking lot	○		
	(4) The road within the site	○		
	(5) The road outisde the site		○	
3*	Incidental Work for New Substation			
	(1) Electricity			
	a) The distributing power line to the site	○		From TR (roof) to AC panels (2nd floor)
	b) Main power equipment	○		From AC panels (2nd floor) to each distribution panels (each panel)
	c) Lighting equipment	○		
	e) Fire alarm system			
	(2) Water Supply			
	a) The city water distribution main to the site		○	
	b) The supply system within the site	○		receiving and elevated tanks
	(3) Air conditioner a) Room air conditioner work b) Indoor ventilation work	○ ○ ○		
	(4) Drainage			
	a) The city drainage main (for storm sewer and others to the site)		○	
	b) The drainage system (for toilet sewer, common waste, storm drainage and others) within the site	○		Including for installating the water-purifying tank (for 10 persons)
	c) The drainage system for rain drainage within the site	○		Use of the existing rain drainage sytem
	(5) Gas Supply			
	a) The city gas main to the site		○	Not necessary
	b) The gas supply system within the site	○		Not necessary
	(6) Telephone System			
	a) The telephone trunk line to the main distribution frame/panel (MDF) of the building		○	
	b) The MDF and the extension after the frame/panel	○		
	(7) Furniture and Equipment			
	a) General furniture		○	
	b) Project equipment	○		
4*	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products			

No.	Item	Work Demarcation		Notes
		Japan	Ghana	
	(1) Marine (Air) transportation of the Products from Japan to Ghana	○		
	(2) Tax exemption and custom clearance of the Products at the port of disembarkation		○	
	(3) Internal transportation from the port of disembarkation to the project site	○		Already secured at the ECG Project office
5*	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the products and the services be exempted		○	
6*	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		○	
7*	To ensure that the Facilities and the products be maintained and used properly and effectively for the implementation of the Project		○	
8*	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project		○	
9*	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A			
	(1) Advising commission of A/P		○	
	(2) Payment commission		○	
10*	Securing and execution of budget for environmental and social considerations necessary for the project implementation		○	
11	Measures necessary to obtain the following permits: - Permits for installation work - Permits to access to restricted areas		○	Acquired prior to the implementation of the project
12	Securing of site for temporary storage of materials and equipment, and the gates and fences		○	Use of the ECG Project office
13	Securing of parking during the work		○	
14	Office for construction work	○		For Japanese contructor
15	Appropriate storage and safety control for materials and equipment at temporary storage	○		
16	Securing access roads, wayleaves and usage permissions for construction of 161kV transmission lines		○	
17	Transfer of existing underground cables nd pipes, and acquisition of related permits (electricity, telephone, water, sewerage, etc.)		○	If necessary
18	Acquisition of permits for trans-road work		○	If necessary
19	Provision of places to dispose of surplus soil and waste water		○	
20	Manufacturing and procurement of materials and equipment	○		
21	Installation, adjustment and tests of materials and equipment	○		The Ghana side lends maintenance tools included in the set of equipment procured to the Japanese contractor
22	Temporary dead-line work during the work		○	

No.	Item	Work Demarcation		Notes
		Japan	Ghana	
23	Removal Work of the existing 33 kV Distribution Panels at Graphic Road Primary Substation (E)		○	Including the material of the temporary 33kV distribution panels, cable, etc.
24	Installation Work of 161 kV Transmission Towers for connection to 161 kV Lines of the Project (including final connection work : Tower N0 → N1)		○	
25	Removal Work of 33 kV Overhead Line between Avenor Primary Substation (D) and Graphic Road Primary Substation (E)		○	
26	Initial operation guidance and operational guidance for maintenance and management of equipment procured	○		
27	Securing of the safety of persons concerned with the project at the project sites		○	
28	Response to and compensation for users of electricity in relation to outages inevitable for the work		○	
29	Announcement of outage plans to users of electricity during the work		○	

Notes: Items with sigh ○ indicate the country of parties responsible. Asterisk marks on figures are items stated in M/M of the primary survey.

2-2-4-4 Consultant Supervision

According to Japan's grant aid system, consultants are to form a project team consistent with the final design and construction supervision based on the spirit of the basic design and smoothly complete the work. This project requires complex work on the substation facilities and transmission lines, with many connections to the existing substation facilities and monitoring based on on-site coordination with GRIDCo and ECG. As such, the consultant is to station at least one engineer on site to handle overall schedule management, quality control, progress control and safety control during the construction supervision stage. Other engineers will also be dispatched to manage contractor progress with equipment installation, commissioning and adjustments, delivery testing and other work. As necessary, a domestic expert is to witness factory inspections and pre-shipment inspections for equipment manufactured domestically, and also supervise to prevent problems after unloading equipment at the site.

(1) Basic Policy for Construction Management

As basic policy, consultants are to supervise progress such that the work is completed within the given construction period. Along with ensuring equipment is delivered on time up to the quality and finished forms given in the agreement, they are to supervise and advise contractors so that they can perform the work safely at the site. The following are the main points to be kept in mind for construction supervision.

2) Schedule Management

Consultant management staff will compare actual progress against the work schedule planned at time of contract monthly and weekly so that contractors will keep the delivery schedule given in the contract. If they interpret work to be behind schedule, they will warn contractors and request them to submit and implement plans to get back on schedule, and guide contractors so they can complete the work and deliver equipment within the contract construction period. The following items will be compared between work schedule and project progress:

- Work progress - progress of equipment and material manufacturing and site civil engineering and construction
- Equipment and material transport to site – equipment and materials for substation, power transmission equipment, civil engineering and construction
- Temporary works and readiness of construction machinery
- Productivity and actual numbers of engineers, skilled workers, laborers and other workers

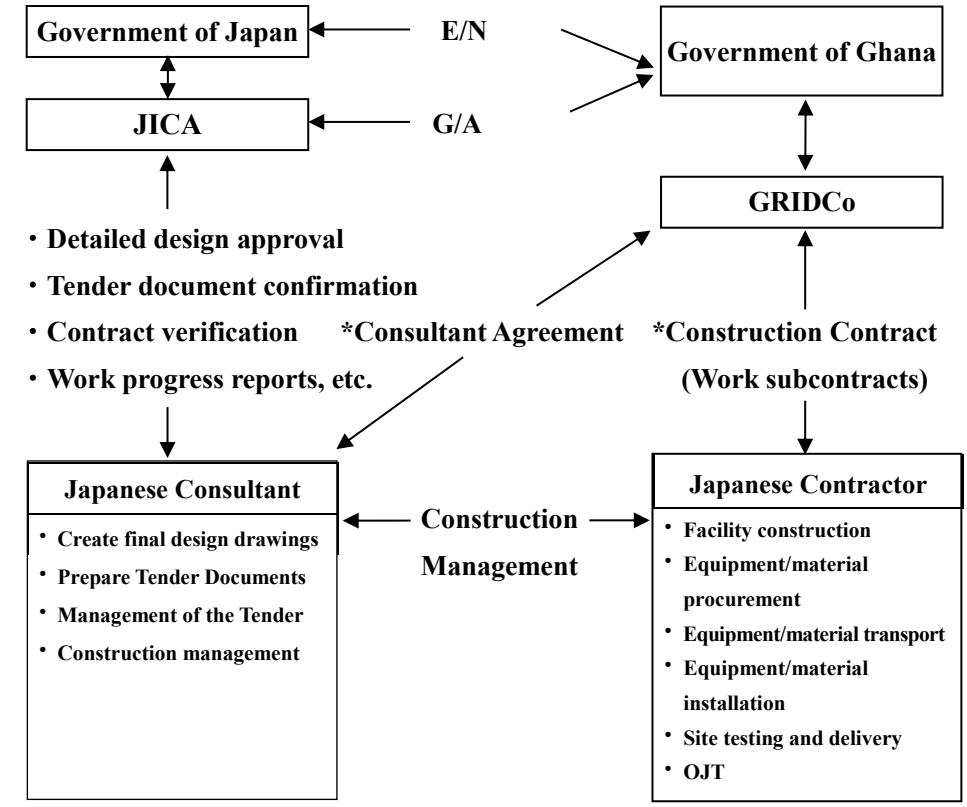
3) Quality and Work Progress Control

Consultant supervisory staff will consult and work together with the contractor's representative, and manage work safely to prevent any occupational accidents on the site during the construction period or accidents involving third parties. The following actions are to be taken in terms of site safety management:

- Establish safety management regulations and select a safety manager
- Prevent disasters through regular inspection of construction machinery
- Decide a service route for transport machinery and other work vehicles, and ensure safe driving
- Strictly insist workers take advantage of worker benefits and take leave

(4) Overall Relationships concerning Project Implementation

Role correlations for the project, including those during construction supervision, are as shown in Figure 2-2-4-4.1.



*JICA shall verify Consultant Agreement and Construction Contract

Figure 2-2-4-4.1 Project Relation Diagram

(5) Construction Managers

The contractor will procure and deliver equipment and materials for new substation construction work on the existing substation grounds and 161 kV transmission line work, as well as the related civil engineering work. Further, they will subcontract local Ghana contractors to perform the work. Accordingly, the contractor is required to ensure subcontractors fully comply with the work schedule, quality, finished form and safety measures given in the work contract. To accomplish this, contractors will deploy engineers with experience in similar overseas work to guide and advise local contractors.

Given the scale and details of the substation facility and transmission line work for this project, contractors will preferably station at least the number of engineers given in Table 2-2-4-4.1.

Table 2-2-4-4.1 Engineers to be dispatched by the Contractor

Title of engineers	Number of engineers	Responsibilities	Dispatch period
Inspector 1	1	Confirmation and verification of shop drawings for Transmission equipment, pre-shipping inspection, equipment test, etc.	Drawing approval period
Inspector 2	1	Confirmation and verification of shop drawings for Substation equipment, pre-shipping inspection, equipment test, etc.	Drawing approval period
Local procurement supervisor 1	1	Supervision of all installation works, coordination with related agency, acquisition of approval, equipment and materials procurement management after customs clearance procedures, labor management, accounting, security management	Throughout the construction and installation period
Local procurement supervisor 2	1	Supervision of equipment material for Transmission/distribution, coordination with related agency, acquisition of approval, labor management, accounting, security management	Transmission line works period
Local procurement supervisor assistant	1	Assistance to the Local procurement supervisor	Throughout the construction and installation period

2-2-4-5 Quality Control Plan

Consultant construction supervisory staff are to supervise and verify that the contractors are maintaining quality, construction and installed forms for equipment procured for the project up to the quality and finished forms given in the contract documents, including technical specifications and detailed design drawings. Staff will request contractors to correct, change or revise the work if quality or finished form is in danger of being compromised.

1) Verify fabrication drawings and specifications for equipment
2) Witness factory inspections for equipment or verify inspections
3) Verify packaging, transportation and temporary placements on site
4) Verify working drawings and installation manual procedures for equipment
5) Verify equipment commissioning, adjustment, testing and inspection reports
6) Supervise site installation of equipment and witness commissioning, adjustments, tests and inspections
7) Verify equipment working drawings, fabrication drawings, and finished forms
8) Verify construction drawings, fabrication drawings, and on-site progress

2-2-4-6 Procurement Plan

As the equipment and materials for the substation facilities to be procured and installed in the project are not manufactured in Ghana, the substation, switchboard and other power distribution facilities for Ghana will be procured from mostly European and Japanese sources. While Indian and Chinese products have recently started being introduced into GRIDCo substation facilities, Japanese and European equipment are more reliable.

Ghana companies such as ECG and GRIDCo, the company who will handle O&M after the project facilities enter service, hold Japanese products in particularly high regard. Japanese substation and power distribution equipment procured in past Japanese grant aid projects is still operating soundly after more than 10 years in service, contributing to this opinion. GRIDCo has also come to rely on the benefits of the high quality and follow-up service of Japanese manufacturers throughout the O&M process. Thus, the implementing body GRIDCo strongly desire Japanese products to be used for key project equipment.

Further, due to land restrictions in this power development project from it being in the Accra area, the project site is within the grounds of the existing Graphic Road primary substation. With large-scale substation facilities being developed in such a small space, the project will involve outdoor installation of gas-insulated switchgears for the 161 kV-class switchgears in efforts to save space. Outdoor installations such as those in this project can reduce the area required for structures to house facilities.

While European manufacturers also have gas-insulated switchgears on the market, European models are generally indoor models. Meanwhile, Japanese manufacturers generally release both outdoor and indoor models, and their technology for outdoor specification models is more mature and superior. In light of this, Japanese outdoor gas-insulated switchgears will be used in this project. Given the above, the suppliers for equipment and materials used in this project are as follows.

(1) Locally Procured Equipment and Materials

Construction equipment/materials: Cement, sand, concrete aggregate, concrete roadblocks, brick, rebar, wood, gasoline, diesel, construction vehicles, cranes, trailers and other temporary work equipment/materials

(2) Equipment and Materials Procured in Japan

1) Substation Facility Equipment and Materials

161/34.5 kVTransformer, 161 kV Gas Insulated Switchgear, Station Service transformer, DC equipment, etc.

2) Transmission Line Equipment and Materials

161 kV Transmission line equipment and materials: insulator, steel materials, etc.

3) Equipment and materials to be procured from Japan or other DAC and ASEAN countries

33 kV switchgear, 161 kV and 33kV cables, etc.

2-2-4-7 Operational Guidance Plan

As basic policy, a trainer from the manufacturer will give guidance on initial operation and O&M methods for the equipment procured in the project before the work is complete as OJT and in accordance with the O&M manuals. To keep this guidance plan progressing smoothly, GRIDCo must appoint a full-time engineer to attend the OJT and keep close contact with Japanese consultants and contractors. The appointed GRIDCo engineer must build up the skill level of staff unable to attend and

work to improve GRIDCo maintenance abilities. Also, specialist manufacturer engineers of moderate skill level are needed for substation facility operations as well as adjustments and testing for transmission line equipment, so local contractors cannot be used. Engineers must be sent from Japan to fulfill these roles and handle quality control, technical guidance and schedule management.

2-2-4-8 Implementation Schedule

Based on the Japan's Grant Aid Scheme, the Project impletation schedule is given in Figure 2-2-4-8.1.

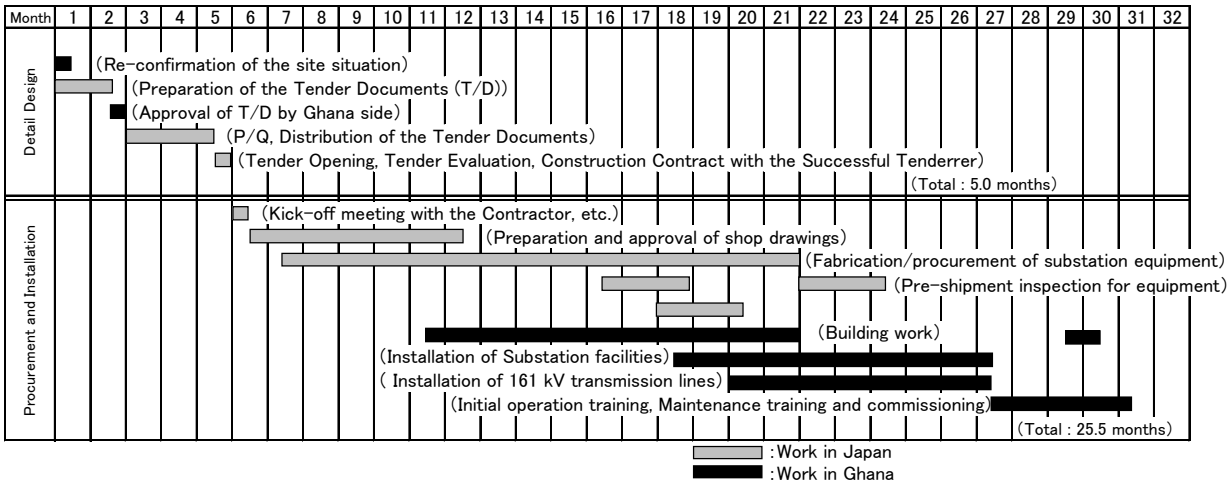


Figure 2-2-4-8.1 Project Implementation Schedule

2-3 Obligations of Recipient Country

Other than the items assigned in Section 2-2-4-3, Ghana is responsible for the following:

Common Items

(1) Providing information and data needed for the project.

(2) Unloading necessary project equipment and materials at Ghanaian port swiftly and handling customs and tax exemption.

(3) Tax exemptions and special arrangements for necessary project equipment and materials and dispatched Japanese workers.

(4) Tax exemptions and measures for procurement of necessary project equipment and materials and business taxes imposed on Japanese corporations and citizens.

(5) Japanese account opening fees and payment fees at authorized foreign exchange bank

(6) All fees needed for project implementation not included in the Japanese grant aid

(7) Appointing a specialist technician to teach O&M techniques for the project, confirming work during the installation period and attending quality inspections.

(8) Proper operation and maintenance of the facilities and equipment built and procured with the Japanese grant aid

(9) Compensating and obtaining consent from residents impacted by enhancement, expansion and construction of substation facilities, 161 kV transmission lines

(10) Inform consumers of planned power outages during work

(11) Environmental monitoring

Preparation Work

(12) Providing for free work offices, equipment/material storehouses and temporary sites

(13) Leveling necessary sites for constructing substations, transmission lines

(14) Removing/relocating waste and unneeded existing structures on sites for new, expanded and enhanced substations

(15) Obtaining wayleave for access road for 161 kV transmission line work

(16) Cutting down trees and crops on the routes for the existing 33 kV transmission lines

(17) Removing unneeded insulation and overhead lines installed on distribution line towers

Ghana Side Work

(18) Removal Work of 33 kV transmission line between Avenor Primary Substation (D) and Graphic Road Primary Substation (E)

(19) Installation Work of 161 kV Transmission Towers for connection to 161 kV Lines of the Project (including final connection work : Tower N0 → N1, etc.)

(20) Removal Work of the existing 33 kV Distribution Panels at Graphic Road Primary Substation (including 33 kV temporary distribution work , etc.)

2-4 Project Operation Plan

2-4-1 Basic Plan

Proper O&M for the transmission and substation facilities, as well as preservation of their surrounding environments, are essential to improving consumer trust in power supply in the project area and steady power supply management. As such, appropriate preventative maintenance is recommended to reduce the rate of facility accidents and improve trust, safety and efficiency levels. The basic concepts for transmission and substation facility maintenance are shown in Table 2-4-1.1. Prevention must be the focus for maintenance of equipment and facilities procured, installed and built for the project.

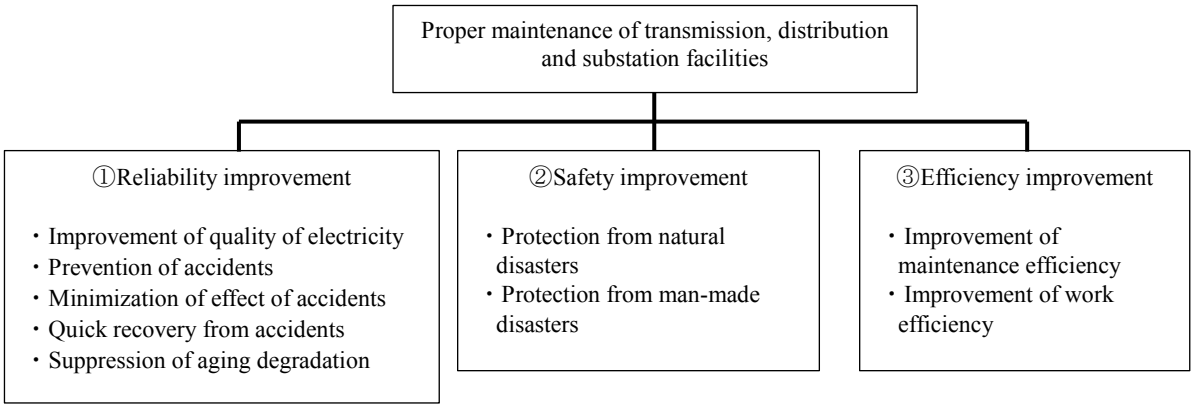


Figure 2-4-1.1 Basic Concepts for Transmission, Distribution and Substation Facility Maintenance

In the project, engineers dispatched by the Japanese contractor are planned to train local engineers in O&M for the substation and transmission facilities during installation and the testing and adjustment periods. The fruits of this OJT can be fully reaped by also having the Japanese side furnish the necessary spare parts, tools for testing and maintenance, and O&M manuals, and establishing an O&M system for after services have started.

Note here that GRIDCo and ECG, who will handle O&M for the facilities provided in the project, possess both personnel with sufficient skill in electrical power and the organizational structure to deploy staff exclusively to the site.

2-4-2 Operation and Maintenance Structure

2-4-2-1 Routine Inspection for Substation Facilities and Periodic Inspection Items

The standard regular inspection items for the substation facilities to be procured and installed in the project are given in Table 2-4-2-1.1. As given in the table, inspections for the above facilities are classed as follows: 1) Daily inspections, which involve a sensory check to detect abnormal heat, sounds and smells from equipment, 2) Normal inspections, which check equipment for loose bolts, surface dirt or damage on insulation and other charging section items not checked on daily inspections, and 3) Detailed inspections, which include functional checks of interlock mechanisms between devices and precision maintenance of instrumentation. Normal inspections will be conducted once

every one to two years, and detailed inspections will be conducted once every four years. Switchboard internal fuses, metering, relays and other components with deteriorating performance, reduced insulation, contact wear or change in qualities should be replaced as appropriate on normal and detailed inspections upon confirming component qualities and frequency of use.

Table 2-4-2-1.1 Inspection Items for Standard Facility Equipment

Inspection Items	Details of Inspection (Method)	Daily	Regular	Detailed
Visual appearance	State of switch indicators and display lights	○	○	
	Abnormal noise and/or smells	○	○	
	Overheat and discoloration of terminal	○	○	
	Cracking, damage or staining of bushings and porcelain tubes	○	○	
	Rust on mounting cases, frame, etc.	○	○	
	Abnormal heat (temperature gauge)	○	○	
	Clamping of bushing terminal (mechanically checked)	○	○	
Operating Devices and Control Panel	Display conditions on measuring instruments	○	○	○
	Indication on operation counters		○	○
	Dampness, rust or staining on operation box or panel		○	○
	Refilling oil, cleaning		○	○
	Clamping of distributing terminals	○	○	○
	Confirmation of switching display status		○	○
	Air or oil leaks		○	○
	Confirmation of pressures (air, etc.) before/after operation		○	○
	Confirmation of operation meter		○	○
	Rust, deformation and/or damage on springs (maintenance)	○	○	○
	Abnormalities of tightening pins		○	○
	Inspection of auxiliary switches and relays (maintenance)		○	○
	Inspection of DC control power source	○		
Measure and Test	Measurement of insulating resistance		○	○
	Measurement of contact resistance			○
	Breakage of heater wires		○	○
	Operation test of relay		○	○

2-4-2-2 Routine Inspection for Transmission Lines and Periodic Inspection Items

In maintaining 161 kV transmission line, the most important services provided to consumers are routine inspection patrols of facilities for accidents, damage and breakage, and immediate repair of detected problem areas. Preventive measures are also needed, such as trimming trees when they are threatening to come in contact with the power lines and cause grounding faults or other problems. Below are the main points which should be checked for during routine patrols:

1) Distribution line severance

2) Insulator damage

3) Contact between lines and trees or other obstructions

4) Tower damage

5) Tilted towers

2-4-3 Spare Parts Purchacing Plan

2-4-3-1 Spare Parts

Parts which wear and deteriorate with daily operations and must be replaced regularly. The following spare parts will be procured for the project, fulfilling quantities needed for one year.

1) 170 kV and 33 kV gas-insulated switchgears

2) 161/34.5 kV transformers

3) Monitoring, control and protection equipment

4) DC power supplies

5) AC distribution boards

6) 161 kV and 33 kV cable terminals

2-4-3-2 Spare parts procurement plan

The Japanese side plans to procure the minimum required standard spare parts for one year for the project. These items are given in 2-4-3-1. Meanwhile, Ghana is responsible for preparing a budget for purchasing necessary replacement parts within one year of project completion.

In the project, the necessary tools for testing and maintenance will be procured for proper O&M of the newly installed substation and transmission facilities. These tools are given in Table 2-4-3-2.1 below.

Table 2-4-3-2.1 Lists for Spare Parts, Testing Equipment and Maintenance Tools

Spare Parts List for GRIDCo

No.	Name of Spare Parts	Q'ty
1.	170 kV Gas Insulated Switchgear	
(1)	Closing coil for CB	1
(2)	Trip coil for CB	1
(3)	Closing contactor for DS & ES	1
(4)	Opening contactor for DS & ES	1
(5)	Interlock coil for DS & ES	1
(6)	Space heater element	6
(7)	SF6 gas and storage cylinder	3
2.	161/34.5 kV, 125 MVA Transformer	
(1)	161 kV Bushing	1
(2)	34.5 kV Bushing	1
(3)	Buchholz relay	1
(4)	Oil thermometer	1
(5)	Oil level gauge	1

No.	Name of Spare Parts	Q'ty
(6)	MCCB (each type)	1
(7)	Auxiliary relay (each type)	1
(8)	Fuse (each type)	100%
(9)	Lamp (each type)	100%
(10)	LED lamp (each type, with socket)	10%
3.	Control and Protection	
(1)	Meter (each type)	1
(2)	Switch (each type)	1
(3)	Lamp (each type)	100%
(4)	LED lamp (each type, with socket)	10%
(5)	MCCB (each type)	1
(6)	Auxiliary relay (each type)	3
(7)	Magnetic contactor (each type)	1
4.	Transformer voltage regulation control	
(1)	Transformer voltage regulator	1
(2)	MCCB (each type)	1
(3)	Meter (each type)	1
(4)	Lamp (each type)	100%
(5)	LED lamp (each type、with socket)	10%
(6)	Fuse (each type)	1
5.	161/34.5 kV Transformer protection	
(1)	Protection relay (each type)	1
(2)	MCCB (each type)	1
(3)	Lamp (each type)	100%
(4)	LED lamp (each type、with socket)	10%
(5)	Fuse (each type)	1
6.	161 kV Transmission line protection	
(1)	Protection relay (each type)	1
(2)	MCCB (each type)	1
(3)	Lamp (each type)	100%
(4)	LED lamp (each type、with socket)	10%
(5)	Fuse (each type)	1
7.	161 kV Bus protection	
(1)	Protection relay (each type)	1
(2)	MCCB (each type)	1
(3)	Lamp (each type)	100%
(4)	LED lamp (each type、with socket)	10%
(5)	Fuse (each type)	1
8.	DC Power supply	
(1)	MCCB (each type)	1

No.	Name of Spare Parts	Q'ty
(2)	Meter (each type)	1
(3)	Lamp (each type)	100%
(4)	LED lamp (each type、with socket)	10%
(5)	Fuse (each type)	1
9.	AC Distribution panel	
(1)	MCCB (each type)	1
(2)	Meter (each type)	1
(3)	Lamp (each type)	100%
(4)	LED lamp (each type、with socket)	10%
(5)	Fuse (each type)	1
10.	161 kV XLPE Cable	
(1)	Cable termination kit for 161 kV XLPE cable for outdoor (each type, 3 phases)	1
(2)	Cable termination kit for 161 kV XLPE cable for indoor (each type, 3 phases)	1

Spare Parts List for ECG

No.	Name of Spare Parts	Q'ty
1.	33 kV Switchgear	
(1)	Lamp (each type)	100%
(2)	LED lamp (each type, with socket)	10%
(3)	MCCB (each type)	1
(4)	Protection relay (each type)	1
(5)	Auxiliary relay (each type)	3
(6)	Magnetic contactor (each type)	1
(7)	Trip coil (each type)	1
(8)	Closing coil (each type)	1
(9)	Space heater element	1
(10)	Meter (each type)	1
(11)	Switch (each type)	1
2.	DC Power supply	
(1)	MCCB (each type)	1
(2)	Meter (each type)	1
(3)	Lamp (each type)	100%
(4)	LED lamp (each type、with socket)	10%
(5)	Fuse (each type)	1
3.	33 kV XLPE Cable	
(1)	Cable termination kit for 33 kV XLPE cable for outdoor (each type, 3 phases)	1
(2)	Cable termination kit for 33 kV XLPE cable for indoor (each type, 3 phases)	1

Testing Equipment and Maintenance Tools

No.	Equipment	Unit	Q'ty
(1)	Oil purifier with tank	set	1
(2)	Transformer oil withstand voltage tester	set	1
(3)	Testing equipment for Protective relays	set	1
(4)	Gas handling unit for GIS	set	1

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

(1) Costs to be borne by the Ghana side

2,057,486 US$ (approximately 212.8 million yen)

Ghana itemized details and their amounts are as given below:

1) RAP Compensation: 554,315 US$ (57,343,000 JPY)

2) Expenses for Environment Permit: 8,670 US$ (896,000 JPY)

3) Expenses for Accra Central BSP: 113,228 US$ (11,713,000 JPY)

(Leveling the land, Removing the un-used equipment, Construction of fences and gates, etc.)

4) Installation Work of 161 kV Transmission Towers for connection to 161 kV Lines of the Project: 100,000 US$ (10,345,000 JPY)
(including final connection work : Tower N0 → N1)

5) Removal Work of 33 kV Overhead Line between Avenor Primary Substation (D) and Graphic Road Primary Substation (E): 86,670 US$ (8,966,000 JPY)

6) Removal Work of the existing 33 kV Distribution Panels at Graphic Road Primary Substation (E):
1,517 US$ (156,000 JPY)

7) Procurement of 6units of Energy meter 6,042 US$ (625,000 JPY)
(GRIDCo:3units, ECG:3units)

8) Procurement and Installation of equipment related to SCADA system at Accra Central BSP (RTU, Multiplexer, ODF) including final connection work
1,000,000 US$ (103,450,000 JPY)

9) Contingency (10 % : Payment of bank commission based on banking, etc.):
・Commission of the Authorization to Pay (A/P)
・Payment commission
187,044 US$ (19,349,400 JPY)

(2) Estimation criteria

1) Time of estimation: February 2014

2) Exchange rate: 1 US$ = 103.45 JPY (TTS average from November 2013 to January 2014)

3) Construction/procurement period: Periods for detailed design, equipment procurement and installation are as shown in the construction schedule.

4) Other: This project is implemented according to the Japan's Grant Aid Scheme.

2-5-2 Operation and Maintenance Cost

The GRIDCo and ECG operate and maintain existing substations, transmission lines and distribution lines in the Project area. These companies shall also operate and maintain the new substations along with the reinforced and new transmission and distribution lines in the Project after they are provided. New substation shall be unmanned, also not needing any new appointments. The GRIDCo shall support new transmission lines outside the substations under present conditions.

Also note that the replacement parts and consumables given in Table 2-4-3-2.1 must be stocked at all times in order to properly operate the substations built or updated in the Project. This shall require regional offices to budget roughly 0.4 million US dollars (1% of equipment costs) if needed. With GRIDCo repair and maintenance costs of 4.3 million US dollars in 2012, O&M costs for new and updated substations in the Project should stay within the budget.

Chapter 3 Project Evaluation

3-1 Preconditions

Preconditions for the project will include acquiring the substation site, compensating parties for the land occupied by sub-transmission lines and obtaining the EP for implementation of the project. As the Ghana side is progressing with the necessary procedures and has experience with past similar Japanese grant aid work for distribution facilities, there are no special issues. An overview of the preconditions follows below.

1) The 161/34.5 kV transformers are scheduled to be constructed on unused public lands. The Ghana side must acquire usage permits from the public agencies owning the scheduled construction sites.

2) The Ghana side must obtain permits from the urban planning offices of each city and land owners for sections to be used bordering military-owned land and in the road reserve along the route planned for the 161 kV transmission lines.

3) The Ghana side must obtain permits from ECG for sections in the project route for the 161 kV transmission lines resting on the ECG wayleave for their existing 33 kV sub-transmission lines.

The Ghana side must register the project with the Ghanaian EPA and perform the required Preliminary Environmental Report and other procedures to obtain an EP.

3-2 Necessary Inputs by the Recipient Country

1) Before work commencement

- Before the Japanese side work commences, the implementing body must first complete its upgrade of transmission lines to allow power supply to the project facilities between the Achimota and Mallam BSPs. This project is already in the bidding phase. Also, the connection towers for project equipment must be put in place in the above work. As another part of this work, the implementing body must also install a connection tower (Tower N0 in the project) for connecting the 161 kV transmission lines of this project.

- The implementing and cooperating bodies must plan and implement the necessary planned outages for the project as needed. These parties must also handle the various procedures associated with the planned outages, as well as take responsibility for notifying, compensating and dealing with claims from consumers.

- First, the implementing and cooperating bodies must put temporary measures in place and remove 6 of the 14 existing 33 kV switchgears, starting from the west end in the electrical room of the existing Graphic Road primary substation, at their own expense. The Japanese side will then start installation of the first 15 of the new 33 kV switchgears, with 28 switchgears to be installed in total.

The implementing and cooperating bodies must keep the temporary measures in place and be able to operate on the remaining eight 33 kV switchgears until the Japanese side completes installation of the first 15 new switchgears.

In similar fashion, the implementing and cooperating bodies must then remove the remaining eight switchgears and continue operation on the 15 new switchgears outfitted by the Japanese side until the Japanese side finishes the remaining 13 new 33 kV switchgears.

Further, along with the above removal of the existing 33 kV switchgears, the implementing and cooperating bodies must also establish floor openings for the new 33 kV switchgears as provided by the Japanese side, accounting for the structure of the existing switchgear housing.

As soon as specifications of the equipment to be delivered becomes clear during the project implementation stage, the parties are to review the dimensions for the openings and this procedure in detail.

- Before the Japanese side work, the implementing and cooperating bodies must remove any cable culverts, ring main units, 33 kV capacitors or other existing equipment for the Graphic Road primary substation transformers which could impede Japanese side work where the project equipment is to be installed.
- At their own expense, the implementing and cooperating bodies must remove the existing 33 kV sub-transmission lines (including tower bases) between the Avenor and Graphic Road primary substations before the Japanese side starts work on the 161 kV transmission lines.
- The implementing and cooperating bodies are to apply to the relevant agencies and obtain permission for burying all transmission, sub-transmission and distribution lines across roads and railways before the Japanese side work.
- The implementing and cooperating bodies must procure a total of six commercial electricity meters (three each for GRIDCo and ECG) and supply them to the Japanese side.
- As necessary, the implementing body must smoothly resettle residents according to the resettlement plan.

2) During the construction period

- The implementing and cooperating bodies must secure a temporary storage yard for project equipment and materials within the ECG project office grounds of approximately 5,000 square meters. They must additionally develop an access road for construction vehicles along the lines from the temporary storage yard to the planned project route for 161 kV transmission lines.
- The implementing and cooperating bodies must obtain entry into the office located in the planned site for 161 kV transmission line towers (owned by the implementing and cooperating bodies), as well as construction permits for the site, from the office authorities.

- The implementing body must monitor how the work is impacting residents and adjust work activity as necessary to make improvements.

3) After work completion and start of service

- Using final connecting materials provided by the Japanese side, the implementing body must at their own expense perform the connections between the connecting tower procured and installed as part of the 161 kV transmission line upgrading work between the Achimota and Mallam BSPs (Tower N0 in the project) and the last tower procured and installed by the Japanese side (Tower N1 in the project).
- The implementing body must procure their own equipment and materials to make the final connections between the SCADA connection board installed by the Japanese side and the existing SCADA communication network in the Accra Central BSP.
- The implementing body must procure their own materials and equipment and make the final connections for the fiber optical cables in the ODF installed in the final tower procured and installed by the Japanese side (Tower N1 in the project).
- The implementing and cooperating bodies must perform the work on fencing, entrances and gates at the site borders for the Graphic Road primary substation accounting for the layout of the project facilities at their own expense.
- The implementing and cooperating bodies must commission, adjust and start operation of protective relays for the transmission feeder for the 28 installed 33 kV switchgears and 33/11 kV transformer feeders for the project at their own expense. (The Japanese side will handle unit testing work.)

3-3 Important Assumptions

The external conditions assumed for the project to achieve and sustain its results are as follows:

1) For overall goal

- National policy on regional electrification does not change.
- The government and economy remain stable.

2) For project objectives

- O&M is performed on a continuous basis.
- Fees are continuously collected, and government support continues.
- Facility security is maintained.

3) For expected outcomes

- Power generation facilities produce sufficient power.
- The O&M plan is implemented.
- Residents (or the government) can cover the connection fees and electricity charges.

3-4 Project Evaluation

3-4-1 Relevance

As shown below, relevance for this cooperation project is judged to be high as it helps to achieve Ghanaian national energy and power policies and benefits the public facilities and poor residents in a target area.

(1) Urgency

Power will be developed mainly as follows:

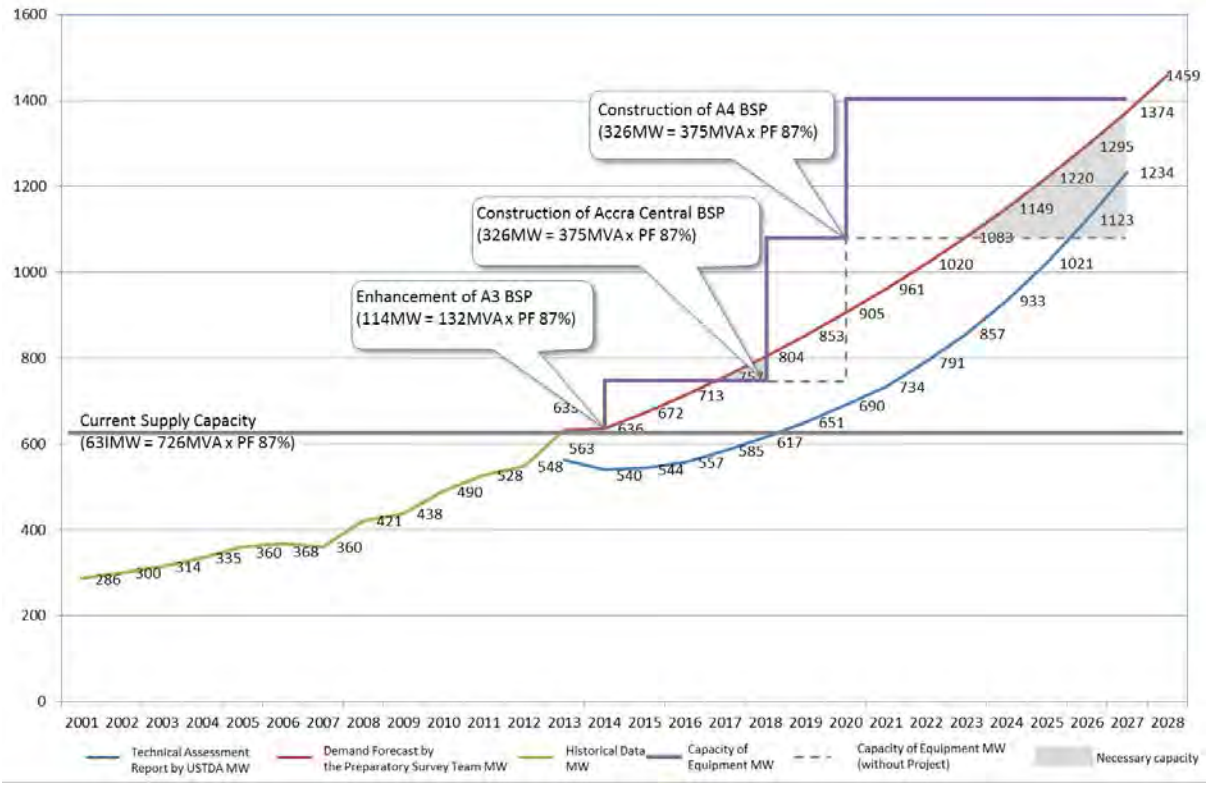
1) Capacity to supply power demand maintained
2) Supply reliability (reducing power downtime, etc.) improved by ensuring reserve supply capacity
3) Power quality improved by improving power system structure, etc.

Of the above points, 1) is the most urgent as it is an underlying factor in stable power supply.

As shown in Section 2-2-2-1 “Prerequisites of the Project”, the distribution facilities for Accra area BSPs are currently in a difficult state of affairs. The facilities cannot supply power alone due to insufficient capacity and are funneling power from the Winneba BSP almost 40 kilometers away using 33 kV sub-transmission lines at high rates of transmission loss.

As such, before securing supply capacity for future increases in demand, 1) above is an urgent need due to the lack of capacity to supply current power demands.

The power plan for the Accra area as confirmed and clarified in the preparatory study is given in Figure 3-4-1.1. As shown in this figure, urgency for the project is deemed very high. If the Accra Central BSP in the project does not become operational in 2018 as planned, Accra area power demands from 2017, a full three years before the target year for evaluation of this project in 2021, will not be met with only the GRIDCo enhancement projects currently underway for the A3 BSP. Note that as bidding and construction for the project will take approximately 31 months, the BSP will go into operation in 2018 if the E/N is signed in 2015.



【Source】Prepared by preparatory study team based on info from GRIDCo

Figure 3-4-1.1 Power plan for the Accra area

As also mentioned in Section 2-2-2-1 "Prerequisites of the Project", the target year for facility planning will be ten years following the start of service. This project must avoid equipment being replaced before the facilities reach their service life once in service, and the ten year figure is consistent with other similar grant aid projects. As shown in Figure 3-4-1.1, implementation of the project is not only urgent, but also absolutely essential in the medium- to long-term. Unless this project is implemented, along with the enhancement projects for the A4 BSP that GRIDCo is attempting to finance and aims to have operational in 2020, distribution facilities are estimated to be far short on the capacity needed to meet power demands in the target year for the facility plan.

(2) Number of Beneficiaries

Electric power is absolutely essential as energy for the self-reliant, sustainable socioeconomic growth of a nation. Particularly in capital areas, which hold government agencies and head offices of the companies which support the national economy, power development projects are one of the most important of economic infrastructure development in helping to establish a secure, efficient power distribution network.

This project is a power distribution enhancement project for the Accra area in the Republic of Ghana, which has had serious problems with power system supply since oil production in the country started in 2010. Enhancing the insufficient supply capacity of the power distribution facilities will be extremely beneficial and is the ultimate solution to economic losses in terms of opportunity costs from the supply issues.

As confirmed by Figure 3-4-1.1, the Accra Central BSP from this project is urgent to the power plan and essential in terms of securing the capacity to supply power to the Accra area. In the Accra area power plan shown in the figure, the A4 BSP is forecasted to start service in 2020. In the same year just before the A4 BSP goes online, power demand will reach an 84% equipment load factor at 905 MW out of a supply capacity of 1,072 MW (1,233 MVA at 87% power factor) for distribution facilities. With the current aging state of Accra power distribution facilities, it seems more appropriate to say that facilities are in waiting for now normalized equipment failures than to say that there is an adequate reserve supply capacity in case of a supply emergency.

In the target year for the facilities plan of 2028, power demand will reach a 105% equipment load factor at 1,459 MW out of a supply capacity of 1,388 MW (1,608 MVA at 87% power factor). Therefore, another 161/33 kV transformer shall be required for stable power supply.

As expressed above, whether looking at the target year for project evaluation or facility planning, it is hard to say that Accra area power distribution facilities maintain a sufficient reserve power supply. Rather, they have facilities on stand-by, waiting for regular operating facilities to fail or normalized equipment failures. This means that distribution facilities for Accra area BSPs will make a constant and direct contribution to the power supply of the Accra area. The ratio of Accra Central BSP facility capacity (375 MVA) to overall distribution facility capacity in the Accra area is given in Table 3-4-1.1.

Table 3-4-1.1 Ratio of Accra Central BSP facility capacity to overall Accra area capacity

Target Year		Accra area	Accra Central BSP	Capacity ratio	Remark
Project Evaluation	3 years from start of service (2021)	1,233 MVA	375 MVA	Approx.30%	When A4 BSP is behind schedule
Facility Plan	10 years from start of service (2028)	1,608 MVA	375 MVA	Approx.23%	

【Source】 Prepared by preparatory study team based on info from GRIDCo

As shown in Table 3-4-1.1, the Accra Central BSP to be developed in this project is confirmed to contribute approximately 30% of the electrical energy supply forming the basis of government agencies, hospitals, schools and other facilities providing public services; the poor and other residents; and socioeconomic activity from companies supporting the national economy as of the target year for project evaluation in 2020. Accra area population (including numbers of those living on less than $1.25 per day), public facilities and socioeconomic status are given in Table 3-4-1.2. The power distribution facilities to be developed in this project are estimated to directly benefit approximately 30% of Accra area socioeconomic activity, which is very high in terms of cost-benefit ratio for the amount of aid.

Table 3-4-1.2 Socioeconomic status in the Accra area

	Items	Q'ty
Population	Total population	Approx. 1,840,000
	Less than 1.25US$ (income)	Approx. 552,000 (30%)
Household	General	165,828 (16%)
	Commercial	127,480 (12.3%)
	Industry	653,986 (63.1%)
	Government faiclities	89,132 (8.6%)
Medical facilities	Hospital	28
	Health center	130
	Others	60
Educational facilities	Primary	246
	Secondary	95
	University	45

【Source】Ghana Statistical Service

(3) Operation and Maintenance Capabilities

Despite its struggles with large-scale capital investments such as the current project, GRIDCo does have a certain level of technical capacity in system operations and has steadily handled O&M for the national power transmission network.

This project includes gas-insulated switchgears and other equipment being introduced into Ghana for the first time. Such equipment may differ from traditional switchgears and equipment in internal structure, but as far as operation methods, system protection functionality and other O&M issues, the required skills do not greatly exceed the technical levels for equipment ever used in Ghana.

Therefore, manufacturer technicians will be used for O&M technology transfers, offering guidance on initial and standard operation based on the characteristics, features and specifications of the equipment. Assuming that the technology transfer of differing operation methods for each delivering manufacturer goes smoothly, there should be no issues in terms of O&M capabilities on the Ghana side for the delivered equipment.

In addition, given the extreme rise in power demands since oil production started in 2010 and the resulting spatial limitations, gas-insulated switchgears are expected to be introduced to save space in not just the Accra area of the project but also regional cities. The introduction of gas-insulated switchgears and associated technology transfers in this project will serve to make effective use of Japanese technical strength and to help improve the technical strength of Ghana for the future.

(4) Project to Contribute to the Development Plan of Ghana

GRIDCo formulated a Transmission Master Plan in February 2011 with a target year of 2020, which was then reviewed in December 2012 with support from the USTDA. As explained in Section 2-2-2-1 "Prerequisites of the Project", however, these upper level plans are made targeting Ghana on the national level. Development projects such as this one for development in

the Accra area and other regions must reconfirm the facility structure, facility capacities, demand distributions and other regional details and break the upper level plans down while adapting them to local features.

In light of this, Figure 3-4-1.1 gives the power plan for Accra area distribution facilities as determined in the preparatory study. As given in Table 3-4-1.1, The Accra Central BSP in this project, with its capacity of 375 MVA, is deemed to greatly contribute to achieving the upper level plan. This is estimated to contribute approximately 30% of the overall distribution facility capacity in the Accra area in the target year for project evaluation in 2021 and about 23% in the target year for the facility plan in 2028.

(5) Scheme of Japan's Grant Aid

As shown in the Country Assistance Policy for Ghana, "Economic Infrastructure Development" such as this project is said to help by "taking full advantage of Japanese technical capabilities".

The key component in this project is to build the largest BSP in Ghana on the small grounds of an existing primary substation in the Accra area. Thus, given the spatial restrictions and in order to reduce noise emissions, advanced technology such as outdoor gas-insulated switchgears and high-capacity forced oil, air-cooled transformers sealed in metal cases will be essential. Given that the facilities will be required to supply stable power, European and Japanese manufacturers are being considered for key equipment in the gas-insulated switchgears and transformers.

For gas-insulated switchgears, most European manufacturers use indoor models as their standard, whereas Japanese manufacturers normally release both indoor and outdoor models and have a longer delivery record for outdoor models with established, verified technology. Meanwhile for transformers, given the characteristics of Japan as an island nation, there are many installations of high-capacity forced oil, air-cooled transformers in sealed metal cases both in Tokyo and other cities. These transformer installations are high quality, helping to save space and reduce noise.

As shown here, the relevance of this project is deemed to be high as a Japanese grant aid project. It contributes to the stable supply of electricity to the Accra area, which supports the social economy of the Republic of Ghana, and it also utilizes the superior technical strengths of Japan.

3-4-2 Effectiveness

The impacts expected from the implementation of the Project are as follows.

(1) Quantitative Impacts

Table 3-4-2.1 Quantitative Impacts

Outcome indicator	Base value (2013) (Current value)	Target value (2021) (3 years after the completion of the Project)	Reference Value (2021) Without the Project
1. Facility capacity of 161/34.5 kV Transformers (MVA) *	726	1,608	1,233
2. Transmission and distribution loss (MW) *	30	49	70
3. CO_2 reduction (ton)*	-	Approx. 72,800	-

[Note]*: Only Accra area

(2) Qualitative Impacts (Whole Project)

The following table shows impacts of each component of the Project.

Table 3-4-2.2 Qualitative Impacts (Whole Project)

Present Status and Problems	Project Countermeasures (Grant Aid Project)	Extent of Project Effects and Improvement
1. With frequent power outage and voltage drop caused by aging equipment for transmission, distribution and substation system and overload operation, Accra area has the following issues. 1) Industrial and economic development is hindered. 2) Operation of public welfare facilities, especially healthcare facilities, is affected.	Procurement and installation of the following equipment: **1. 161/34.5 kV Substation equipment** • 375 MVA＝125 MVA×3 banks **2. 161 kV Transmission equipment** • 161 kV overhead line (Approx. 3.0 km) and 161 kV steel towers (18) • 161 kV underground cable (Approx. 0.4 km)	Stable power supply will revitalize the industries and economic activities in Accra and improve stable operation of public welfare facilities and healthcare services as well as the living environment of local residents. As the population of Accra is 1.84 million, the indirect impact will be significant.
2. In Ghana, there are frequent power interruptions and power loss caused by the deterioration and overload of the transmission and distribution facilities.	Same as the above	The project reduces dependency on Achimota BSP and Mallam BSP which are next to Accra Central BSP on power supply. Also, the project alleviates the risk of unstable power supply and power loss.
3. Ghana has serious problems such as unstable power supply and power shortages in Accra area and other cities, which interferes with economic activity. Also, the BSP is not easy to construct	A Gas Insulated Switchgear is introduced.	Introduction of Gas Insulated Switchgear enables to minimize the installation space and to construct a compact-type BSP.

Present Status and Problems	Project Countermeasures (Grant Aid Project)	Extent of Project Effects and Improvement
due to the land limitations.		

(3) Calculation of the Reduction Amount of CO_2 Emission by the Project

1) Effect of Power Loss on CO_2 Reduction

The reduction amount of CO_2 emission attributable to a power loss as a result of the Project is calculated in the following manner using the emission factors listed in Table 3-4-2.3.

① Calculation of the reduced amount of power loss (GWh/year)

② Reduction of power loss (GWh/year) x 3,600 (GJ/GWh) ÷thermal efficiency of power generating system (0.45) = reduction of calorific value (GJ/year)

③ Reduced calorific value (GJ/year) x emission constant x 44/12 = reduction amount of CO_2 emission

Table 3-4-2.3 Emission Factor by Type of Fuel

Type of Fuel	Unit Calorific Value	Emission Factor
Coal	25.7 GJ/t	0.0247 tC/GJ
Gas Oil	37.7 GJ/kl	0.0187 tC/GJ
Bunker A Oil	39.1 GJ/kl	0.0189 tC/GJ
Natural Gas	54.6 GJ/t	0.0135 tC/GJ

【Source】Ministry of the Environment and METI, "Manual for Calculation of GHG Emission Amount and Reporting (Ver.3.4)", May, 2013

Assuming improvement of the power loss by 21 MW (=70-49) through the implementation of the Project, the CO_2 reduction calculation result based on the actual load in 2013 is 72,800 ton.