

Rwanda Energy Group (REG)
Ministry of Infrastructure
The Republic of Rwanda

**PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR
IMPROVEMENT OF SUBSTATIONS
AND
DISTRIBUTION NETWORK PHASE 2
IN
THE REPUBLIC OF RWANDA**

MARCH 2016

**JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)**

YACHIYO ENGINEERING CO., LTD.

IL
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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to Yachiyo Engineering Co., Ltd..

The survey team held a series of discussions with the officials concerned of the Government of Rwanda, 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.

March, 2016

Yoshinobu IKURA

Director General,

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Japan International Cooperation Agency

SUMMARY

1. Overview of the Country

The Republic of Rwanda (hereinafter referred to as “Rwanda”) is located in central Africa between 1° - 3° south latitude, and 29° - 31° east longitude, and is bordered by Tanzania to the east, the Democratic Republic of the Congo to the west, the Republic of Uganda to the north, and Burundi to the south. The population of Rwanda is about 12.1 million (2014). Its territory is approximately 26,300 km² (about 0.07 times of the area of Japan) and almost completely flat land more than 1,500 meters above sea level. Its climate is subtropical throughout the year with an annual average temperature of about 16°C to 28°C. The rainy season extends from February to May and from September to December, and its maximum monthly rainfall reaches less than 324 mm.

However, economy of Rwanda is dependent on the primary industry, as its main exporting materials are coffee and mineral resources. Rwanda is exposed to fluctuation of their international market prices.

2. Background of the Project

Under these circumstances, Rwanda is planning to increase the installed capacity and diversity energy resources by utilizing indigenous resources in accordance with the “National Energy Policy and Strategy”, “Economic Development and Poverty Reduction Strategy”, “Electric Development Strategy”, etc. Nevertheless, more policies and strategies are insufficient to achieve the targeted increased and diversified electrical energy sector unless such policies and strategies are accompanied by a well prepared concrete Electricity Master Plan that takes into consideration an effective and efficient energy mix.

The distribution network in Kigali city was mainly established in the 1980s and it does not cover all the metropolitan area. Besides the civil war and insufficient maintenance has deteriorated existing facilities and it has led to the high distribution loss rate and show accident restoration in the network. To meet the increasing demand for electricity in Kigali City, the distribution network is needed to be upgraded and expanded.

Based on the background, the Government of Rwanda (GOR) has requested the Government of Japan (GOJ) on the Project for Improvement of Substations and Distribution Network Phase 2.

3. Outline of the study findings and Project contents

In response to the request, JICA dispatched the Survey Team to Rwanda from March 7 to April 17, 2015 (first field survey) in order to reconfirm the contents of the request and discuss the contents for implementation with related agencies on the Rwanda side (responsible government agency: Ministry of Infrastructure (MoI), and implementing agency: REG), 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. Also, JICA dispatched the Survey Team to Rwanda for the second field survey (outline explanations) from November 7 to November 14, 2015 in order to explain and discuss the draft preparatory survey report and reach a basic agreement with the Rwandan 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	Capacity
A. Procurement and Installation Work	
1. Ndera substation (1) 20 MVA 110/15 kV transformers (2) 110 kV switchgear (3) 15kV switchgear (4) Control and supervisory facilities	2 units 1 set 1 set 1 set
2. Transmission Line (1) Two circuits of 110 kV transmission lines from the existing line between Birembo and Gasogi substations to Ndera Substation	Approx. 2.2 km
3. Distribution Line 3.1 (Route 1) One circuit of 15 kV distribution line from existing Gasogi Substation to Kabuga Ring Main Unit (RMU) Switching Station (1) 15 kV Overhead line (ACSR, Single conductor) 3.2 (Route 2) Two circuits of 15 kV distribution lines from Ndera Substation to existing line between Birembo and Free Zone Phase 1 substations (1) 15 kV Overhead line (ACSR, Single conductor) 3.3 (Route 3) Re-routing for one circuit of 15 kV distribution line nearby Ndera Substation (1) 15 kV Overhead line (ACSR, Single conductor)	Approx. 6.5 km Approx. 650 m Approx. 400 m
4. Modification of existing Gasogi Substation (1) 15 kV switchgear panel for outgoing feeder to Kabuga RMU Switching Station	1 set
5. RMU Switching Stations 5.1 Kabuga RMU Switching Stations (1) RMU facilities 5.2 Murindi RMU Switching Stations (1) RMU facilities (2) First Tower (Tension Tower)	1 set 1 set 1 tower
B. Procurement Work	
6. Maintenance Tools for the Equipment of the Project	1 lot
7. Spare Parts for the Equipment of the Project	1 lot
C. Construction Work	
8. Foundation for the Equipment of the Project (Transformers, Towers for 110 kV Transmission Line, etc.)	1 lot
9. Building of the Project (Ndera substation, Kabuga and Murindi RMU Switching Stations)	3 buildings

4. Project implementation schedule and cost estimation

(1) Cost Estuation

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 Rwanda side will be 2,350,000 US\$ (approximately 282.4 million yen). The contents and costs to be borne by the Rwanda side are as given below:

- | | |
|---|----------------------------------|
| (1) RAP Compensation: | 262,000 US\$ (31,500,000 JPY) |
| (2) Expenses for land acquisition and levelling work of Ndera substation and RMUs: | 1,003,000 US\$ (120,500,000 JPY) |
| (3) Expenses for communication facilities for Murindi RMU switching substation: | 270,000 US\$ (32,000,000 JPY) |
| (4) Removal Work of 15 kV Overhead Line around Ndera substation: | 3,000 US\$ (400,000 JPY) |
| (5) Expenses for stockyard: | 40,000 US\$ (4,800,000 JPY) |
| (6) Procurement and Installation of equipment related to SCADA system at Ndera substation | 550,000 US\$ (66,100,000 JPY) |
| (7) Contingency (10 % : Payment of bank commission based on banking, etc.): | 222,000 US\$ (26,600,000 JPY) |

(2) Project Implementation Schedule

The implementation schedule for the Project including the detailed design will be approximately 24 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 Rwanda and impart benefits for the general public of Rwanda.

2) Efficiency

a) Quantitative effects

Outcome indicator	Base value (2015) (Current value)	Reference Value (2021) Without the Project	Target value (2021) (3 years after the completion of the Project)
1. Facility capacity of 110 kV Transformers (MVA) *	105	195	235
2. Transformer load factor in Gikondo substation (%)	59	63 ~ 90	53 ~ 76
3. Power loss *	0.72 % (467 kW)	2.06 % (3,937 kW)	1.72 % (3,225 kW)

[Note]*: Only Kigali area

b) Qualitative effects

Present Status and Problems	Project Countermeasures (Grant Aid Project)	Extent of Project Effects and Improvement
1. According to formulation of SEZ in Rwanda, the power demand in Ndera area has been rapidly increasing, but the present capacity of power transformer is not sufficient and aging. It is a major cause of the unstable power supply and transmission and distribution network loss.	Procurement and installation of the following equipment: 1. 110 kV Substation equipment <ul style="list-style-type: none"> 40 MVA = 20 MVA × 2 banks 2. 110 kV Transmission and 15 kV distribution equipment <ul style="list-style-type: none"> 110 kV overhead line (Approx. 2.2 km) 15 kV overhead line (Approx. 7.5 km) 	Stable power supply will revitalize the industries and economic activities in Kigali and improve stable operation of public welfare facilities and healthcare services as well as the living environment of local residents.
2. According to formulation of SEZ in Rwanda, distribution network around Ndera area is concerned about unstable power supply due to housing land development in Kabuga area and Murindi area.	1. Installation of Kabuga RMU switching station and 15 kV distribution line between 110/15 kV Gasogi substation and the RMU.	The RMU switching stations enable to carry out stable power supply to Kabuga area and the south part of Kabuga area. The new RMU switching station is unmanned station and remotely controlled by the existing National Control Center (NCC) in Gikondo.
	2. Installation of Murindi RMU switching station and the first tower to connect to the power system.	The RMU switching stations enable to carry out stable power supply to Murindi area and around the international airport area. The new RMU switching station is unmanned station and remotely controlled by the existing National Control Center (NCC) in Gikondo.

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 Rwanda side is deemed to possess adequate personnel and budget for implementing the Project and conducting operation and maintenance after implementation.

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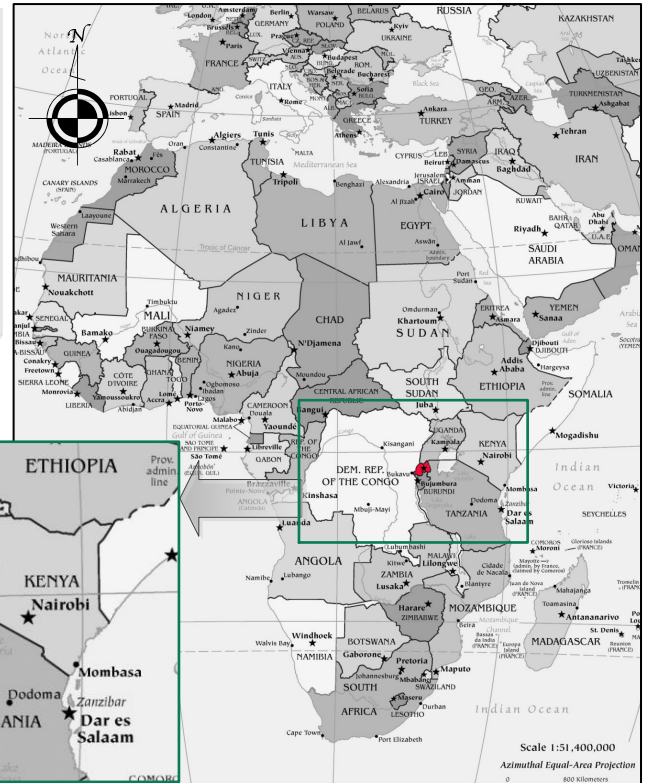
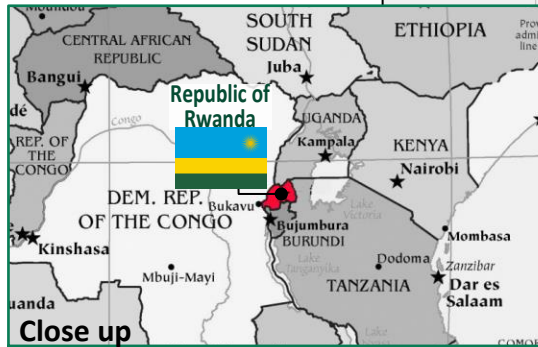
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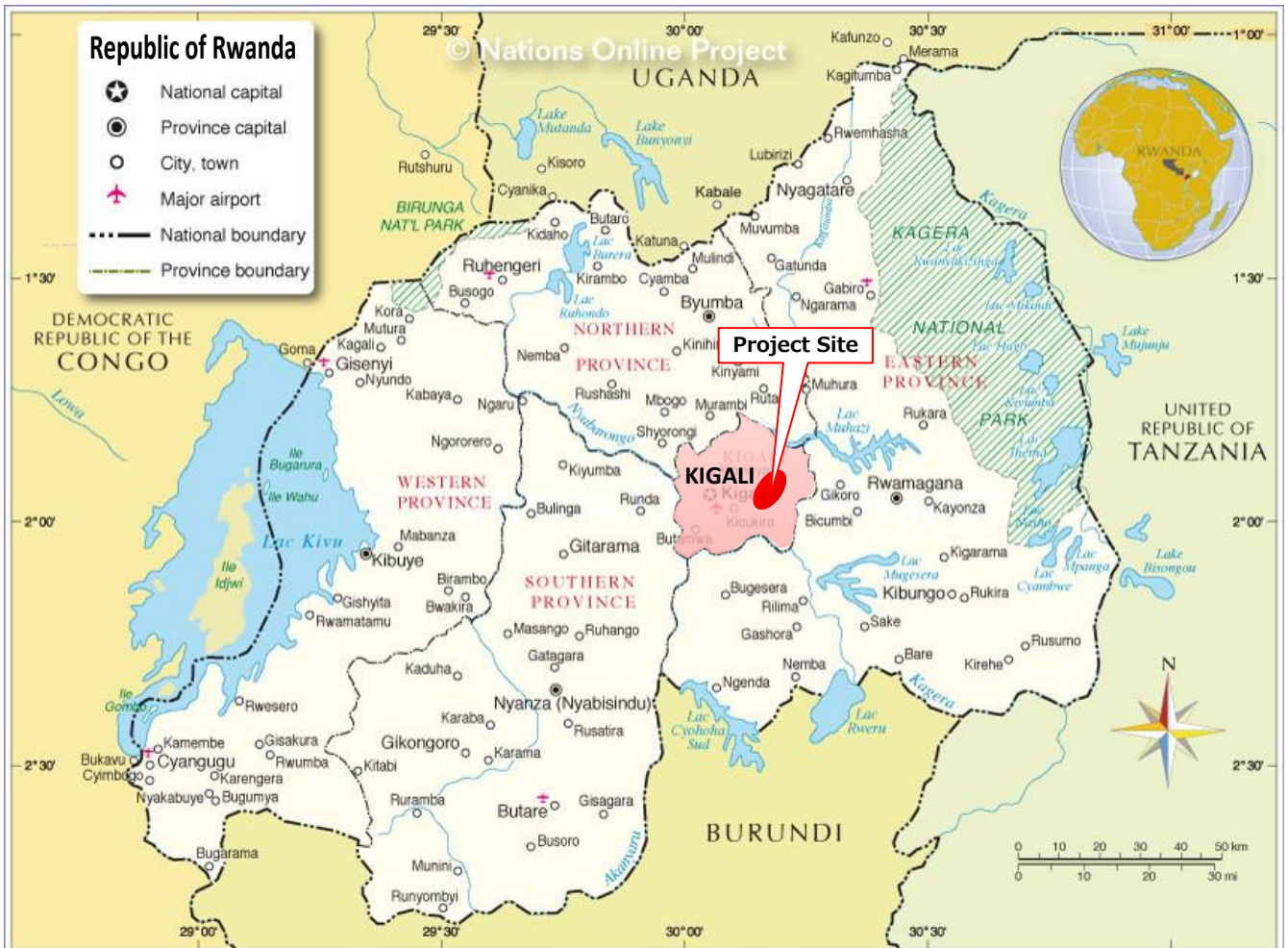
The Republic of Rwanda

Area: 26,338km²
 Population: 11,300,000 (UNFPA, 2013)
 Capital: Kigali
 Religion: Catholic 57%, Protestant 26%,
 Adventist 11%, Muslim 4.6%
 GNI(USD) : 1,430 (2013)
 GDP : 4.6% (2013)

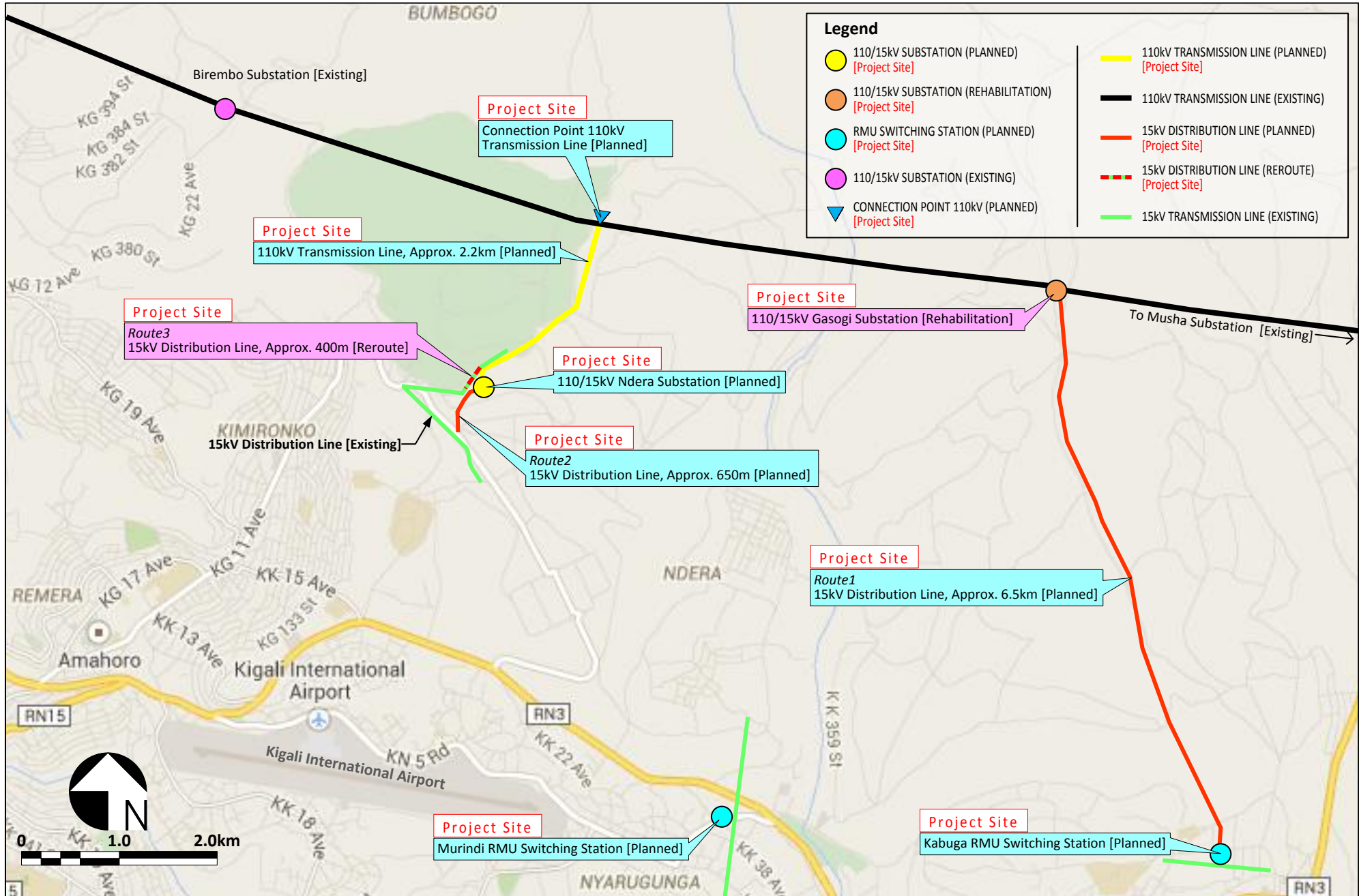
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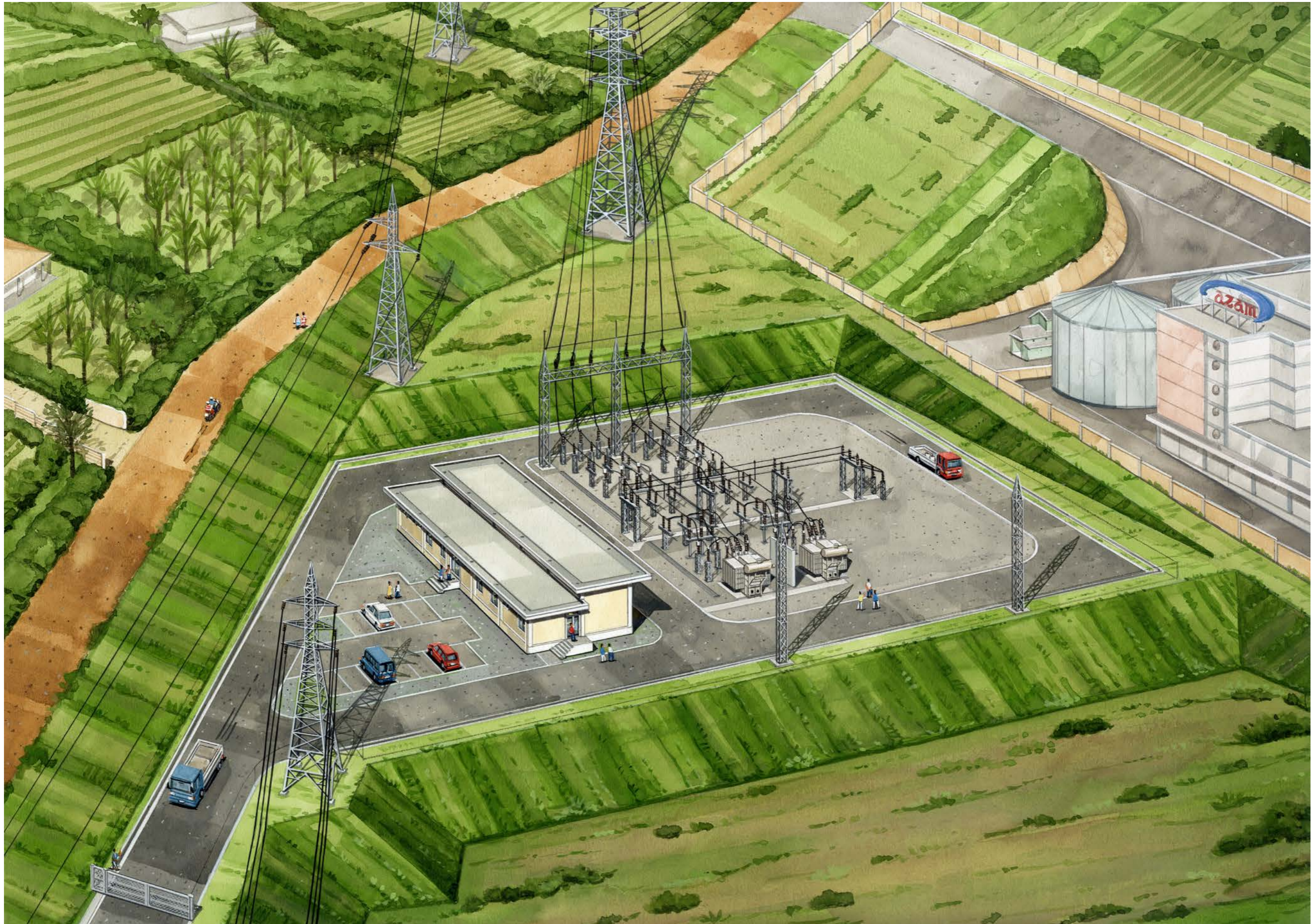
Map of Africa



Location of Project Site



Location Map of Project Site



The Project for Improvement of Substations and Distribution Network Phase 2
(Architectural Redering of Ndera Substation)

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Abbreviations

AFD	Agence Française de Développement
ARAP	Abbreviated Resettlement Action Plan
AfDB	African Development Bank
BCU	Bay Control Units
BTC	Belgian Technical Corporation
COMESA	Common Market for Eastern and Southern Africa
CV	Cross-linked polyethylene insulated Vinyl sheath cable
CVVS	Control-use Vinyl insulated Vinyl sheathed cable
DFID	Department for International Development
DIN	Deutscher Normenausschuss
EAPP	Eastern African Power Pool
EARP	Electricity Access Rollout Program
EDCL	Energy Development Corporation Limited
EGL	Energie des Grands Lacs
EIA	Environmental Impact Assess
ESSP	Energy Sector Strategic Plan
EU	European Union
EUCL	Energy Utility Corporation Limited
EWSA	Energy Water and Sanitation Authority
FMO	Financierings-Maatschappij voor Ontwikkelingslanden
FONERWA	Fund for Environment and climate change in Rwanda
G/A	Grant Agreement
GDP	Gross Domestic Product
GIS	Gas Insulation System
GIZ	Gesellschaft für Internationale Zusammenarbeit
GSW	Galvanized Steel Wire
IDA	International Development Association
IEC	International Electrotechnical Commission
JEC	Japanese Electrotechnical Committee
JEM	Japan Engineering Management Inc.
JICA	Japan International Cooperation Agency
JIS	Japan Industrial Standards
KfW	Kreditanstalt für Wiederaufbau
LTC	on-Load Tap Changer
M/D	Minutes of Discussions
MCCB	Molded Case Circuit Breaker
MDGs	Millennium Development Goals
MININFRA	Ministry of Infrastructure
NECC	National Electricity Control Centre
NLTC	No Load Tap Changer

OJT	On the Job Training
ONAN	Oil Natural Air Natural
OPGW	Optical Ground Wire
PAPs	Project Affected Persons
RDB	Rwanda Development Board
REG	Rwanda Energy Group
REMA	Rwanda Environmental Management Agency
RMU	Ring Main Unit
ROW	Right of Way
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition System
SI	the International system of unit
TOR	Term of Reference
WHO	World Health Organization

Chapter 1 Background of the Project

1-1 Background of the Project

Electrical power consumption per capita in Rwanda is extremely low comparing with other East African countries, and 84 % of whole energy consumption is provided by traditional biomass sources such as charcoal and wood. Electrical power generated has been increased since 2004, when the serious power shortage occurred, however, the indexes of power supply, such as an electrification rate of 16 % and installed capacity of 110 MW are still at the lower end and indicate insufficient power supply to meet increasing power demand that results from a consistently growing economy (average of 8 % growth over past 2-3 years) and improved living standards.

The power generation plants in Rwanda consists mainly of hydro (56 %) and diesel (40 %), and thus the country faces a big challenge to raise foreign currency to import fossil fuel (for diesel power plans) whose prices on the world market are incessantly surging.

Under these circumstances, Rwanda is planning to increase the installed capacity and diversity energy resources by utilizing indigenous resources in accordance with the “National Energy Policy and Strategy”, “Economic Development and Poverty Reduction Strategy”, “Electric Development Strategy”, etc. Nevertheless, more policies and strategies are insufficient to achieve the targeted increased and diversified electrical energy sector unless such policies and strategies are accompanied by a well prepared concrete Electricity Master Plan that takes into consideration an effective and efficient energy mix.

The distribution network in Kigali city was mainly established in the 1980s and it does not cover all the metropolitan area. Besides the civil war and insufficient maintenance has deteriorated existing facilities and it has led to the high distribution loss rate and show accident restoration in the network. To meet the increasing demand for electricity in Kigali City, the distribution network is needed to be upgateded and expanded.

Based on the background, the Government of Rwanda (GOR) has requested the Government of Japan (GOJ) on the Project for Improvement of Substations and Distribution Network Phase 2.

1-2 Natural Conditions

(1) Location of the planned area

Rwanda is a country of the plateau called “Thousand hills of the country”, Kigali as the capital of Rwanda is also a city having hills. The Project site for the new Nudera Substation Building is located in the land owned by the Rwanda Energy Group (REG) where is away approximately 4 kilometers north of Kigali International Airport. The land is surrounded by the AZAM Factory on the east side and a steep road width approximately 9 meters on the northwest side. Existing 10 MW diesel powerplant is in service at the south part of the land, and the future construction of new 50 MW diesel powerplant is planning at the same area.

(2) Topographic condition

As the result of the topographic survey, the area of the north part of the land owned by REG is approximately 15,000 square meters, the land length is triangle-shape land with maximum approximately 150 meters in the east-west direction, and 170 m in the north-south direction. The land elevations are approximately from 1,540 meters at the south side to 1,560 meters at the north side, and the land has approximately 20 meters height difference.

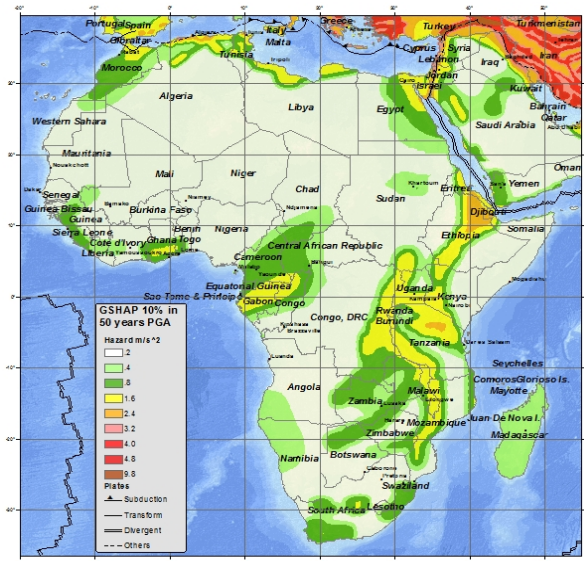
The Project site for new Nudera Substation Building is planning to be located in the center of the land. The slope of the land shall be maintained to be flat as 1,545 to 1,547 meters elevation by the excavation and filling works, and to be connected from the public road to the Project site.

(3) Geological condition

As the result of the soil investigation, the soil type of the Project site is mainly silty clay, and hard soil from the approximately 2 meters deep. The groundwater levels at each point of the soil investigation were not found by the time of the survey on April, 2015. The foundation of the new Nudera Substation Building shall be designed by the spread foundation on the ground surface of the target bearing capacity. Since a part of the Project site will be filling area, some foundations of the construction work shall be designed with the rubble concrete to be on the ground surface of the target bearing capacity.

(4) Earthquakes

A magnitude 4.7 earthquake on January 17, 2002, and a magnitude 6.0 earthquake on February 4, 2008 had been recorded in Rwanda. The earthquake on 2008 was away approximately 300 kilometers north-west of Kigali at a depth of 10 kilometers. There is no record about the seismic intensity of Kigali by the earthquake on 2008. As shown in Figure 1-2.1 “Disaster Prediction Map in Africa”, Rwanda is predicted the disaster caused by the earthquake.



Source: U.S. Geological Survey

Figure 1-2.1 Disaster Prediction Map in Africa

(5) Ground water quality

As the result of the soil investigation, the impacts from chlorides and sulfides must be accounted for in designs for underground structures.

(6) Weather conditions

Rwanda is located near by the equator; however, the climate is the temperate zone by the high elevation. Annual average temperature is 28 degrees as maximum and 16 degrees as minimum in Kigali. Monthly mean rainfall at the rainy season from February to May and from September to December is approximately 89 to 324 millimeters, and 55 millimeters at the dry season from June to August. Annual rainfall is approximately 775 to 1,220 millimeters

Table 1-2.1 Monthly mean temperature in Kigali [unit: degree]

Month Temperature	Jan.	Feb.	Mar.	Aip.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Maximum	29.4	28.3	28.1	27.5	27.2	27.2	28.2	28.9	28.0	28.1	27.6	27.9
Minimum	16.0	16.1	16.1	16.2	16.5	15.6	15.3	16.1	16.3	16.1	16.2	16.1

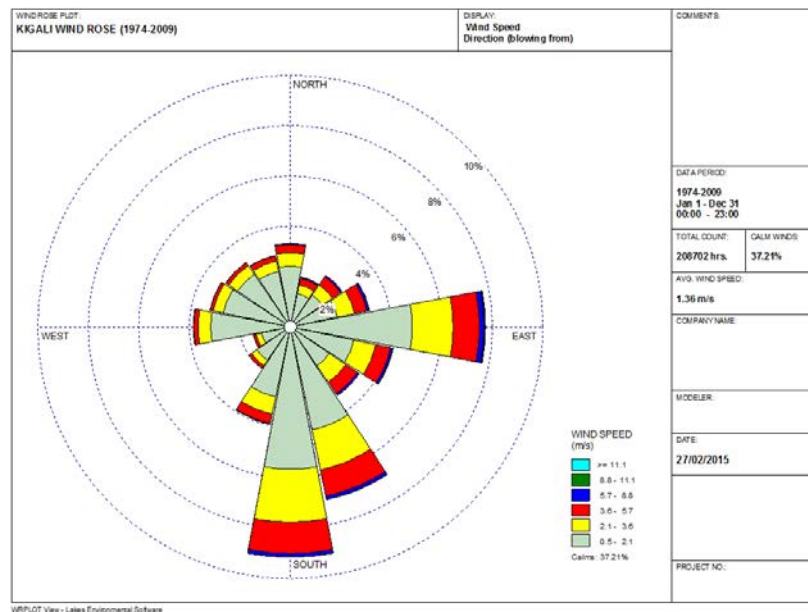
Source: Recods in 2010 to 2014 by the Rwanda Meteorology Agency

Table 1-2.2 Monthly mean rainfall in Kigali [unit: millimeter]

Month Rainfall	Jan.	Feb.	Mar.	Aip.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Maximum	133.3	315.7	324.3	184.4	222.3	50.7	12.0	70.6	87.0	137.1	217.4	89.2

Source: Recods in 2010 to 2014 by the Rwanda Meteorology Agency

As shown in Figure 1-2.2 “Diagrams of Wind Speed and Direction in Kigali (Kigali International Airport)”, average wind speed is 1.37 meters per second, and it is almos less wind. Wind direction facing to the east or the south.



Source: Rwanda Meteorology Agency

Figure 1-2.2 Diagrams of Wind Speed and Direction in Kigali (Kigali International Airport)

Weather Conditions in Kigali is shown in Table 1-2.3

Table 1-2.3 Weather Conditions

Temperature	Maximum	28 degrees
	Minimum	16 degrees
Average Wind Speed		1.37 meters per second
Rainfall (Maximum Monthly mean Rainfall)		324 millimeters
Humidity		67 – 87 %
Seismic Factor		0.10 G

Source: Rwanda Meteorology Agency and JICA study team

1-3 Environmental and Social Considerations

1-3-1 Environmental Impact Evaluation

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

The details of the all project components are described in the Chapter 2. Out of which that may have impacts on natural and social environments are shown in Table 1-3-1-1.1.

The locations of the components are indicated in Project Site.

Table 1-3-1-1.1 Project Components

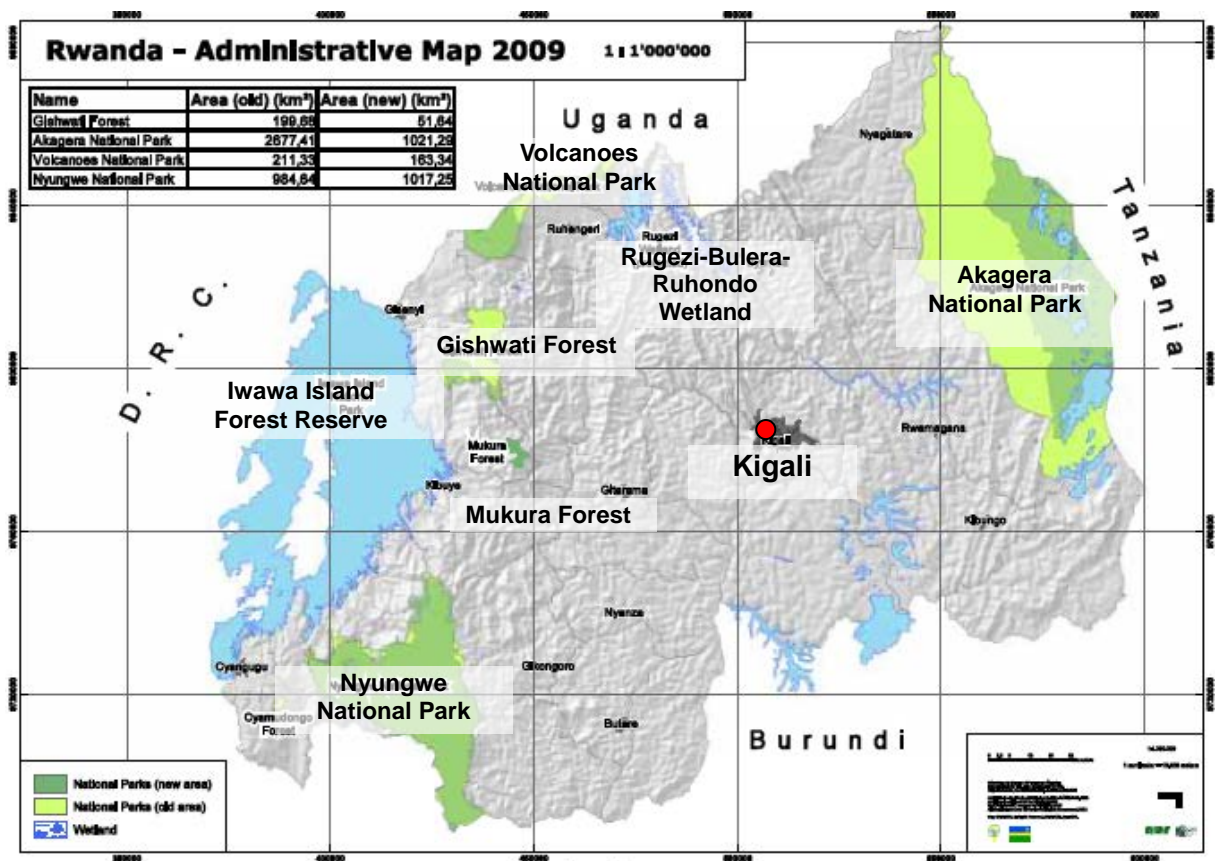
Components	Land Required
1. Ndera substation (a) 20 MVA 110/15 kV transformers (b) 110 kV switchgear (c) 15kV switchgear (d) Control and supervisory facilities	Approx. 5,600m ²
2. Transmission Line (a) Two circuits of 110 kV transmission lines from the existing line between Birembo and Gasogi substations to Ndera Substation	Approx. 2.2 km ROW 15 m Approx. 10 towers Connection point Approx. 2,500 m ² (Approx. 50 m x 50 m)
3. Distribution Line (a) Two circuits of 15 kV distribution lines from Ndera Substation to existing line between Birembo and Free Zone Phase 1 substations	Approx. 650 m ROW 10 m 4 towers
(b) One circuit of 15 kV distribution line from existing Gasogi Substation to Kabuga Ring Main Unit (RMU) Switching Station	Approx. 6.5 km ROW 10 m Approx. 43 towers/poles
(c) One circuit of 15kV distribution line for changing the alignment of the existing 15kV distribution line	Approx. 400 m ROW 6 m Approx. 2 towers/poles
4. RMU Switching Stations (a) RMU Switching Stations at Kabuga and Murindi. (b) Tension tower.	Kabuga Approx. 300 m ² (Approx. 20 m x 15 m) Murindi Approx. 300m ² (Approx. 20m x 15m) 1 tower
Access Roads	Approx. 400m ²
Storage area	Approx. 5,000m ²

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

Please refer 1-2 Natural Conditions for the natural environment.

The proposed project site is located within City of Kigali at altitude of around 1,500m with several hills. The city center of Kigali has commercial and residential areas surrounded by residential and agricultural areas. The area around the proposed new Ndera Substation is proposed as free trade zone by the Government of Rwanda and is being developed.

There is no protected area within and around the City of Kigali. Rwanda has three National Parks (Akagera, Nyungwe, Volcanoes), three Forest Reserves (Gishwati, Iwawa Island, Mukura) and one Ramsar registered site (Rugezi-Bulera-Ruhondo wetland complex), but all of them are situated near the borders away from Kigali (Figure 1-3-1-2.1).



Source: Rwanda State of Environment and Outlook, 2009, REMA

Figure 1-3-1-2.1 Protected Areas in Rwanda

1-3-1-3 Legal and Institutional Frameworks for Environmental and Social Considerations

(1) Legal Framework for Environmental and Social Considerations

Legal framework relevant to environmental and social considerations in Rwanda is summarized

in Table 1-3-1-3.1. By the Constitution, every citizen is entitled to a healthy and satisfying environment and every person has the duty to protect, safeguard and promote the environment. The state shall protect the environment. Further, by the environmental laws and development policies and strategies, it is required to promote proper environmental management system based on regulations in order to reduce poverty and sustainable development.

In terms of Environmental Impact Assessment, Ministerial Order No. 003/2008 of 15/08/2008 relating to The Requirements and Procedure for Environmental Impact Assessment deals with its procedure and Ministerial Order No. 004/2008 of 15/08/2008 establishing the List of Works, Activities and Projects that have to Undertake an Environment Impact Assessment stipulates projects required EIA, hence these two orders are basis for EIA in Rwanda.

Table 1-3-1-3.1 Legal Framework Concerning Environmental and Social Considerations
(including guidelines)

Category	Name	Year
Constitution	The Constitution of the Republic of Rwanda	2003
Environment	No.04/2005 Organic Law determining the modalities of protection, conservation and promotion of environment in Rwanda	2005
	No.08/2005 of 14/07/2005 Organic Law determining the use and management of land in Rwanda”	2005
EIA	Ministerial Order No. 003/2008 of 15/08/2008 Relating to The Requirements and Procedure for Environmental Impact Assessment	2008
	Ministerial Order No. 004/2008 of 15/08/2008 establishing the List of Works, Activities and Projects that have to Undertake an Environment Impact Assessment	2008
	General Guidelines and Procedure for Environmental Impact Assessment 2006	2006
	Sector Guidelines for EIA for Hydro-Power Development Projects	2008
Land Acquisition and Resettlement	No. 08/2005 Organic Law determining the Use and Management of Land in Rwanda	2005
	Law No. 43/2013 of 16/06/2013 governing land in Rwanda determining the use and management of land in Rwanda	2013
	Law No. 17/2010 of 12/05/2010 establishing and organizing the real property valuation profession in Rwanda	2010
	Presidential Order No. 54/01 of 12/10/2006 determining the structure, the responsibilities, the functioning and the composition of Land Commissions	2006
	Ministerial Order No. 001/2006 determining the structure of land registers, the responsibilities and the functioning of the District Land Bureau	2006
	Ministerial Order No. 008/2009 determining the reference land prices in the City of Kigali	2009
	Law No. 18/2007 Relating to Expropriation in the Public Interest	2007

Source: JICA Study Team

(2) Institutional Framework for Environmental Impact Assessment

The Invest Implementation Division of Rwanda Development Board (RDB) is the responsible body for EIA Certificate Authorization. Rwanda Environment Management Agency (REMA) is responsible for monitoring.

Environmental and Social Safeguard Division (the official name of this division is not yet determined as of August 2015) under EDCL is responsible for environmental and social considerations for projects by EDCL. In this division, three environmental experts and 2 social experts responsible for land acquisition and resettlement are appointed. EDCL uses WB safeguards policies as a benchmark.

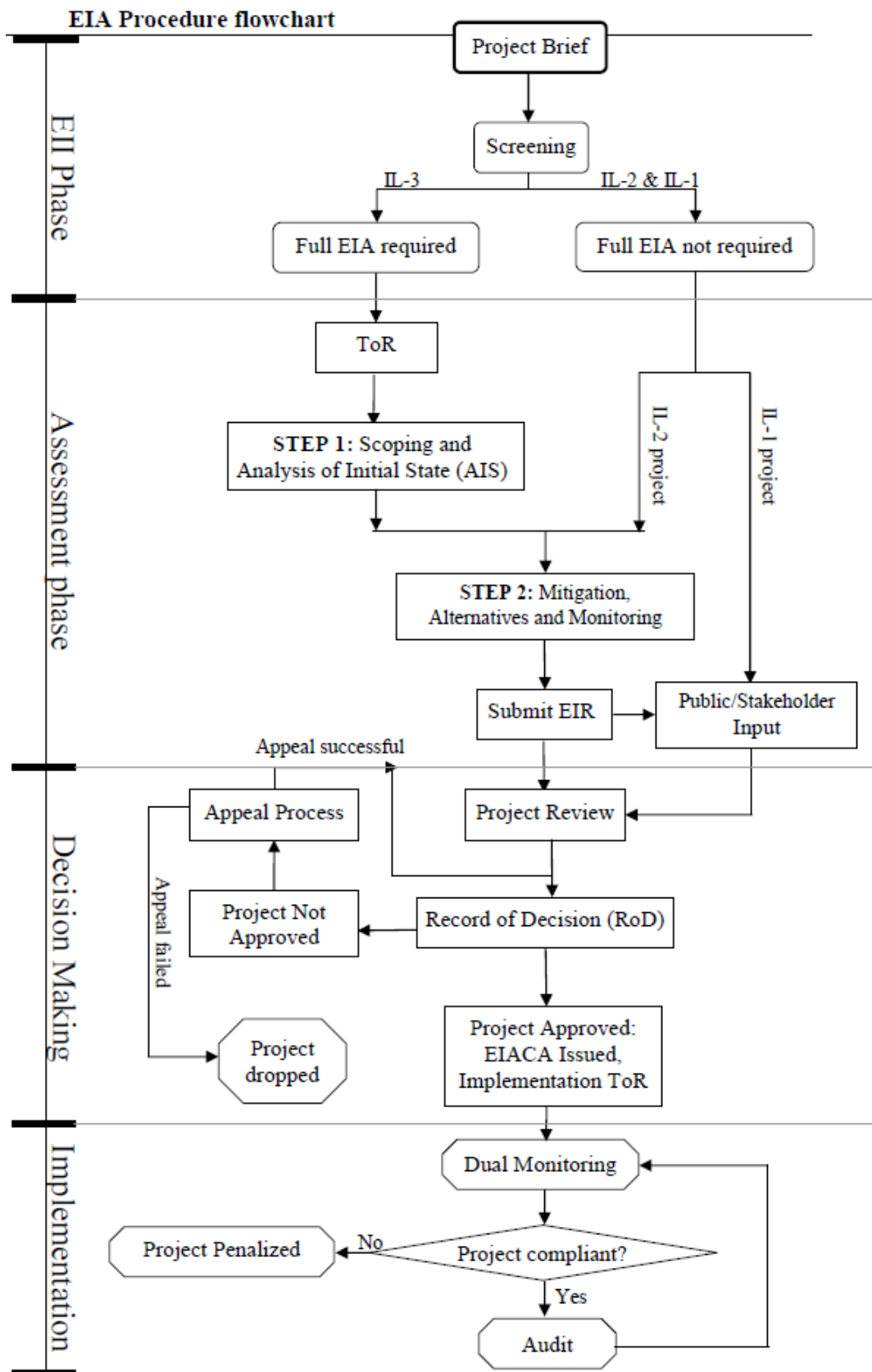
(3) EIA Procedure

1) Procedure for EIA

By Article 67 of No.04/2005 Organic Law determining the modalities of protection, conservation and promotion of environment in Rwanda, it is stipulated that every project, program and policy shall be subjected to environmental impact assessment, before obtaining authorization for its implementation. By Article 69 of the same law, it is stipulated that the environmental impact assessment shall be examined and approved by the Rwanda Environmental Management Authority (after 2009, by RDB).

General Guidelines and Procedure for EIA (2006) states EIA procedure, example of ToR for EIA study, contents of EIA report, public participation, etc. EIA must be carried out by EIA experts (individual or company) authorized by the Ministry of Natural Resources.

General EIA procedure in Rwanda is indicated in Figure 1-3-1-3.1 Procedure for EIA. The procedure will be commenced by submission of a Project Brief from the project proponent to RDB.



Source: General Guidelines and Procedure for EIA

Figure 1-3-1-3.1 Procedure for EIA

2) **EIA Screening**

Based on a Project Brief submitted to RDB, RDB will carry out screening and the project will be categorized as below to move on to the procedure. Ministerial Order No. 004/2008 of 15/08/2008 establishing the List of Works, Activities and Projects that have to undertake an Environment Impact Assessment has a list of projects requiring EIA, however there are no quantitative criteria. Categorization is based on contents, location, characteristics and scope of impacts of each project.

- IL 1: Projects not requiring further environmental analysis

The project passes directly to decision-making level without further environmental analysis.

- IL 2: Projects not requiring a full EIA but necessitate further level of assessment

This category represents projects believed to have adverse, but not irreversible environmental impacts and mitigation and management measures can be readily designed and incorporated into the project. The EIA process for these projects is similar to that of IL3 projects.

- IL 3: Projects requiring a full EIA

This category involves projects for which it is evident that there will be significant and adverse environmental impacts whose mitigation measures cannot readily be prescribed, and thus, must undergo through a complete EIA process.

For the projects that are not required to have an EIA, RDB will issue an EIA Certificate of Authorization.

3) **Obtaining an EIA Certificate of Authorization for the Project**

General EIA procedure in Rwanda is as shown by the flowchart in Figure 1-3-1-3.1 . EDCL submitted a Project Brief to RDB on 7 April, 2015. On 7 May, 2015, RDB issued a letter to EDCL stating the necessity of an EIA study for the project and its TOR (Appendix 10). On 28 July 2015, an EIA report (Appendix 11) was submitted to RDB, and an EIA Certificate of Authorization was issued on 25 August 2015 (Appendix 12).

1-3-1-4 Comparison of the Alternatives

Analysis of the alternatives is shown in Table 1-3-1-4.1. Since the project site is located in a built-up area, there is no difference among the alternatives in terms of natural environmental aspects; therefore, the numbers of buildings to be resettled and land acquisition are the main issues in comparison.

With non-project alternative, resettlement and land acquisition will be avoided, however the power transmission and distribution facilities will not be improved to meet the increasing demand on the power in the capital city Kigali, and the stable power supply cannot be expected. This situation of

unstable power supply will hinder economic development and improvement of living standards of people.

For the new Ndera Substation, a plot of land in Free Zone, where the Government of Rwanda has been working on development since 2011, was already secured before September 2014 by REG. Other alternate locations are not recommended because they will be away from the Free Zone to which the power supply is targeted to and may cause land acquisition and resettlement.

The same reasons will apply to proposed sites for Murindi and Kabuga RMUs. The sites are located under the existing transmission line or at the shortest distance along the new distribution line and there is no structure, trees, and crops in the site. By considering other alternatives, it will be away from the existing line or the distance of the new transmission line will be longer, hence causing higher project costs and necessity of resettlement. The presently proposed sites are best options for new RMUs.

Table 1-3-1-4.1 Analysis of Alternatives

Transmission Line 110kV

Item	Alternative 1	Alternative 2
Starting point	Connecting to the existing transmission line between Birembo-Gasogi.	Gasogi Substation
Ending point	Ndera Substation	Ndera Substation
Distance	Approx. 2.2km	Approx. 6.5 km
Impacts on Natural Environment	No difference compare to Alternative 2.	No difference compare to Alternative 1. The longer distance requires more towers, hence some impacts on landscape.
Impacts on Social Environment	Less impact on land acquisition and resettlement compare to Alternative 2.	Much more impact on land acquisition and resettlement compare to Alternative 2.
Project Costs	Lower than Alternative 2 due to the shorter distance and fewer towers.	Higher than Alternative 1 due to the longer distance and more towers.
Evaluation	Recommended due to the less impacts on surroundings and lower costs.	Not recommended due to more impacts on social aspects and higher costs compare to Alternative 2.

Distribution line 15kV

Item	Alternative 1	Alternative 2
Starting point	Gasogi Substation	Gasogi Substation
Ending point	Kabuga RMU	Kabuga RMU
Route	From Gasogi Substation, along the existing road from for approximately 2.8km, then connect to the RMU with a direct line.	Along the existing road, all the way.
Distance	Approx. 6.5 km	Approx. 7.5 km
Impacts on Natural Environment	No difference compare to Alternative 2.	No difference compare to Alternative 1.
Impacts on Social Environment	Less impact on land acquisition and resettlement compare to Alternative 2.	More impact on land acquisition and resettlement compare to Alternative 2.
Project Costs	Lower than Alternative 2 due to the shorter distance and fewer towers.	Higher than Alternative 1 due to the longer distance and more towers.
Evaluation	Recommended due to the less impacts on surroundings and lower costs.	Not recommended due to more impacts on social aspects and higher costs compare to Alternative 2.

Source: JICA Study Team

1-3-1-5 Scoping

The main components of the project are construction of a new Ndera substation, a new transmission line (110kV, approximately 2.2km, with towers) from the Ndera substation, a new transmission line (15kV, approximately 6.5km with towers) and two new RMUs at Kabuga and Murindi. Scoping was conducted towards these components by site observations and hearing from the relevant individuals as indicated in.

Table 1-3-1-5.1 Scoping

	No.	Item	Phase		Expected Impacts
			Planning Construction	Operation	
Social Environment	1	Involuntary Resettlement	B-	D	Planning/Construction Phase: There may be a small scale involuntary resettlement due to the land acquisition for 110kV transmission line and 15kV distribution line. Operation Phase: no impact is expected.
	2	Poverty	B-	D	Planning/Construction Phase: There may be the poor among the Project Affected People (PAPs) for resettlement.
	3	Indigenous/Mi norities	D	D	There is no indigenous people or minorities within the project sites
	4	Economic activities, living and livelihood	B+/-	A+	Planning/Construction Phase: Some temporary adverse impacts are expected due to the involuntary resettlement. On the other hand during the construction, positive impacts by employments by construction works and contribution to local economic activities due to the presence of construction workers may be expected. Operation Phase: Positive impacts on socio economic aspects of residences and industries due to the stable power supply are expected.
	5	Land Use and Utilization of local resources	B-	D	Planning/Construction Phase: Some impact due to the limited access to agricultural land is expected. Operation Phase: Although land will be acquired for the Ndera Substation, two RMUs, transmission line and distribution line, development activities are limited and will not cause changes in land use and local resources.
	6	Water Use and Water Right	D	D	There is no major water body near the project sites.
	7	Existing social infrastructure and services	B-	A+	Planning/Construction Phase: Traffic around the construction sites near the existing road and the two RMUs may be affected due to delivery of materials, etc. Temporary power cuts are expected due to the works on the existing lines. Operation Phase: Positive impacts are expected due to the stable power supply.
	8	Social institutions such as social infrastructure and local decision-making institutions	D	D	No impacts are expected as the project sites are limited in local. The project will contribute to the improvement of public service in power sector; hence will not cause any impact on social institutions.
	9	Misdistribution of benefits & damages	D	D	The project will contribute to the improvement of public service in power sector; hence will not cause any misdistribution

	No.	Item	Phase		Expected Impacts
			Planning Construction	Operation	
	10	Local conflicts of interest	D	D	The project will contribute to the improvement of public service in power sector; hence will not cause any conflicts
	11	Heritage	D	D	There is no heritage or culturally important site near the project sites.
	12	Landscape	D	D	There is no naturally or culturally important landscape near the project sites.
	13	Gender	D	D	No adverse impact on gender issues is expected by the project.
	14	Children's right	D	D	No adverse impact on children's right is expected by the project.
	15	Infectious Disease (HIV/AIDS, etc.)	C	D	Construction Phase: If workers are not hired locally, there may be a possibility of infectious diseases due to the lack of management and education.
	16	Occupational health hazards	B-	D	Construction Phase: It is necessary to protect workers from the hazards and risk of accidents.
Natural Environment	17	Protected Areas	D	D	No protected area is present near the project sites
	18	Ecosystem	D	D	The project sites are within a built-up area of the Kigali city and there is no important fauna and flora can be affected by the project.
	19	Hydrology	D	D	There is no major river or stream near the project sites.
	20	Geological Features	B-	D	Planning Phase: Levelling of the land is necessary for the Ndera Substation, but it is limited to the site and will not have any major impact.
Pollution Control	21	Air Pollution	B-	D	Planning/Construction Phase: Due to the land leveling work at Ndera and operation of heavy machineries during the construction works, temporary impacts on air pollution are expected. However, these impacts may be mitigated largely by general measurements that are required to the contractor.
	22	Water Pollution	D	D	No activity that may cause the water pollution is expected. No water bodies that may be affected are present near the project sites.
	23	Soil Pollution	B-	B-	Planning/Construction/Operation Phase. Insulating oil will be used for transformers. It may cause soil pollution if it is leaked.
	24	Waste	B-	D	Although the leveling is planned, it is not expected to have left over soil. Dismantling of existing towers, responsibilities of the project proponent, may incur wasted materials.
	25	Noise/Vibration	B-	C	Construction Phase: Temporary impacts are expected due to the operation of heavy machineries. Operation Operation Phase: Transformers at the Ndera Substation may cause some noises, however they will be located away from the boundaries of the site. The location is within Free Zone with factories and roads. There is no residential area, hospital or school.
	26	Ground subsidence	D	D	No impact is expected.
	27	Odor	B-	D	Construction Phase: If not managed properly, waste may cause odor. Operation Phase: No impact is expected.
	28	Bottom sediment	D	D	There is no river or swamp near the project site, hence no impact is expected.
	29	Electromagnetic field	D	C	Operation Phase: Some impacts may be incurred to residents nearby.

	No.	Item	Phase		Expected Impacts
			Planning Construction	Operation	
Others	30	Accidents	B-	D	Construction Phase: Erecting towers and rewiring may trigger general accidents caused by construction works such as falling accident of workers or parts
	31	Electrocution	D	B-	Operation Phase: Electrocution may occur by climbing the tower.
	32	Fire	D	B-	Operation Phase: Fire accidents and electrical circuits may occur due to the broken conductors or lighting.
	33	Bird collision	D	C	Operation Phase: Birds may collide to lines or towers and may be electrocuted.
	34	Protected Plant Species	B-	D	Construction Phase: Plants to be cleared within ROW may include protected species.
	35	Global warming	D	D	The project will not cover a large area; hence global warming or impacts across the borders are not expected.

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

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

C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)

Source: JICA Study Team

1-3-1-6 TOR for Environmental and Social Considerations Study

Based on the scoping results above, the TOR for EIA study was determined as below.

Table 1-3-1-6.1 TOR for Environmental and Social Considerations Study

No.	Item	Evaluation	Study Item	Methods
1	Involuntary resettlement	Planning Phase B- Construction Phase B-	<ul style="list-style-type: none"> Confirming necessity and scale of resettlement and land acquisition Mitigation measures for resettlement 	<ul style="list-style-type: none"> Study on scale of resettlement and preparation of resettlement action plan by local consultant Site visit
2	Poverty	Planning Phase B- Construction Phase B-	<ul style="list-style-type: none"> Same as above 	<ul style="list-style-type: none"> Same as above
4	Economic activities, living and livelihood	Planning Phase B- Construction Phase B-	<ul style="list-style-type: none"> Same as above Land use and socio-economic activities in the project site Benefits 	<ul style="list-style-type: none"> Same as above Socio-economic study by local consultant Review of existing literature and data
5	Land Use and Utilization of local resources	Construction Phase B-	<ul style="list-style-type: none"> Agricultural land within ROW 	<ul style="list-style-type: none"> Geological Features Site visit
7	Existing social infrastructure and services	Construction Phase B-	<ul style="list-style-type: none"> Social infrastructures nearby 	<ul style="list-style-type: none"> Site visit Preparation of Power cut plan
15	Infectious Disease (HIV/AIDS, etc.)	Construction Phase C	<ul style="list-style-type: none"> Target group for employment of construction workers 	<ul style="list-style-type: none"> Review of existing literature and data (previous examples)

No.	Item	Evaluation	Study Item	Methods
16	Occupational health hazards	Construction Phase B-	<ul style="list-style-type: none"> • Labor Safety measures 	<ul style="list-style-type: none"> • Review of existing literature and data (relevant labor regulations, EDCL environmental and social guidelines for tendering, etc.)
20	Geological Features	Construction Phase B-	<ul style="list-style-type: none"> • Land leveling for the Ndera Substation 	<ul style="list-style-type: none"> • Review of existing literature and data (design, methods, etc.)
21	Air Pollution	Construction Phase B-	<ul style="list-style-type: none"> • Operation of heavy machineries 	<ul style="list-style-type: none"> • Review of existing literature and data (EDCL environmental and social guidelines for tendering, etc.)
23	Soil Pollution	Construction Phase B- Operation Phase B-	<ul style="list-style-type: none"> • Setting of transformer and insulating oil pipe. 	<ul style="list-style-type: none"> • Review of existing literature and data (EDCL environmental and social guidelines for tendering, examples from other substations, etc.)
24	Waste	Construction Phase B-	<ul style="list-style-type: none"> • Disposal of wastes from dismantling the existing towers and lines 	<ul style="list-style-type: none"> • Review of existing literature and data (EDCL environmental and social guidelines for tendering, etc.) • Relevant regulations and guidelines for waste management
25	Noise/Vibration	Construction Phase B- Operation Phase B-	<ul style="list-style-type: none"> • Noise • Surrounding of the Ndera Substation 	<ul style="list-style-type: none"> • Review of existing literature and data • Construction methods and design of the Ndera Substation • Monitoring during operation Phase for noise problem
27	Odor	Construction Phase B-	<ul style="list-style-type: none"> • Waste management at construction site 	<ul style="list-style-type: none"> • Review of existing literature and data (EDCL environmental and social guidelines for tendering, etc.) • Relevant regulations and guidelines for waste management
29	Electric magnetic Fields	Operation Phase C	<ul style="list-style-type: none"> • Distance between the power line and buildings 	<ul style="list-style-type: none"> • Review of existing literature and data (report from international organization, etc.)
30	Accident	Construction Phase B-	<ul style="list-style-type: none"> • Situation of the project site • Accident prevention measure during construction phase 	<ul style="list-style-type: none"> • Review of existing literature and data (EDCL environmental and social guidelines for tendering, etc.) • Interview with contractors
31	Electrocution	Operation Phase B-	<ul style="list-style-type: none"> • Electrocution prevention measures 	<ul style="list-style-type: none"> • Review of existing literature and data (examples from the past etc.)
32	Fire	Operation Phase B-	<ul style="list-style-type: none"> • Fire prevention measure 	<ul style="list-style-type: none"> • Review of existing literature and data (examples from the past etc.) • Interview with contractors
33	Bird Collision	Operation Phase B-	<ul style="list-style-type: none"> • Route of migratory birds • Reports from the past 	<ul style="list-style-type: none"> • Review of existing literature and data • Interview with Experts
34	Protected Plant Species	Construction Phase B-	Plant species to be cleared	<ul style="list-style-type: none"> • Study on the plant clearance within ROW during RAP study by local consultant • Site visit

Source: JICA Study Team

1-3-1-7 Mitigation Measures

The results of the Study based on the TOR above are summarized in the table below.

Table 1-3-1-7.1 Results of Environmental and Social Consideration Study

No.	Item	Results
1	Involuntary resettlement	<ul style="list-style-type: none"> • 14,539.2m² of land will be acquired. • Four (4) buildings (3 houses and 1 annex) will be resettled. • Fifty nine (59) households and the total of 191 people will be affected. Out of which, 3 households (13 people) are resettled. However, all the affected households own other lands in the vicinity or are not depending on the land as residence or for living. Hence there is no household severely affected by the project resulting changing livelihood or residence.
2	Poverty	<ul style="list-style-type: none"> • There is no poor among project affected people (PAPs)
4	Economic activities, living and livelihood	<ul style="list-style-type: none"> • Planning/Construction Phase: Some temporary impacts on living and livelihood are expected due to the resettlement • On the other hand during the construction, positive impacts by employments by construction works and contribution to local economic activities due to the presence of construction workers may be expected. • Operation Phase: Positive impacts on socio economic aspects of residences and industries due to the stable power supply are expected.
5	Land Use and Utilization of local resources	<ul style="list-style-type: none"> • Construction Phase: Agricultural land within ROW will not be accessed.
7	Existing social infrastructure and services	<ul style="list-style-type: none"> • Planning/Construction Phase: Traffic around the construction sites near the existing road and the two RMUs may be affected due to delivery of materials, etc. Temporary power cuts are expected due to the works on the existing lines. • Operation Phase: Positive impacts are expected due to the stable power supply.
15	Infectious Disease (HIV/AIDS, etc.)	<ul style="list-style-type: none"> • Construction workers will be employed locally. There will be no influx of people from outside to bring infectious diseases.
16	Occupational health hazards	<ul style="list-style-type: none"> • Without proper measure, accidents and poor labor environment may occur during construction phase.
20	Geological Features	<ul style="list-style-type: none"> • Planning Phase: Levelling of the land is necessary for the Ndera Substation, but it is limited to the site and will not have any major impact.
21	Air Pollution	<ul style="list-style-type: none"> • Planning/Construction Phase: Due to the land leveling work at Ndera and operation of heavy machineries during the construction works, temporary impacts on air pollution are expected. However, these impacts may be mitigated largely by general measurements that are required to the contractor.
23	Soil Pollution	<ul style="list-style-type: none"> • Planning/Construction/Operation Phase. Insulating oil will be used for transformers. It may cause soil pollution if it is leaked.
24	Waste	<ul style="list-style-type: none"> • Although the leveling is planned, it is not expected to have left over soil. Dismantling of existing towers, responsibilities of the project proponent, may incur wasted materials.
25	Noise/Vibration	<ul style="list-style-type: none"> • Construction Phase: Temporary impacts are expected due to the operation of heavy machineries. • Operation Phase: Transformers at the Ndera Substation may cause some noises, however they will be located away from the boundaries of the site. The location is within Free Zone with factories and roads. There is no residential area, hospital or school.
27	Odor	<ul style="list-style-type: none"> • Construction Phase: If not managed properly, waste and toilets for workers may cause odor.
29	Electric magnetic Fields	<ul style="list-style-type: none"> • Clearance between structure and power line is 5m. A report by WHO states the relation between electric magnetic field and impacts on human body is not confirmed, hence there will be no impacts to residents living near the project sites.
30	Accident	<ul style="list-style-type: none"> • Construction Phase: General accident related to construction activities such as erection of towers and rewiring of power line may happen.
31	Electrocution	<ul style="list-style-type: none"> • Operation Phase: Without proper measures, electrocution may occur by touching the tower.

No.	Item	Results
32	Fire	<ul style="list-style-type: none"> Without proper measurement, there may be risks of fire caused by broken conductor and lightening during operation phase.
33	Bird Collision	<ul style="list-style-type: none"> There is no migratory route for birds. There are already many transmission and distribution lines around the project sites, however, there has been no report of bird collision.
34	Protected Plant Species	<ul style="list-style-type: none"> Two (2) trees of the species nationally protected for cultural and religious reasons are present within ROW and will be removed. However, this species are commonly found around the project sites and throughout the country.

1-3-1-8 Impact Evaluations

Based on the study results above, the impacts of the project are evaluated and compared to the evaluations at scoping.

	No.	Item	Evaluation at Scoping		Evaluation Based on Results		Reason for Evaluation
			Planning Phase Construction Phase	Operation Phase	Planning Phase Construction Phase	Operation Phase	
Social Environment	1	Involuntary Resettlement	B-	D	B-	D	Involuntary resettlement is triggered, however it is only 3 households and they can resettle within their own property or nearby.
	2	Poverty	B-	D	D	D	No impact due to the absence of the poor among PAPs.
	3	Indigenous/Minorities	D	D	N/A	N/A	
	4	Economic activities, living and livelihood	B+/-	A+	B+/-	A+	The Impacts are limited to planning and construction phase only and their scope is also limited.
	5	Land Use and Utilization of local resources	B-	D	B-	D	The impacts are limited during construction phase within ROW.
	6	Water Use and Water Right	D	D	N/A	N/A	
	7	Existing social infrastructure and services	B-	A+	B-	A+	The impact is limited during construction phase. It is temporary and locally limited and can be mitigated by general measures.
	8	Social institutions such as social infrastructure and local decision-making institutions	D	D	N/A	N/A	
	9	Misdistribution of benefits & damages	D	D	N/A	N/A	
	10	Local conflicts of interest	D	D	N/A	N/A	
	11	Heritage	D	D	N/A	N/A	

	No.	Item	Evaluation at Scoping		Evaluation Based on Results		Reason for Evaluation
			Planning Phase Construction Phase	Operation Phase	Planning Phase Construction Phase	Operation Phase	
	12	Landscape	D	D	N/A	N/A	
	13	Gender	D	D	N/A	N/A	
	14	Children's right	D	D	N/A	N/A	
	15	Infectious Disease (HIV/AIDS, etc.)	C	D	D	D	No influx of people from outside is expected, hence no impact.
	16	Occupational health hazards	B-	D	B-	D	The impact is only during construction phase and can be mitigated with general measures.
	Environment	17	Protected Areas	D	D	N/A	N/A
18		Ecosystem	D	D	N/A	N/A	
19		Hydrology	D	D	N/A	N/A	
20		Geological Features	B-	D	D	D	Leveling will not cause any impact.
Pollution	21	Air Pollution	B-	D	B-	D	The impact is limited during construction phase. It is temporary and locally limited and can be mitigated by general measures.
	22	Water Pollution	D	D	N/A	N/A	
	23	Soil Pollution	B-	B-	B-	B-	The impact is expected during construction and operation phase, however it is limited only to the inside of the substation and can be mitigated by general measures.
	24	Waste	B-	D	B-	D	The impact is limited during construction phase. It is temporary and locally limited and can be mitigated by general measures.
	25	Noise/Vibration	B-	C	B-	D	The impact is limited during construction phase. It is temporary and locally limited and can be mitigated by general measures.
	26	Ground subsidence	D	D	N/A	N/A	
	27	Odor	B-	D	B-	D	The impact is limited during construction phase. It is temporary and locally limited and can be mitigated by general measures.
	28	Bottom sediment	D	D	N/A	N/A	

	No.	Item	Evaluation at Scoping		Evaluation Based on Results		Reason for Evaluation
			Planning Phase Construction Phase	Operation Phase	Planning Phase Construction Phase	Operation Phase	
	29	Electromagnetic field	D	C	D	D	There is enough clearance from the power line and WHO does not confirm its impacts on human body.
その他	30	Accidents	B-	D	B-	D	The impact is limited during construction phase. It is temporary and locally limited and can be mitigated by general measures.
	31	Electrocution	D	B-	D	B-	The impact will be during operation phase, however it can be prevented with general measures.
	32	Fire	D	B-	D	B-	The impact will be during operation phase, however it can be prevented with general measures.
	33	Bird collision	D	C	D	D	No impact is expected due to the absence of migratory route or previous reports around the project sites.
	34	Protected Plant Species	B-	D	B-	D	Only two trees are affected. Mitigation measure is readily available.
	35	Global warming	D	D	N/A	N/A	

1-3-1-9 Mitigation Measures

The following table summarizes mitigation measures towards the items with adverse impacts.

Table 1-3-1-9.1 Mitigation Measures

No.	Item	Impact	Mitigation Measures	Implementation/Responsible Body	Cost (USD)
Planning Phase					
1	Involuntary Resettlement	Loss of assets, income and livelihood due to resettlement (including temporary ones)	<ul style="list-style-type: none"> In accordance with JICA guidelines and WB OP4.12, An Abbreviated Resettlement Action Plan (ARAP) will be prepared based on the consensus with project affected people, compensation at full replacement cost and support and will be implemented. 	EUCL Relevant Sectors	251, 878USD
Construction Phase					
4	Economic activities, living and livelihood	Impacts on living and livelihood due to resettlement (including temporary ones)	<ul style="list-style-type: none"> Same as above PAPs will have priority for the project related employment opportunities. 	Same as above	N/A

No.	Item	Impact	Mitigation Measures	Implementation/Responsible Body	Cost (USD)
5	Land Use and Utilization of local resources	Limited access to agricultural land due to land acquisition.	<ul style="list-style-type: none"> • Presentation of a clear construction work schedule and smooth implementation • Sharing and coordinating a work plan with residents and communities 	Contractor	N/A
7	Existing social infrastructure and services	Impacts on traffic during construction works Power Cut during construction works	<ul style="list-style-type: none"> • By announcing construction plans to nearby residents and collaborating with local police, enforcement of traffic safety and mitigation of traffic congestion • Preparation of power cut plan and sharing the plan with affected communities 	EUCL Contractor	N/A
16	Occupational health hazards	Health and safety of construction workers	<ul style="list-style-type: none"> • EUCL will confirm environmental and social safety management plan proposed by contractor at tendering. Based on this plan, the contractor will carry out safety and management tasks and avoid and mitigate risks of accidents. • Based on laboring laws, the contractor must provide protective gear to workers, ensure them to wear them and provide safe working environment. • Construction site (especially the storage site) will be fenced, lighted and guarded by security guards to prevent intruders and theft 	EUCL Contractor	Include in construction costs
21	Air Pollution	Air pollution by heavy machineries during leveling and construction works	<ul style="list-style-type: none"> • Minimize number of deliveries through timely scheduling. • Only contract automobiles with vehicle inspection certification, which are expected to have less exhaust emissions. 	Contractor	N/A
23	Soil Pollution	Spillage of insulating oil from transformer	<ul style="list-style-type: none"> • Insulating oil as well as transformers will be set in the metal box. To prevent spillage, oil dike will be set under the transformers and filled with stone chips. • Protection of exposed ground with vegetation and rain drainage, etc. to prevent run-off 	Contractor	Include in construction costs
24	Waste	Dismantling of the existing tower under the responsibility of the implementing agency Waste during construction	<ul style="list-style-type: none"> • EUCL will recycle any materials saved from dismantling the existing towers and unrecyclable materials will be properly hand over to waste Management Company. • Regular disposal of solid waste to Nduba damp site or have a contract with a RURA registered waste disposal company to dispose it of 	Contractor	included in construction costs
25	Noise/Vibration	Noise during leveling and construction	<ul style="list-style-type: none"> • Controlling operation time to reduce impact by noise as much as possible. Use of proper automobile with inspection certificate 	Contractor	N/A

No.	Item	Impact	Mitigation Measures	Implementation/Responsible Body	Cost (USD)
27	Odor	Odors from waste and toilets	<ul style="list-style-type: none"> Regular disposal of solid waste to Nduba dump site or have a contract with a RURA registered waste disposal company to dispose it off. Mobile toilets installed on site with a person in-charge of ensuring proper hygiene of these toilets 	Contractor	included in construction costs
30	Accidents	Accidents involving workers and residents	<ul style="list-style-type: none"> Same as for occupational health hazards When wiring or removing power lines, fall prevention net will be used. 	Contractor	included in construction costs
34	Protected Plant	Cutting 2 trees of a protected species	<ul style="list-style-type: none"> Vegetation clearance should be limited within ROW. Plantation of the species removed. 	EUCL	3USD/ supplying
Operation Phase					
23	Soil pollution	Spillage of insulating oil from transformers	<ul style="list-style-type: none"> Insulating oil as well as transformers will be set in the metal box. To prevent spillage, oil dike will be set under the transformers and filled with stone chips. 	EUCL	included in construction costs
31	Electrocution	Electrocution caused by contacting with wire or tower	<ul style="list-style-type: none"> Based on IEC Standards, proper insulator set is connected to each voltage. Tower will be equipped with metals to prevent climbing and signboard indicating high voltage. Residents nearby will be informed about prevention of electrocution. Ground wires with enough capacity will be set. -EUCL operatives will check house wiring carefully 	EUCL Contractor	included in construction costs
32	Fire	Fire risks caused by broken insulators	<ul style="list-style-type: none"> Ground wires with enough capacity will be set. 	EUCL Contractor	included in construction costs

Source: JICA Study Team

1-3-1-10 Environmental Management Plan and Monitoring

Monitoring plan for each item is as below.

Table 1-3-1-10.1 Monitoring Plan

No		Item	Methods	Frequency	Responsible body
Planning Phase					
1	Involuntary Resettlement/Land acquisition	Compensation payment to bank accounts of PAPs	Counting the number of payment transaction to PAPs	Monthly until completion of land acquisition	EDCL
Construction Phase					
1	Land Use and Utilization of local resources	Work schedule and progress	Work schedule	Monthly during construction	Contractor/ EDCL

No		Item	Methods	Frequency	Responsible body
2	Existing social infrastructure and services	Rewiring of the existing line Power cut	Confirming work plan Confirming a power cut plan	During rewiring works During construction	Contractor/ EDCL
3	Occupational health hazards	Workers with protective gear Reports on accidents	Site inspection Confirming the reports	Daily during construction	Contractor/ EDCL
4	Security at construction sites	Security guards Fence Lighting at night	Site inspection	Daily during construction	Contractor
5	Protected Plant	Adherence to ROW Plantation of protected specie	Checking on no vegetation clearance outside of ROW. Confirming the number of trees planted and growth.	Monthly	Contractor/ EDCL
6	Air pollution	Inspection certification of vehicle and heavy machineries	Site inspection	Daily during construction phase	Contractor/Sector Infrastructure Department
7	Soil Pollution	PAHs, BTEX,	Soil sampling at the Ndera substation (GC/MS methods)	3 times, before, during and after construction	Contractor
8	Waste	Waste management	Site inspection	Daily during construction phase	EDCL/Sector Infrastructure Department
9	Noise/vibration	Inspection certification of vehicle and heavy machineries	Site inspection	Daily during construction phase	Contractor/Sector Infrastructure Department
10	Odor	Waste management	Site inspection	Daily during construction phase	Contractor/Sector Infrastructure Department
11	Temporary Toilets	Management of temporary toilets	Site inspection	Daily during construction phase	EDCL/Contractor
Operation Phase					
1	Electrocution	Climbing prevention measure at towers	Site inspection	At commission and regular maintenance	EUCL/Sector Infrastructure Department
2	Soil Pollution	PAHs , BTEX	Soil sampling at the Ndera substation (GC/MS methods)	Annually	EUCL
3	Fire risks	Fire prevention measures	Site inspection	At commission and regular maintenance	EUCL/Sector Infrastructure Department

Source: JICA Study Team

1-3-1-11 Stakeholder Meeting

The TOR for the EIA study by RDB is not requiring stakeholder meetings as the project's impacts are limited locally and temporarily and their characteristics are related to general construction works (e.g. noise/vibration, dust, air pollution, traffic, power cuts, etc.). However, since there were stakeholder meetings for preparation of a resettlement plan, stakeholder meetings concerning EIA were held at the timing of the meetings for resettlement for each Sector. Please refer 1-4-2-10 Stakeholder Meetings for

the date and place of the meetings.

During meetings, the proponent explained the project characteristics, components and their locations, project schedule, adverse and positive impacts by the projects, resettlement and land acquisition, compensation entitlement and process and grievance redress mechanism.

The opinions raised by stakeholders during meetings were supportive towards the implementation of the project. They were incorporated into the EIA study items and mitigation measures are reflected in the environmental management plan if any impact is expected. For the questions and answers relevant to resettlement and land acquisition, please refer 1-4-2-10 Stakeholder Meetings. The below are the summary of opinions raised during meetings.

- In case of employment opportunities related to the project, do residents in affected communities have the priority?
- Are affected area will be benefitted from this Project?
- Is there any impact of electric magnetic field from the power line?
- Are there any measures to prevent electrocution?
- Are there any measures to prevent fire risks by broken insulator or lightning?
- Will waste at construction sites be properly managed during construction to prevent odor?
- Are there any measures to prevent accidents and crime during construction?

1-3-2 Land Acquisition and Resettlement

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

In Rwanda, ROW of transmission and distribution lines is determined for each project and there are no regulations or laws concerning land acquisition within ROW. The ROW for transmission and distribution lines for this project and criteria for land acquisition and resettlement decided by REG are shown in Table 1-3-2-1.1 (Appendix 10).

Table 1-3-2-1.1 Criteria for Resettlement and Land Acquisition

Items	Criteria
ROW	110kV T/L: 15m width (7.5m +7.5m) 15kV D/L for double circuits: 10m width (5m +5m) 15kV D/L for Single circuit: 10m width (5m +5m)
Land Acquisition	Lands are acquired only where towers are erected.
Resettlement of structures lived or used by people such as houses, shops, etc.	A minimum vertical clearance from the lowest conductor to the top of structures is 5m. This is applied to the transmission line (110kV) and all distribution lines (15kV) of the project. Structures within ROW do not meet the above minimum clearance, meaning the distance between the lowest conductor and the top of structures is less than 5m, are subject of resettlement.
Resettlement of trees	All trees within ROW must be removed.
Resettlement of other objects	Other objects within ROW not meeting the minimum clearance will be

	evaluated based on social impacts and safety.
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Source: JICA Study Team

Project components and their required land are presented in Table 1-3-2-1.2. The all components are located within Gasobo District, on the western side of the Kigali City center.

Table 1-3-2-1.2 Project Components and Required Land

Component	Land Required	Note
1. Ndera substation	15,000m ²	REG has already secured a land in Free Zone developed by the Government of Rwanda (Appendix 13)
2. Transmission Line (a) Two circuits of 110 kV transmission lines from the existing line between Birembo and Gasogi substations to Ndera Substation. Approx. 2.2km.	2,836m ²	Land is required for the following structures. Connecting Point (32m x 38m) Tower Type A (256m ²) x 2 Tower Type B (169m ²) x 4 Tower Type C (144m ²) x 3
3. Distribution Line (a) Two circuits of 15 kV distribution lines from Ndera Substation to existing line between Birembo and Free Zone Phase 1 substations. Approx. 650m	2,836m ²	Land is required for the following structures. Tower Type D (64m ²) x 4
(b) One circuit of 15 kV distribution line from existing Gasogi Substation to Kabuga Ring Main Unit (RMU) Switching Station Approx. 6.5km	1,212 m ²	Land is required for the following structures. Tower Type D (64m ²) x 15 Tower Type E (9m ²) x 28
(c) One circuit of 15kV distribution line for changing the alignment of the existing 15kV distribution line.	128m ²	Tower Type D (64m ²) x 2
4. RMU Switching Stations (a) RMU Switching Stations at Kabuga and Murindi.	Kabuga 300m ² Murindi 300m ²	For both RMUs, candidate sites, without any structure, are already identified.
Access Road	Approx. 400m ²	<ul style="list-style-type: none"> • Since land for the access road is available within the proposed site for the Ndera Substation, hence land acquisition is not necessary. The road can be used during the operation phase. • For construction of transmission and distribution lines, the existing roads can be used and local labors will be employed for transportation of materials.
Storage	Approx. 5,000m ²	<ul style="list-style-type: none"> • A land within the Free Zone near the Ndera Substation can be used for storage purpose for temporarily. • For materials for transmission and distribution lines, vacant lands, storages, etc., at the communities along the site can be used temporarily with rental fees.

Source: JICA Study Team

1-3-2-2 Legal Framework on Land Acquisition and Resettlement

(1) Legal Framework in Rwanda

Legal framework for land acquisition and resettlement in Rwanda is shown in Table 1-3-1-3.1.

Law No. 18/2007 Relating to Expropriation in the Public Interest stipulates the process of land acquisition of public works. (hereinafter “ Expropriation Law”)

Ministerial Order No. 001/2006 determining the structure of land registers, the responsibilities and the functioning of the District Land Bureau regulates function and responsibilities of District Land Bureau.

Law No. 17/2010 of 12/05/2010 establishing and organizing the real property valuation profession in Rwanda states that real property valuation must be carried out by Certified Valuers (hereinafter “Valuation Law”)

(2) JICA Policies on 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) GAP Analysis between the JICA Guidelines and Laws of Rwanda

Table 1-3-2-2.1 below is analyzed gaps between the JICA Guidelines and laws of Rwanda and policies applied to fulfill the gaps.

Table 1-3-2-2.1 GAP Analysis between the JICA Guidelines and Laws of Rwanda

No.	JICA Guidelines	Laws of the Country	Gap between JICA Guidelines & Laws of the Country	Policies applied to the Project
1.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	No similar provisions in the Rwandan National Law.	Expropriation of land for public interest is regarded as inevitable and the affected persons shall be given fair and just compensation Article 3 of the expropriation law	Alternative analysis, including no project option, is conducted to minimize impacts of involuntary resettlement and loss of means of livelihood.

No.	JICA Guidelines	Laws of the Country	Gap between JICA Guidelines & Laws of the Country	Policies applied to the Project
2.	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	In the Rwandan National Law on expropriation, compensation of destroyed properties is considered	No measures to minimize impact of the displaced people	Alternative analysis, including no project option, is conducted to minimize impacts of involuntary resettlement and loss of means of livelihood. Compensation will be made for any loss caused by the project as described in this ARAP based on legislations of the country and JICA guidelines.
3.	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. (JICA GL)	There are no explicit provisions on livelihood restoration	The Rwandan legislation is silent on this matter.	Compensation will be based on full replacement costs and provided before resettlement. Assistance and supports are provided to PAPs to restore their livelihood at least at its original level, if not better.
4.	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	Compensation is calculated considering the size, nature and location and considering the prevailing market prices. (Article 22) The Expropriation Law	No gap. Although the word "market price" used in the Expropriation Law actually includes any fees, costs, taxes, etc. hence it is actually the same as "full replacement cost."	Compensation will be based on the full replacement cost, including any fees and costs involved.
5.	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	The Expropriation Law, Article 23 stated the just compensation shall be awarded to the expropriated person before he or she relocates.	No gap. Compensation will be provided prior to relocation.	Compensation and other kinds of assistance will be provided prior to displacement.
6.	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	It is not indicated in the Rwandan National Law, however it is requested by the Rwandan Development Board to be mentioned in the EIA report	No gap.	Since this project will not trigger a large scale resettlement, an ARAP will be prepared in accordance with JICA GL.
7.	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made	The expropriation law governs the specifics of land acquisition. The law provides for public dissemination on the importance of the project to be established and the	No major gap.	Consultations with PAPs and their communities was held on the 4th , 7th , 11th, 12th, 13th, 18th, 22nd, 26th May 2015 in community groups. Individual PAP

No.	JICA Guidelines	Laws of the Country	Gap between JICA Guidelines & Laws of the Country	Policies applied to the Project
	available to them in advance. (JICA GL)	need for expropriation. (Article 11, 12, 13)		consultations and local authorities were done through to mid-June. Information on the project and ARAP was provided in advance.
8.	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	The medium of exchange in Rwanda is Kinyarwanda and all Rwandans can hear and speak Kinyarwanda language.	No gap	Kinyarwanda will be used in consultation and Compensation payment agreements with PAPs are prepared in Kinyarwanda.
9	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	General Guidelines and Procedure for EIA states public participation in planning and decision making for the project.	There are no specific guidelines for participation of affected people in planning, implementation, and monitoring of RAP.	Consultations during EIA and ARAP preparation will be used as opportunities for public participation in ARAP planning, implementation and monitoring.
10.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	The expropriation law article 26 provides complaints procedures for individuals dissatisfied with the value of their compensation. The law stipulates that the dissatisfied person has a period of 30 days after the project approval decision has been taken to appeal(Article 19)	No gap.	An appropriate and accessible grievance mechanism will be established. (Refer to chapter 6 of this ARAP)
11.	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. (WB OP4.12 Para.6)	According to the Rwandan expropriation law, the census of the affected people is conducted as well as inventory of their properties at the beginning of the land survey, which is considered the cut-off date. (Article 17)	No gap in terms of conducting inventory and establishment of cut –off date. However, no socio-economic survey is conducted by government funded projects.	An initial baseline survey (including socio-economic survey) will be conducted based on WB OP 4.12. A cut-off date for this project is the 13th May 2015.
11.	Eligibility of benefits includes, the PAPs who have formal legal rights to	The Rwandan legislation (organic land law 5, 6, 7) defines the eligibility as	There is a gap. The Rwandan legislation does not specifically	Follow the OP4.12 guidelines and principles. Eligibility to benefits

No.	JICA Guidelines	Laws of the Country	Gap between JICA Guidelines & Laws of the Country	Policies applied to the Project
	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. (WB OP4.12 Para.15)	both formal (legal) and informal (customary) owners of expropriated land. Article 18 of the Expropriation law considered in addition to legal documents, a document or testimony of the neighbors confirming ownership for the land as an evidence.	recognize all users of land to be expropriated while OP 4.12 chapter 14(a),(b),(c) entitles those with formal legal rights to land, those with no formal legal rights to land and those who have no recognizable right or claim to the land they are occupying	includes both formal and informal owners of land and owners of other assets affected by the Project.
12.	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are Land-based. (WB OP4.12 Para.11)	Article 23 of the expropriation law provides for fair and just compensation and it stipulates that this could be monetary or an alternative land or a building equivalent to the determination of just monetary compensation.	No major gap.	Due to the fact that land owners as well as displaced persons opted for full payment compensation as opposed to land to land, monetary based compensation will be generally applied.
13.	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	There are no explicit support for transition period and livelihood restoration	The Rwandan legislation is silent on this matter.	Since full compensation is by cash transfer payment as opted by all PAPs, there will be no need for support during transition period. It shall be observed that property can only be acquired after PAP has been paid.
14.	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. (WB OP4.12 Para.8)	No clear provision on the vulnerable groups among those displaced	The Rwandan legislation is silent on this matter.	No vulnerable groups were found in this project area hence would not apply.
15.	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)	No indication in the Rwandan National law	The Rwandan legislation is silent on this matter	PAPs were fewer than 200 people hence ARAP will be prepared for this project.

Source: JICA Study Team

(4) Policies Applied to the Project

I. The Government of Rwanda will use the Project Resettlement Policy (the Project Policy)

for the “IMPROVEMENT OF SUBSTATIONS, TRANSMISSION AND DISTRIBUTION NETWORK IN KIGALI PHASE 2” specifically because existing national laws and regulations have not been designed to address involuntary resettlement according to international practice, including JICA’s policy. The Project Policy is aimed at filling-in any gaps in what local laws and regulations cannot provide in order to help ensure that PAPs are able to rehabilitate themselves to at least their pre-project condition. This section discusses the principles of the Project Policy and the entitlements of the PAPs based on the type and degree of their losses. Where there are gaps between Rwanda’s legal framework for resettlement and JICA’s Policy on Involuntary Resettlement, practicable mutually agreeable approaches will be designed consistent with Government practices and JICA’s Policy.

- II. Land acquisition and involuntary resettlement will be avoided where feasible, or minimized, by identifying possible alternative project designs that have the least adverse impact on the communities in the project area.
- III. Where displacement of households is unavoidable, all PAPs (including communities) losing assets, livelihoods or resources will be fully compensated and assisted so that they can improve, or at least restore, their former economic and social conditions.
- IV. Compensation and rehabilitation support will be provided to any PAPs, that is, any person or household or business which on account of project implementation would have his, her or their:
 - Standard of living adversely affected;
 - Right, title or interest in any house, interest in, or right to use, any land (including premises, agricultural and grazing land, commercial properties, tenancy, or right in annual or perennial crops and trees or any other fixed or moveable assets, acquired or possessed, temporarily or permanently;
 - Income earning opportunities, business, occupation, work or place of residence or habitat adversely affected temporarily or permanently; or
 - Social and cultural activities and relationships affected or any other losses that may be identified during the process of resettlement planning.
- V. All affected people will be eligible for compensation and rehabilitation assistance, irrespective of tenure status, social or economic standing and any such factors that may discriminate against achievement of the objectives outlined above. Lack of legal rights to the assets lost or adversely affected tenure status and social or economic status will not bar the PAPs from entitlements to such compensation and rehabilitation measures or resettlement objectives. All PAPs residing, working, doing business and/or cultivating land within the project impacted areas as of the date of the latest census and inventory of

lost assets(IOL), are entitled to compensation for their lost assets (land and/or non-land assets), at replacement cost, if available and restoration of incomes and businesses, and will be provided with rehabilitation measures sufficient to assist them to improve or at least maintain their pre-project living standards, income-earning capacity and production levels.

- VI. PAPs that lose only part of their physical assets will not be left with a portion that will be inadequate to sustain their current standard of living. The minimum size of remaining land and structures will be agreed during the resettlement planning process.
- VII. People temporarily affected are to be considered PAPs and resettlement plans address the issue of temporary acquisition.
- VIII. Where a host community is affected by the development of a resettlement site in that community, the host community shall be involved in any resettlement planning and decision-making. All attempts shall be made to minimize the adverse impacts of resettlement upon host communities.
- IX. The resettlement plans will be designed in accordance with Rwanda's expropriation law No. 18/2007 and JICA's Policy on Involuntary Resettlement.
- X. The Resettlement Plan will be translated into local languages and disclosed for the reference of PAPs as well as other interested groups.
- XI. Payment for land and/or non-land assets will be based on the replacement cost.
- XII. Compensation for PAPs dependent on agricultural activities will be land-based wherever possible. Land-based strategies may include provision of replacement land, ensuring greater security of tenure, and upgrading livelihoods of people without legal land titles. If replacement land is not available, other strategies may be built around opportunities for re-training, skill development, wage employment, or self-employment, including access to credit. Solely cash compensation will be avoided as an option if possible, as this may not address losses that are not easily quantified, such as access to services and traditional rights, and may eventually lead to those populations being worse off than without the project.
- XIII. Replacement lands, if the preferred option of PAPs, should be within the immediate vicinity of the affected lands wherever possible and be of comparable productive capacity and potential. As a second option, sites should be identified that minimize the social disruption of those affected; such lands should also have access to services and facilities similar to those available in the lands affected.
- XIV. Resettlement assistance will be provided not only for immediate loss, but also for a transition period needed to restore livelihood and standards of living of PAPs. Such

support could take the form of short-term jobs, subsistence support, salary maintenance, or similar arrangements.

- XV. The resettlement plan must consider the needs of those most vulnerable to the adverse impacts of resettlement (including the poor, those without legal title to land, ethnic minorities, and women, children, elderly and disabled) and ensure they are considered in resettlement planning and mitigation measures identified. Assistance should be provided to help them improve their socio-economic status.
- XVI. PAPs will be involved in the process of developing and implementing resettlement plans.
- XVII. PAPs and their communities will be consulted about the project, the rights and options available to them, and proposed mitigation measures for adverse effects, and to the extent possible be involved in the decisions that are made concerning their resettlement.
- XVIII. Adequate budgetary support will be fully committed and made available to cover the costs of land acquisition (including compensation and income restoration measures) within the agreed implementation period. The funds for all resettlement activities will come from the Government.
- XIX. Displacement does not occur before provision of compensation and of other assistance required for relocation. Sufficient civic infrastructure must be provided in resettlement site prior to relocation. Acquisition of assets, payment of compensation, and the resettlement and start of the livelihood rehabilitation activities of PAPs, will be completed prior to any construction activities, except when a court of law orders so in expropriation cases. (Livelihood restoration measures must also be in place but not necessarily completed prior to construction activities, as these may be ongoing activities.)
- XX. Organization and administrative arrangements for the effective preparation and implementation of the resettlement plan will be identified and in place prior to the commencement of the process; this will include the provision of adequate human resources for supervision, consultation, and monitoring of land acquisition and rehabilitation activities.
- XXI. Appropriate reporting (including auditing and redress functions), monitoring and evaluation mechanisms, will be identified and set in place as part of the resettlement management system. An external monitoring group will be hired by the project and will evaluate the resettlement process and final outcome. Such groups may include qualified NGOs, research institutions or universities.

Cut-off-date of Eligibility

In the Project, Cut-off dates for titleholders will be the date of notification under the Expropriation law No.18/2007 and for non-titled holders will be the beginning date of the census

survey; 13th /May/2015. This date was disclosed to the PAPs during preliminary meetings with PAPs and local authorities held on the 4th and 11th May, 2015, informed individually and through meetings that any development after the valuation exercise shall not be compensated.

Principle of Replacement Cost

All compensation for land and non-land assets owned by households/shop owners who meet the cut-off-date will be based on the principle of full replacement cost. Full replacement cost is the amount calculated before displacement which is needed to replace an affected asset without depreciation and without deduction for taxes and/or costs of transaction.

Based on the above policies, an Abbreviated Resettlement Action Plan was prepared for this project (Appendix 14).

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

(1) Census Survey

A census survey was carried out from the 13th May, 2015 and this is set as the project cut-off date. REG notified Gasobo District and four Sectors under the District to inform affected Sectors, Cells and villages not to carry out any development activities within the project sites. The residents nearby the project sites are also informed on the 4th and 11th of May about the cutoff date and commencement of the census survey and that any construction, expansion or improvement on their assets and people coming into the area after the cut-off date are not eligible for compensation or assistance.

The results of the census counted that there will be 59 households and 191 persons affected by the project. Out of which 3 households (13 persons) are required to displace their houses. However, they can rebuild their houses within their properties left after acquisition or property nearby. For other 10 households, the land after acquiring the project target portion is not economically viable, hence the entire properties will be acquired. All the project affected households own other properties within the vicinity or their livelihoods are not depending on the affected land, they do not need to change their residence or farming lands from the present living areas.

Table 1-3-2-3.1 Project Affected Households (PAHs) and Affected Persons(APs)

Type of Loss	PAHs			APs		
	Legal	Illegal	Total	Legal	Illegal	Total
Required for Displacement						
1. Households (Structure on Private Land)	3	-	3	13	-	13
Not Required for Displacement						
2. Land Owners	46	-	46	148	-	148
3. Tree/Crop Owners without Land	10	-	10	30	-	30
Total			59			191

Source: JICA Study Team

Out of the 46 land owners affected by the project, 4 persons are living outside of Kigali or abroad and could not be contacted so far (“Absent PAPs”). For other 8 PAPs, they were informed about the project, however, they have not reached to consensus as of the end of August 2015. The process for consensus making with these PAPs is explained in 1-3-2-4(4) Absent PAPs and PAPs under Consensus Making.

(2) Asset Inventory

The assets affected by the project are mainly land, crops and trees. The structures affected by the project are three houses and one annexure to one of the houses.

Table 1-3-2-3.2 shows the affected land area and land use type of each Sector. If the land remained after acquisition for construction of towers and RMUs are determined as “not economically viable” due to its small sizes and odd shapes, by agreements with PAPs, the remaining lands are also acquired.

Table 1-3-2-3.2 Affected Land Area and Type by Sector

No.	Sector	Land Type	Affected Area (m ²)
I	Bunbogo	Agricultural	11,462.48
II	Rusororo	Agricultural	689
III	Ndera	Agricultural	1,416.72
IV	Nyarugunga	Residential	971
Total			14,539.2

Source: JICA Study Team

Table 1-3-2-3.3 indicates the buildings to be affected by the project. Figure 1-3-2-3.1 is an example of such buildings.

The affected buildings are three houses and one annexure to one of the houses. However, the affected households of these buildings are able to rebuild their houses within the original property or other properties within the vicinity of the original ones, hence it will not cause any change in their livelihood or living environment in negative way.

Table 1-3-2-3.3 Buildings to be Affected

No	Sector	Type of Structure	Number	Price (RWF)
I	Bunbogo	Single story, mud brick, residence	1	3,980,088.69
		Single story, mud brick, residence	1	3,676,962.24
		Single story, mud brick, annexure to residence	1	1,016,959.6
II	Ndera	Single story, mud brick residence	1	711,367.62
Total			4	9,385,378.15

Source: JICA Study Team



Figure 1-3-2-3.1 Example of Affected Buildings

The following table shows the affected agricultural land and type of crops. For this project, after the construction works have finished, agricultural activities are allowed, hence the impact on PAPs are only temporary.

Table 1-3-2-3.4 Affected Crops

Crop Type	Affected Area (m ²)
Napier grass "Ubwatsi bw'inka"	3119
Peas "Amashaza"	881
Cassava leaves "Isombe"	26
Sweet potatoes "Ibijumba"	951
Maize "Ibigori"	1971
Beans "Ibishyimbo"	2243.8
Sorghum "Amasaka"	390
Ground nuts "Ubunyobwa"	700
Imiravumba	86
Passparum	789
Flowers "Indabo"	168
Tomatoes "Inyanya"	284.7
Total	11,609.5

Source: JICA Study Team

Trees that will be affected by the project and subject for compensation are mainly eucalyptus trees (12,317 trees), and a type of spurge locally called "Imiyenzi." In total, 26 species and 20,622 plants will be affected.

(3) Socio-Economic Baseline of PAPs

Out of 59 PAHs, sixteen (16) households are headed by females. However, in Rwanda, women has equal right for possession of property and with higher achievement by women, female headed household means simply woman has properties and does not mean social vulnerable household.

Table 1-3-2-3.5 Socio-Economic Information of PAHs

Gender of Heads of Households	Male : 43, Female : 16
Average age of Heads of Households	Male : 47years old, Female : 45years old
Average Number per Household	7 members
Typical House Type	Earth brick houses, plastered with cement mortar and iron sheet roofing
Number of handicapped persons	6 persons
Livelihood of Heads of Affected Households	Farming 32 Kiosk 12 Employment 8 Civil Servant 6 Student 1
Land owned by PAPs	Maximum area owned by one PAP : 26,983m ² Minimum area owned by one PAP : 222m ² Average area owned by PAPs : 13,602m ²

Source: JICA Study Team

The information on the Gasobo District and its Sectors directly affected by the project, such as Bunbogo, Ndera and Rusororo is as follows.

Table 1-3-2-3.6 Socio-Economic of Gasobo District

Rate of households above poverty line	86.8%
Rate of households with appliance	Mobile phone 75.5% Radio 57.5% TV 27.1%
Rate of households with at least one savings account	61.2%
Employment rate	78%

Source: Fourth Population and Housing Census-2012, National Institute of Statistics of Rwanda

Table 1-3-2-3.7 Population by Affected Sector

Sector	Population			Population Density (km ²)
	Total	Male	Female	
Bunbogo	35,891	17,926	17,965	592
Ndera	41,785	20,954	20,831	830
Rusororo	36,215	18,291	17,924	693

Source: Fourth Population and Housing Census-2012, National Institute of Statistics of Rwanda

(4) Vulnerable Group

There are 6 handicapped persons among the PAPs. However, there is no household which is headed by social vulnerable persons. As mentioned above, female headed households are not considered as vulnerable households, as it simply means that female member of the house is the owner of assets.

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

(1) Compensations toward Loss

The cutoff date for compensation and assistance is 13 May 2015.

The Resettlement and Compensation Committees, comprised of members from EDCL and

Sector authorities are established at each Sector. Their duty is to verify whether all assets valued and all PAPs have been fully compensated at the full replacement cost agreed by both the PAP and EDCL.

Losses caused by the Project and compensation toward them are as summarized below.

Loss of Land

A total of 14,539.2m² will be lost by the project. If the remaining land is considered economically not viable in terms of the size and shape and if PAPs opt to, the remaining land or the land larger than the area required for the project is acquired based on consensus of the owner. Compensation is at full replacement cost based on the recent market price. Since all PAPs prefer monetary compensation, there is no land for land compensation.

Loss of Houses

The project causes loss of 4 structures (3 houses and 1 annexure). The 3 affected households are able to relocate them within original property or properties nearby. Compensation will be paid at full replacement cost toward construction materials, labors, etc. Since there is enough time for the construction of new houses, there is no assistant for transitional period.

Loss of Agricultural Crops

A total of 11,609.5m² of agricultural land within ROW is temporarily affected. The crops affected by the project are compensated at the average price of the last three years. After the completion of the construction works, people are allowed to cultivate, hence the impacts on the PAPs are temporarily.

Loss of Trees

A total of 20,622 trees within ROW will be cleared by the project. They will be compensated based on the species, tree age, etc.

(2) Livelihood Restoration

As mention in the above, there will be only 3 households to be relocated, but they will relocate within the original living area. Throughout the PAHs, the project is not expected to cause any significant change in their living conditions and livelihood. However, during the construction, agricultural activities within ROW are suspended. To compensate this, employment opportunities during the construction will be provided to PAPs with priority. Female PAPs should be provided with the opportunities equally, whenever possible.

(3) Entitlement Matrix

Based on the laws of Rwanda, JICA guidelines, and World Bank Safeguards Policies, compensation and assistance by the project, entitlements, and compensation calculation methods

are summarized in the matrix below.

Table 1-3-2-4.1 Entitlement Matrix

Type of Loss	Entitled Person	Type of Impact	Compensation/Entitlement/ benefits	Responsible Organization
Land (Agricultural/residential)	Title holder	No displacement Less than 20% of land holding affected, the remaining land remains economically viable.	Cash compensation for affected land equivalent to full replacement cost	EDCL/ MINECOFIN
		Displacement More than 20% of land holding lost or less than 20% of land holding lost but remaining land not economically viable	Cash compensation for affected land equivalent to full replacement cost	
	Rental/lease holder	No displacement: Land used for residence partially affected, limited loss, and the remaining land remains viable for present use	Cash compensation equivalent to 10% of lease/ rental fee for the remaining period of rental/ lease agreement (written or verbal)	EDCL/MINEC OFIN
Buildings and structures	Owner	Displacement: Entire structure affected or structure partially affected but the remaining structure is not suitable for continued use	Cash compensation of full replacement cost for entire structure and other fixed assets without depreciation, or alternative structure of equal or better size and quality in an available location which is acceptable to the PAP. Right to salvage materials without deduction from compensation.	EDCL/MINEC OFIN
Standing crops	1. Land owners 2. Crop Owner	Crops affected by land acquisition or temporary acquisition or easement	Cash compensation equivalent to average of last 3 years market value/ full replacement cost for the mature and harvested crop. For crop owners with lease title: Cash compensation for the harvest of the affected land equivalent to average market value (full replacement cost) of last 3 years, or market value (full replacement) of the crop for the remaining period of tenancy/ lease agreement, whichever is greater.	EDCL/MINEC OFIN
Trees	1. Land owners 2. Tree Owner	Trees lost	Cash compensation based on type, age and productive value of affected trees plus 10% premium	EDCL/MINEC OFIN
Temporary Acquisition	1. Owner 2. Tenant/occupant	Temporary acquisition	Cash compensation for any assets affected (e.g. boundary wall demolished, trees removed)	EDCL/MINEC OFIN

Source: JICA Study Team

(4) Absent PAPs and PAPs under Consensus Making

To contact and have consensus with the four (4) absent PAPs, EDCL will continue to gather

information at District Land Bureau and from the neighbors. As of now, mobile phone numbers of the PAPs are the only contacts available, EDCL will call or send SMS messages, and communication logs will be recorded. Sign board with EDCL's phone number will be put at the targeted land plot and neighbors and relevant village and Cell Leaders will be asked for collaborating to communicate with the absent PAPs.

Since there are land owners around the Kigali City who only possess properties as assets, but are not actually residing nor carrying out any livelihood activities on the land, REG has carried out land acquisition with such cases by the laws and practices of Rwanda. By Article 25 of the Expropriation Law, once compensation amount is approved by the District Land Bureau, compensation must be paid to the PAP within 120days. After 30days of presentation of compensation amount to the PAP, if he or she fails to present a bank account, the compensation amount will be paid into an account at District Bureau, and later the PAP can withdraw the amount from the account. Whenever owners of land subject to land acquisition are absent or not identified, this process is normally carried out (According to the social safeguard officer of EDCL, a transmission line project by AfDB has also applied this process.)

Concerning the eight (8) PAPs who have not reached consensus, the reasons for not agreeing are: "the subject land is under mediation and the land owner is not yet decided (1 PAP)," "the land owners are requesting EDCL to acquire their entire property instead of the portion required project alone (2 PAPs)," and "the land owners are informed about the project, but they are ignoring communication by EDCL (5 PAPs). According to the social safeguards officers of EDCL, around the Kigali City, there has been many development plans, both private and public, however they were never materialized, hence land owners in the areas will not be interested in negotiation, unless the project become more concrete. EDCL will continue to consult with PAPs to reach consensus before the implementation of the project.

If the PAPs who are absent or have not reached consensus have any complaint or grievance, the grievance redress mechanism below will be available.

1-3-2-5 Grievance Redress Mechanism

Grievances and complaints for the ARAP of the project will be dealt as below based on Article 19 and 26 of the Expropriation Laws and locally practiced conflict resolution methods at community level. Beside the Resettlement and Compensation Committees at Sector level, an independent group comprised with representatives of PAPs, Sector authorities, and representative from EDCL will be formed at each Sector in order to supervise that grievances are handled properly.

Stage 1- PAP will raise the issue with Village leaders "locally called Umudugudu" for a solution to be reached. If the resolution at this stage does not satisfy the PAP, it is raised to the next stage.

Stage 2- The issue is raised at the Cell level "locally called Akagali". At this stage are Cell mediators "locally called Abunzi" that sort out matter below a threshold of 5Million Rwanda Francs. Here the

grievance is assessed by these mediators in the presence of the PAP and written resolution declared. Should it not be satisfying to the PAP, then the PAP will raise it with the next stage.

Stage 3- At the Sector level; where a team from the Sector and District land commission seat to resolve the issues between the PAP and developer (EDCL). In case grievance reached this stage, it is at this level that from previous projects, effective resolutions are passed to the satisfaction of both parties.

Stage-4-However, should the above fail, the matter is raised by the grieving PAP to the Courts of law.

The above mentioned process is explained to the PAPs through the public consultations, negotiation at the individual level and a monthly village meeting. From Stage 1 to 3, the process will not involve any fees, however at Stage 4, fees for a legal service and valuation will be borne by the PAPs with grievance. The entire process at any stage will be carried out in Kinyarwanda.

At any stage, EDCL will be present in discussion. According to REG, all cases of grievance or complaints have been resolved up to Stage 2.

Grievances and complaints should be dealt within 30 days. However, even after this period, they will be dealt until they are resolved.

This grievance mechanism will be available until consensus are reached with all PAPs and compensation payment to all PAPs is completed.

1-3-2-6 Institutional Framework

Institutional framework for implementation of the ARAP is as follows

(1) EDCL Environmental and Social Safeguards Team (tentative name)

The team is responsible for environmental and social considerations of REG projects. There are 3 environmental safeguards experts and 2 social safeguards experts. At this point, the name of the team is tentative. EDCL uses the World Bank safeguards policies as a benchmark. Preparation and implementation of resettlement plans are carried out by the social safeguards experts.

(2) Resettlement and Compensation Committee

The committee will be established at the Sector level and will be comprised of Sector authorities and EDCL social safeguards experts. Their duty is to verify whether all assets valued and all PAPs have been fully compensated at the full replacement cost agreed by both the PAP and EDCL.

(3) EUCL Finance Department

It is responsible of submission of compensation forms prepared in accordance with the ARAP and approved by social safeguards experts, along with payment orders to Ministry of Finance

and Economic Planning.

(4) District Land Bureau

It is responsible for land management (land registration, land use, supervising property transactions, etc.) at Sector Level.

(5) EUCL Finance Department

Shall be responsible for disbursing the full replacement compensation to verified PAPs as per list and bank accounts submitted by EDCL.

1-3-2-7 Implementation Schedule

Responsible organizations and the schedule for the ARAP preparation and implementation are shown in Table 1-3-2-7.1. This schedule is applicable to the PAPs who have already reached consensus. For those who are absent or have not reached consensus, the process to be taken are the same but the timing when each process happens may differ, depending on the PAPs. In any case, it is aimed to reach consensus with all PAPs and complete compensation payments by the tender document preparation stage (April 2016).

Table 1-3-2-7.1 Implementation Schedule and Responsible Organization

Process	Responsible Organization	2015						
		May	Jun	Jul	Aug	Sept	Oct	Nov
1. ARAP Preparation	EDCL	X	X	X	X			
2. Preparation of compensation forms	EDCL, Sector/Cell leaders, District Land Bureau			X	X	X		
3. Approval of compensation forms	EDCL Social Safeguard Expert				X	X		
4. Financial arrangement in EDCL	EDCL Social Safeguard Specialist, Finance Department				X	X		
5. Submission of compensation payment order to MINECOFIN	EDCL Finance Department					X		
6. Payment order to the Bank	MINECOFINE					X	X	
7. Compensation Payment	Banko of Rwanda					X	X	X

Source: JICA Study Team

1-3-2-8 Cost and Finance

Costs for land acquisition and resettlement and budget required for implementation, and their breakdowns are as follows. EDCL is responsible for securing the fund for costs displayed in the ARAP.

Table 1-3-2-8.1 Cost and Budget for Implementation

Item	Cost(Rwf)
Compensation costs	165,834,553
ARAP Implementation budget	16,515,751
Total	182,350,304

Source: JICA Study Team

Table 1-3-2-8.2 Cost of Compensation

Items for Compensation	Cost (Rwf)
Land	111,344,377.
Crops/Trees	45,104,798
Buildings	9,385,378
Total	165,834,553

Source: JICA Study Team

Table 1-3-2-8.3 Breakdowns for Implementation Budget

	Activities	Responsible Organization	Unit	Quantity	Cost(Rwf)
1	Implementation Preparation				
	EDCL Internal Training	EDCL	Lump sum	1	300,000
	Consultation with Sector Leaders	EDCL/ Sector Leaders	Trips	6	60,000
	Consultations with PAPs through Sector and Cell authorities on progress of project and compensation	EDCL/Cell Leaders, Sector Leaders	Trips	5	50,000
2	Implementation				
	Notification to PAPs of Compensation Payment	EDCL/ Sector Leaders	Trips	3	30,000
	Grievance Redress	EDCL/ Sector Leaders	Lump sum	1	200,000
3	Contingency	EDCL Sector Leaders			
	Contingency funds for increased costs	EDCL	Lump sum	1	15,775,751
4	Documentation of compensation process	EDCL	Lump sum	1	100,000
	Total				16,515,751

Source: JICA Study Team

1-3-2-9 Monitoring System

The monitoring will be carried out by a committee composed of; Sector representatives, representatives at the Cell level and EDCL, to ensure that all of the responsible implementing agencies follow the schedule and comply with the principles of the ARAP.

For the absent PAPs, if the compensation is paid by the procedure regulated in Uganda, EDCL will continue to monitor on them.

A draft of monitoring form for land acquisition is under 1-3-3-1 Draft Monitoring Forms.

1-3-2-10 Stakeholder Meeting

Since this project covers 4 Sectors and components can be divided in 3 locations, considering the convenience of participants, stakeholder meetings are held at Sector or Cells. The PAPs who could not attend the meetings, are visited individually or explained over the phone.

Since there is only 1 PAH for the land for Murindi RMU, which is located within Nyaragunga Sector, a meeting was held only with the land owner and representatives of the Sector and Cell.

During the meetings and individual discussion, the project characteristics, components and their locations, project schedule, adverse and positive impacts by the projects, the necessity and scope of resettlement and land acquisition, entitlement, calculation methods, process and schedule of compensation and grievance redress mechanism were explained to the PAPs. The PAPs were agreed on the items explained in the meetings and discussions.

PAPs were involved in the process of documentation and valuation of their assets. Property valuation forms were presented to PAPs for verification, once they were comfortable with the proposed full replacement cost for their property, they signed or thumb pressed in ink against their names as a sign of agreement. These compensation agreement forms shall compose the Volume II of the ARAP report. The ARAP in English and Kinyarwanda will be disclosed after the approval by REG and a translated copy of ARAP in Kinyarwanda will be displayed at Cell, Sector and District offices.

The summary of stakeholder meetings at each Sector is shown in the table below.

Table 1-3-2-10.1 Summary of Stakeholder Meetings

	Date	Participants	Agenda
Bunbogo Sector			
First Round	4 May 2015	Representatives from Sector/Cell 10 participants	Project brief and necessity for land acquisition
Second Round	7 May 2015	Representatives from Sector/Cell 3 participants	Confirmation on project sites and request for consultations with PAPs
Third Round (Musave Cell)	11 May 2015	PAPs, Representatives from Cell 14 participants	Project brief and sites, necessity for land acquisition, loss and compensation methods, etc. . Q & A
Third Round (Kyaga Cell)	12 May 2015	PAPs, Representatives from Cell 6 participants	Same as above
Rusororo Sector			
First Round	13 May 2015	Representatives from Sector/Cell 2 participants	Project brief and necessity for land acquisition
Second Round	18 May 2015	Representatives from Cell 1 participant	Confirmation on project sites and request for consultations with PAPs
Third Round	22 May 2015	PAPs, Representatives from Cell 6 participants	Project brief and sites, necessity for land acquisition, loss and compensation methods, etc. . Q & A
Ndera Sector			
First Round	22 May 2015	Representatives from Sector/Cell 8 participants	Project brief and necessity for land acquisition , Confirmation on project sites and request for consultations with PAPs
Second Round	22 May 2015	PAPs, Representatives from Cell	Project brief and sites, necessity for land acquisition, loss and

		20 participants	compensation methods, etc. ◦ Q & A
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Source: JICA Study Team

Main questions and comments raised by participants and responses from EDCL are summarized in the table below.

Table 1-3-2-10.2 Main Questions and Answers

Questions/Comments	Questioner	Responses from EDCL
What are the assets that are subject for compensation? How the compensation is calculated? When the compensation will be paid? Is it paid before the construction starts?	PAPs Sector/Cell Representatives	Compensation will be paid for the loss of land, structure, trees and crops at a full replacement cost in accordance with a resettlement action plan. Compensation will be paid before relocation and construction.
Does this project bring any benefits such as power supply in the affected areas?	Sector/Cell Representatives PAPs	The project will supply power to Bunbogo, Ndera and Rusororo Sectors, so there will be benefits to the areas.
Are there any employment opportunities during construction?	PAPs Community residents	There will be employment opportunities and PAPs will be provided with more priority.
The construction work plan should be presented beforehand.	Sector/Cell Representatives	The construction work plan will be presented to Sector and Cell representative. If any changes, they will be notified.

Source: JICA Study Team

1-3-3 Others

1-3-3-1 Draft Monitoring Form

Below are drafts of monitoring forms based on the EMP and for resettlement and land acquisition.

Environmental Management

Construction Phase

	Monitoring Item	Parameters to be monitored	Monitoring result and reports made during this period	Measures to be taken	Frequency
1	Land use & Utilization of local resources	Construction Duration			Before construction commencement and quarterly during construction phase
2	Existing social infrastructure and services	Existing line re-routed			During construction of Route 3
3	Occupation health hazards	Workers with protective gear Records of accidents			Monthly
4	Security in the project area	Hoarding fence, light and security guards			Throughout the construction phase

	Monitoring Item	Parameters to be monitored	Monitoring result and reports made during this period	Measures to be taken	Frequency
5	Protected flora species	<ul style="list-style-type: none"> • ROW width dimensions • Number of Umuco trees offset in tree nursery 			Throughout the construction phase
6	Air pollution	Automobiles with inspection certificates			Throughout the construction phase
7	Soil degradation/pollution	Soil parameters; PAHs, BTEX,			Before construction, mid-term of construction and end of construction
8	Solid Waste	Solid waste on site			Throughout the construction phase
9	Noise/Vibration	Automobiles with inspection certificates			Throughout the construction phase
10	Odor	Solid waste on site			Throughout the construction phase
11	Poor sanitation	Clean mobile toilets on site			Throughout the construction phase

Operation Phase

	Monitoring Item	Parameters to be monitored	Monitoring result/reports made during this period	Measures to be taken	Frequency
1	Human electrocution	Towers with proposed mitigation precautionary measures installed			At commissioning of the construction completion
2	Soil degradation/pollution	Soil parameters; PAHs and BTEX			Annually
3	Fire risk	Towers with proposed mitigation precautionary measures installed			At construction completion. Also inspection throughout operation as part of Operation and Maintenance.

Resettlement and Land Acquisition

Monitoring on land acquisition and resettlement will be conducted monthly by EDCL.

Activities	Expected Date Completion	Responsible Organization.
Approval of ARAP		EDCL
Processing Compensation Fund	31 Oct 2015	EDCL/ MINECOFIN

Progress of Compensation Payment and Land Acquisition

Components	Planned Total	Unit	Monthly Progress			Progress in %		Expected Date Completion	Responsible Organization.
			Sept 2015	Oct 2015	Nov 2015	Till the last month	Up to the month		
Compensation Payment									
Ndera Substation area	20	HH						30 Nov 2015	EDCL/ MINECOFIN
15kV DL Gasogi-Kabuga	38	HH						30 Nov 2015	EDCL/ MINECOFIN
Murindi RMU	1	HH						30 Nov 2015	EDCL/ MINECOFIN
Total	59	HH						30 Nov 2015	EDCL/ MINECOFIN
Land Acquisition									
Ndera Substation area	11,462.48	m ²						30 Nov 2015	EDCL/Sector Leader
15kV DL Gasogi-Kabuga	2105.72	m ²						30 Nov 2015	EDCL/Sector Leader
Murindi RMU	971	m ²						30 Nov 2015	EDCL/Sector Leader
Total	14,539.2	m ²						30 Nov 2015	EDCL/Sector Leader

Note: The figures in this table include the PAPs without consensus and absent

Progress of Consensus with PAPs absent and without consensus

Type of PAPs	Number	Unit	Monthly Progress							Expected Date Completion	Responsible Organization.
			Sept 2015	Oct 2015	Nov 2015	Dec 2015	Jan 2016	Feb 2016	Mar 2016		
Absent	4	HH									EDCL
Without Consensus	8	HH									EDCL
Total	12	HH									EDCL

Remarks on Progress with PAPs absent and without consensus

No.	Name of PAP	Status/Progress in this month	Action Plan for the next month
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

1-3-3-2 Environmental Check List

The below is the Environmental Check List of the Project based on the JICA Guidelines for Environmental and Social Consideration.

Table 1-3-3-2.1 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, 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? (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?	(a) Y (b) (c) (d)	(a)-(c) The EIA report has been already approved on 25 Aug. 2015. Conditions are general issues concerning the construction works and they are already addressed in the EIA report with mitigation measures and monitoring plan. (d) No additional approval is required.
	(2) Explanation to the 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) Stakeholder meetings are held at least twice at Sector level during EIA/ARAP study. PAPs who could not attend the meetings were contacted individually. For absent PAPs, EDCL continues to attempt to contact with them. (b) Main comments raised during meetings are concerning compensation for loss and employment opportunities during construction, and they are addressed in ARAP.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Alternative plans, including no-project option are examined. Different routes for transmission lines and distribution lines, and locations of the Ndera substation and two RMUs were examined. There is no major difference in terms of impacts on natural environment among alternatives; however, the present project is most preferable in terms of lower impacts on social and economic aspects.
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) There are no rivers or water areas around the project sites.
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) The Project site is within Kigali City and there is no protected area nearby. The Project will not affect the protected area.
	(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?	(a) N (b) N (c) N (d) N (e) N	(a) There is no forested area near the project site. (b) There is no protected habitat of endangered species. (c) No significant ecological impact is anticipated. (d) No significant impacts are expected on habitat fragmentation and migration routes.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		<p>(c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?</p> <p>(d) Are adequate measures taken to prevent disruption of migration routes and habitat fragmentation of wildlife and livestock?</p> <p>(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 considered?</p> <p>(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?</p>	(f)N	<p>(e) There is no such possibility as there is no important ecosystem near the project site. The project will not introduce non-native invasive species or pests.</p> <p>(f)The project site is within Kigali city, which is already developed.</p>
3 Natural Environment	(3) Topography and Geology	<p>(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?</p> <p>(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?</p> <p>(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?</p>	<p>(a)N</p> <p>(b)Y</p> <p>(c)Y</p>	<p>(a)The study confirmed that there was hard soil at 2m below the surface. For the structure bases, the top soft soil will be removed and the hard soil will be directly used as bases.</p> <p>.(b)-(c)The site for Ndera Substation requires land preparation, by cutting soil from the north side and filling to the south side of the land. The slope is gentle and will not cause landslides. To avoid soil runoff, the rain gutter will be created the top and bottom of the slope. There will be no soil waste to cause soil run off.</p>
4 Social Environment	(1) Resettlement	<p>(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement?</p> <p>(b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement?</p> <p>(c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?</p> <p>(d) Are the compensations going to be paid prior to the resettlement?</p> <p>(e) Are the compensation policies prepared in document?</p> <p>(f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, and people below the poverty line, ethnic minorities, and indigenous peoples?</p> <p>(g) Are agreements with the affected people obtained prior to resettlement?</p>	<p>(a) Y</p> <p>(b) Y</p> <p>(c) Y</p> <p>(d) Y</p> <p>(e) Y</p> <p>(f) Y</p> <p>(g) Y</p> <p>(h) Y</p> <p>(i) Y</p> <p>(j) Y</p>	<p>(a) A small scale resettlement (59PAHs with 191PAPs) due to the loss of land, structures, crops and trees is triggered. Only 3 households need to relocate. To minimize the impact, the project site selection avoids areas with many houses and the smaller bases for towers are selected.</p> <p>(b) Stakeholder meetings as well as individual consultations were held to explain project brief and locations, calculation method for compensations/restoration measure (priority employment of PAPs) in local language and they will be continued during implementation.</p> <p>(c)Census survey and inventory of assets to be lost is conducted on all PAPs. The resettlement plan is including compensation with full replacement costs, restoration of livelihoods and living standards by temporary employment considering the suspension of agricultural activities during the construction.</p>

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		<p>(h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?</p> <p>(i) Are any plans developed to monitor the impacts of resettlement?</p> <p>(j) Is the grievance redress mechanism established?</p>		<p>(d) The compensation will be paid prior to the resettlement. It is also stipulated in the laws of Rwanda.</p> <p>(e) An Abbreviated Resettlement Action Plan was prepared in accordance with JICA Guidelines and World Bank safeguard policies.</p> <p>(f) The PAHs of this project does not include the households headed by the vulnerable groups. Female household heads are simply the owners of assets and they are not widows or single mothers. For the employment during construction, female PAPs will be provided with equal opportunities.</p> <p>(g) As of now, there are 4 absent PAPs who lives away and have not been contacted and 8 PAPs who have not reached consensus. Efforts will be continuously made to contact or build consensus before implementation of resettlement. Failing, the process will be carried out in accordance with the law of Rwanda. However the grievance redress mechanism will remain in case these PAPs have complaints.</p> <p>(h) The organizational framework was established and EDCL will play the major role for implementation. EDCL has experience in implementing other RAPs and is responsible for securing the fund.</p> <p>(i) Monitoring is carried out monthly. The plan is included in ARAP.</p> <p>(j) The Grievance redress mechanism is established based on locally practiced conflict resolution method at community level and legal practice.</p>
	(2) Living and Livelihood	<p>(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?</p> <p>(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?</p> <p>(c) Is there any possibility that installation of structures, such as power line towers will cause radio interference? If any significant radio interference is anticipated, are adequate measures considered?</p> <p>(d) Are the compensations for transmission wires given in accordance with the domestic law?</p>	<p>(a) Y</p> <p>(b) Y</p> <p>(c) Y</p> <p>(d) Y</p>	<p>(a) A small scale resettlement is triggered. An ARAP was prepared and any loss will be compensated at full replacement cost</p> <p>(b) Since all labors will be employed locally within Kigali, no immigration of workers is expected.</p> <p>(c) There is no radio interference anticipated due to the low voltage and distance.</p> <p>(d) The compensation will be given in accordance with ARAP and the domestic law.</p>
4 Social Environment	(3) Heritage	<p>(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered</p>	(a) N	<p>(a) There is no such possibility as there is no heritage site.</p>

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		to protect these sites in accordance with the country's laws?		
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a)N	(a)The project will not affect the landscape. The area around the project site is already developed.
	(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)N/A (b)N/A	(a)There are no ethnic minorities and indigenous people affected by the project. (b)There are no ethnic minorities and indigenous people affected by the project.
	(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 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?	(a) N (b) Y (c)Y (d)Y	(a) -(d)The project proponent observes all laws and ordinances associated with working conditions of the country. EDCL has the document called "Environmental and Social Requirements for Tender" and the contractor is required to observe safety and hazard management as well as health and well-being of workers and local communities described in the document.
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)Y (c)Y	(a) EDCL's "Environmental and Social Requirements for Tender" covers requirements to reduce impacts during construction. (b) The project site is within Kigali City hence construction activities are not going to affect the natural environment. (c)Construction activities may disturb the traffic around the site. EDCL requires the contractor to control traffic with collaboration with local police and mitigation measures will be included in Environmental Management Plan.
	(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	(a)Y (b)Y (c)Y (d)Y	(a)-(d) For the items with impacts, EDCL (planning and construction phases) and EUCL (operation phase) will be monitoring. Monitoring plan and responsible organizations are included in the EIA report. RDB notified the frequency of monitoring report.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?		
6 Note	Reference to Checklist of 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	(a)There is no additional Environmental Items that may be affected.
	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	(a)The impacts of this Project are limited to its immediate vicinity and most of them are related to construction activities. There is no such impact to trans boundary or global issues.

Chapter 2 Contents of the Project

2-1 Outline of the Project

2-1-1 Overall objectives and Project purpose

Rwanda is planning to increase the installed capacity and diversity energy resources by utilizing indigenous resources in accordance with the “National Energy Policy and Strategy”, “Economic Development and Poverty Reduction Strategy”, “Electric Development Strategy”, etc. Nevertheless, more policies and strategies are insufficient to achieve the targeted increased and diversified electrical energy sector unless such policies and strategies are accompanied by a well prepared concrete Electricity Master Plan that takes into consideration an effective and efficient energy mix.

However, the power development projects based on this upper level plan have been stalled, particularly by power transmission/distribution facilities in the Kigali area. The GOR has thus requested grant aid from Japan to achieve self-reliant, sustainable socioeconomic growth with the Project for Improvement of Substations and Distribution Network Phase 2.

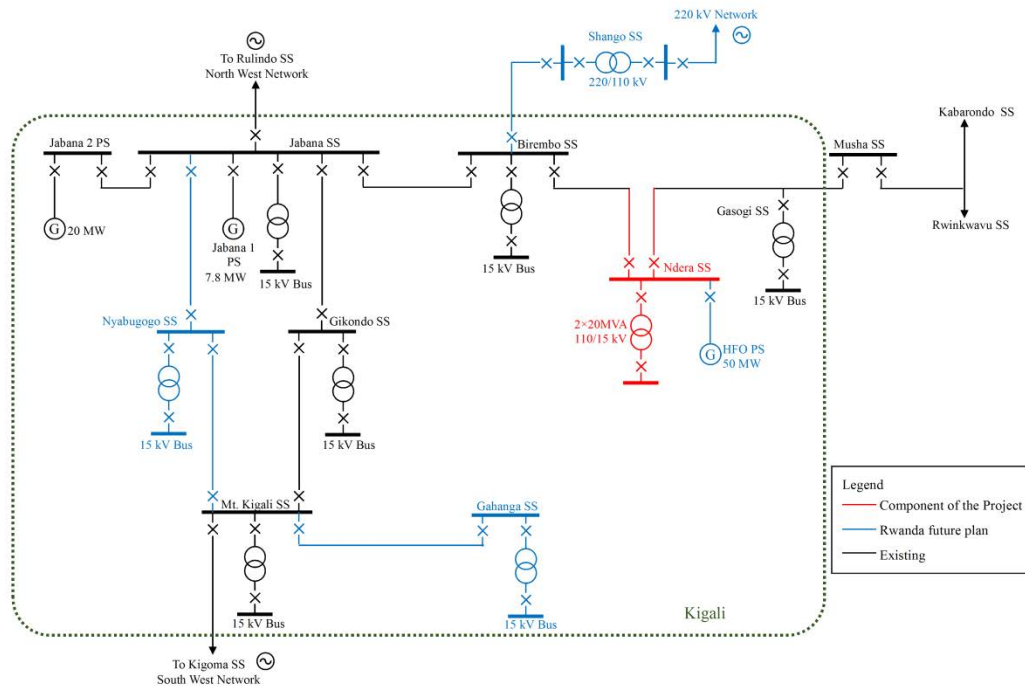
2-1-2 Outline of the Project

This project is meant to help to enhance transmission and distribution facilities in the Kigali area to improve the serious damage done to economic activity in the area by insufficient supply capacity from power transmission/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	Capacity
Procurement and Installation Work	
1. Ndera substation (1) 20 MVA 110/15 kV transformers (2) 110 kV switchgear (3) 15kV switchgear (4) Control and supervisory facilities	2 units 1 set 1 set 1 set
2. Transmission Line (1) Two circuits of 110 kV transmission lines from the existing line between Birembo and Gasogi substations to Ndera Substation	Approx. 2.2 km
3. Distribution Line 3.1 (Route 1) One circuit of 15 kV distribution line from existing Gasogi Substation to Kabuga Ring Main Unit (RMU) Switching Station (1) 15 kV Overhead line (ACSR, Single conductor) 3.2 (Route 2) Two circuits of 15 kV distribution lines from Ndera Substation to existing line between Birembo and Free Zone Phase 1 substations (1) 15 kV Overhead line (ACSR, Single conductor) 3.3 (Route 3) Re-routing for one circuit of 15 kV distribution line nearby Ndera Substation (1) 15 kV Overhead line (ACSR, Single conductor)	Approx. 6.5 km Approx. 650 m Approx. 400 m
4. Modification of existing Gasogi Substation (1) 15 kV switchgear panel for outgoing feeder to Kabuga RMU Switching Station	1 set
5. RMU Switching Stations 5.1 Kabuga RMU Switching Stations (1) RMU facilities 5.2 Murindi RMU Switching Stations (1) RMU facilities (2) First Tower (Tension Tower)	1 set 1 set 1 tower
Procurement Work	
6. Maintenance Tools for the Equipment of the Project	1 lot
7. Spare Parts for the Equipment of the Project	1 lot
Construction Work	
8. Foundation for the Equipment of the Project (Transformers, Towers for 110 kV Transmission Line, etc.)	1 lot
9. Building of the Project (Ndera substation, Kabuga and Murindi RMU Switching Stations)	3 buildings

Source: JICA Study Team



Source: JICA Study 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 Rwanda 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 Kigali 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 Kigali area for the project are from February to May, and September to December with dry seasons in other periods. Rwanda is located near by the equator; however, the climate is the temperate zone by the high elevation as approximately 1,600 meters. Annual average temperature is 28 degrees as maximum and 16 degrees as minimum in Kigali.

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

Annual rainfall in the Kigali area for the project is around 775 to 1,220 millimeters, but there are squalls in certain areas. As such, foundations for substation facilities will be raised 0.2 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 REG standard angle of 30 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.

(3) Geological conditions and Earthquakes

As the results of the research and the soil investigation, the structure design of the new Ndera Substation Building shall be conformed to the following design standards; Wind speed: 34 meter per second, Bearing Capacity: 150 kilo Newton per square meter, Seismic coefficient: 0.10.

2-2-1-3 Plan for Socioeconomic Conditions

The project site is in the Kigali 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/distribution 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 and distribution 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 Kigali 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 Kigali will be used as sub-contractors.

Since no industry of steel manufacturing, it is very costly to construct the steel structure buildings in Rwanda, so that there is less building by the steel structure. On other hand there is one ready mixed concrete factory in Kigali, the constructions by the reinforced concrete structure are common. Therefore, the design for the Ndera Substation Building, Transformer foundation, Equipment foundation, cable pit, new Switching Stations, and tower foundation shall be planned by the reinforced

concrete structure.

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

Still, market research on local Rwanda contractors and past work order materials from the implementing agency suggest that construction workers, work vehicles, construction equipment and materials can be procured in Rwanda with relative ease. As the skilled labor and common workers for the civil and construction works for substation facilities, 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, reinforcing bar and other materials used in the civil and construction works for the substation and foundation of the transmission towers can be purchased locally, equipment and materials are to be purchased locally to the extent possible in this project. However, the equipment for substation and transmission facilities procured in this project are not manufactured in Rwanda, in consideration of the actual procurement for the existing equipment and capability of operation & maintenance by EUCL, the Equipment shall be procured from Japan or a third country.

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, EUCL does have a certain level of technical capacity in system operations and has steadily handled O&M for the national power transmission and distribution network. 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 Rwanda 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. As Project substation and RMU switching stations have equipped SCADA with developing technology, the Contractor shall arrange necessary manufacturer's instructor(s) to transfer initial and operation technic procured systems such as main equipment of substation and SCADA system, for a half month after test operation completed.

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 Kigali 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 Rwanda side work, the Japanese side will plan on consulting with the Rwanda side to decide which items the Rwanda side can reasonably handle without exceeding Rwanda 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 REG when designing the power distribution facilities built, procured and installed in the project, conforming to existing facility configurations, REG 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 Rwanda work schedules and work to streamline importing and other various procedures.

With concurrent construction of the substation and 110 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 forecast for the Project

The main project components are construction of 110/15 kV Ndera substation and upgrading the transmission lines to the substation to 110 kV lines to improve power distribution within the Kigali area. The substation includes three 110/15 kV voltage class transformers with 20 MVA x 2 capacity, one transmission line and three distribution lines.

The purpose of the preparatory study will be to clarify project prerequisites by estimating power demand in the Kigali area. It will act as base data to verify project relevance and effectiveness in light of the power transmission/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 transmission/distribution facilities in the Kigali city. 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 Kigali 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 transmission/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.

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

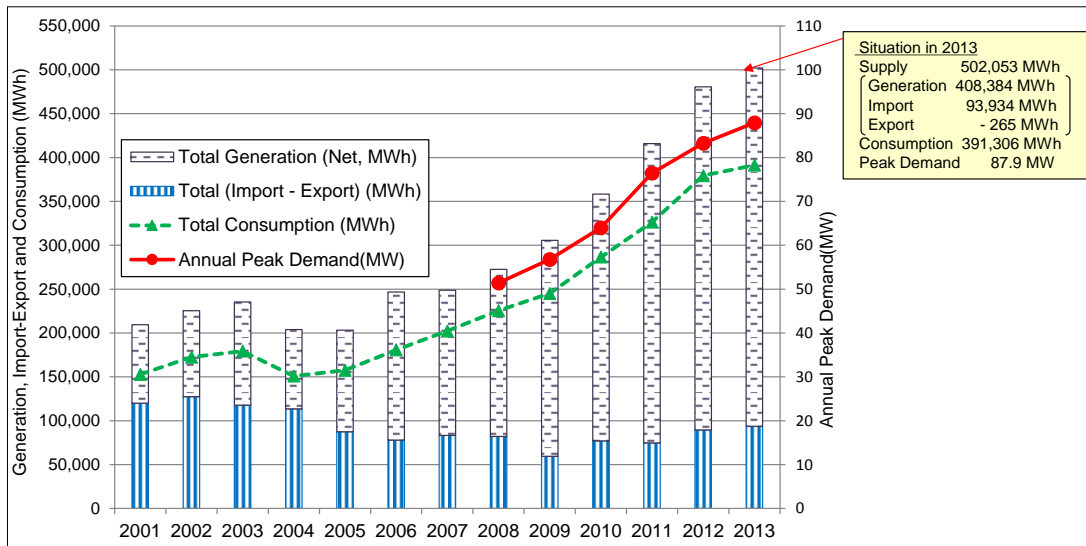
2-2-2-2 Power System Analysis

(1) Electricity Supply-Demand Situation and Demand Forecast

The power demand forecast in Rwanda studied in 2013 to 2014 under the Project for Preparation of Electricity Development Plan for Sustainable Geothermal Energy Development in Rwanda (hereinafter referred to as “Electricity & Geothermal MP”) has been mutually agreed. The electricity supply-demand situation and the nationwide power demand forecast which was studied under Electricity & Geothermal MP are summarized below, and the demand forecast for the central zone in which Kigali city accounts for the majority of demand.

1) Electricity Supply-Demand Situation

Since 2008, power supply in Rwanda has shown a year-on-year increase of approx. 10%, with power supply in 2013 totaling 502,053 MWh. Electricity sales in 2013 were 391,306 MWh. The disparity between 502,053 MWh and 391,306 MWh was accounted for by an approx.22% power loss.



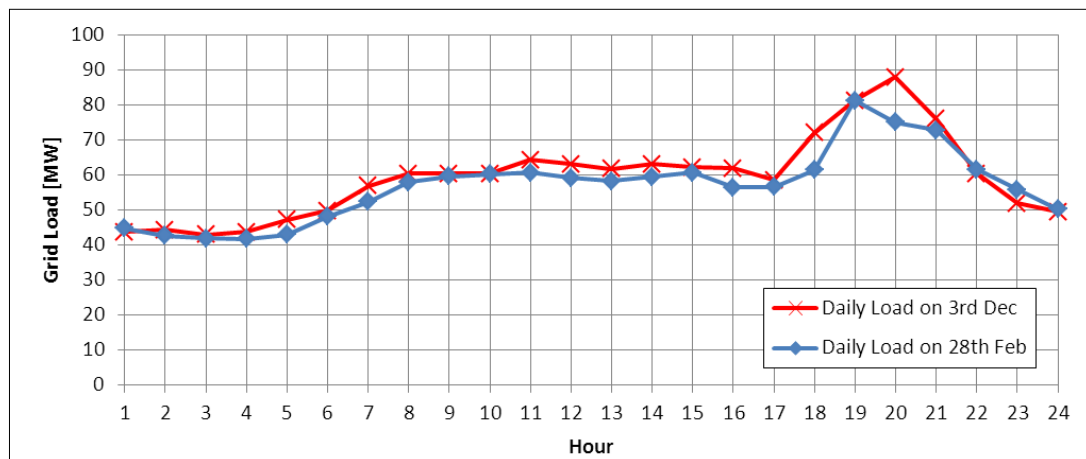
Source: JICA Report of Electricity & Geothermal MP

Figure 2-2-2-1 Transition of yearly supply-demand

The composition of power sources for power supply in Rwanda in recent years is accounted for by: hydro-power of approx. 53 %, including import from Rusizi 1 and Rusizi 2; diesel power of approx. 45%; and methane/solar, etc. of approx. 2%. The ratio for diesel power generation, which uses high-cost fuel, is large.

In the same way as power supply, annual maximum demand in Rwanda shows a particularly large rise after 2008. In 2013, a maximum demand of 87.9MW was recorded. In 2013, a maximum demand of 87.9MW was recorded.

Figure 2-2-2-2 shows the daily load curve on 3rd December, when the maximum power demand for 2013 was recorded, as well the load curve on 28th February, when the maximum power demand for February, the month showing the smallest monthly power supply, was recorded. On the both days, power demand was maximum during the period from 19:00 to 20:00, when electricity consumed for lighting at households reaches peak demand.



Source: JICA Report of Electricity & Geothermal MP

Figure 2-2-2-2 Daily load curves

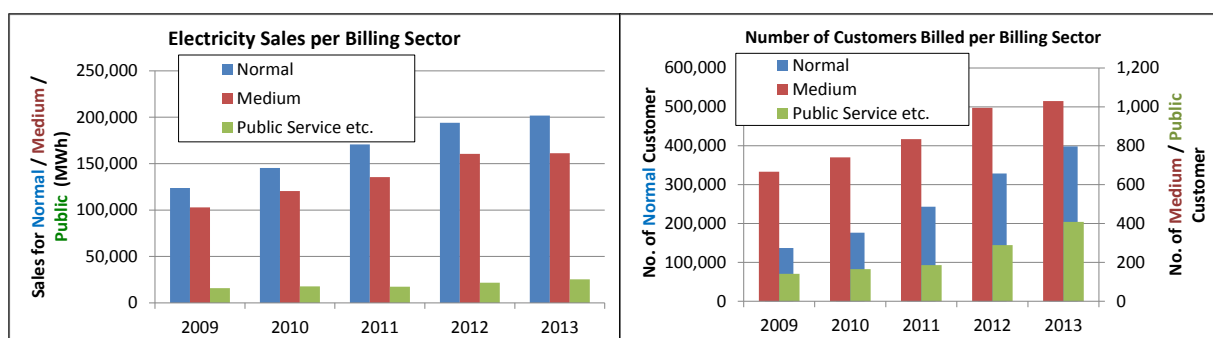
2) Status of Electricity Sales

Electricity sales is now categorized in three billing sectors below:

- The Normal Customer covers general households
- The Medium Customers covers industrial and commercial facilities
- The Public Service (&Diplomat) Customer includes public facilities such as government offices, public hospitals and schools, as well as embassies

Of the 2013 electricity sales, the Normal Customer accounted for 52%, and the Medium Customer and the Public Service Customer 41% and 7%, respectively.

Figure 2-2-2.3 shows the change in the electricity sales and number of customers during 2009 – 2013 for the three billing sectors. The electricity sales have increased by about 13% annually for all the sectors. The number of customers under the Medium Customer increased by 12%, while those under the Normal Customer and Public Service Customer jumped by about 30%. According to REG (former EWSA), this large increase was due to the electrification in the rural areas promoted by the national government and EWSA.

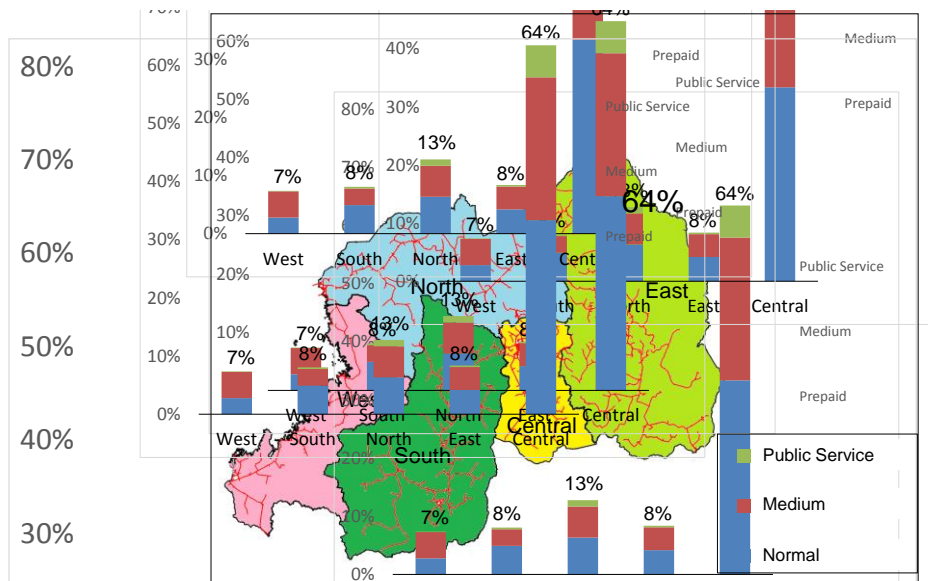


Source: JICA Report of Electricity & Geothermal MP

Figure 2-2-2.3 Change in electricity sales and No. of customers by billing sector

3) Power Consumption by Zone

The trend in power consumption by zone is shown in Figure 2-2-2.4. The zones were established based on the method REG (former EWSA) uses to plan the rural electrification (originally created by Sofreco, a contractor of EWSA) and the country was divided into East, West, South, North and Central to correspond to groups of Medium Voltage Lines. The power consumption in the Central zone (Kigali City and Bugesera district) is the largest, consuming 64% of the country's electricity while other zones use about 10% each. In the West zone with cement and beer factories, the rate of power use by the Medium Customer is greater than other zones.



Source: JICA Report of Electricity & Geothermal MP

Figure 2-2-2.4 Electricity sales by zone and billing sector

4) Power Demand Forecast Nationwide

Two approaches were taken for different billing sectors to forecast power demand.

The first approach was for the Normal Customer such as households, and used a bottom-up method (a product of the future number of customers and specific consumption). Upon forecasting, the rural electrification plan of REG (former EWSA) was given thorough consideration.

The second approach was for the Medium Customer that includes industrial and commercial facilities and the Public Service Customer, and used a macroscopic method. This method creates a power demand model (approximate formula) based on the correlation between the historical economic and social indicators and power demand, and forecasts the future power demand by entering the future economic and social growth into the model.

The main premises for each forecast scenario are shown in Table 2-2-2-1.

Table 2-2-2-1 Main premises for each case

Case	High Case	Medium Case	Low Case	(Reference) Extreme High Case
Normal Customer	High	Medium	Low	High
Electrification Rate in 2017/18	48%	42%	35%	48%
Medium Customer	High	Medium	Low	Extreme High
GDP Growth Rate	8.5 %	7.5%	6.5%	11.5%
Specific Large Scale Consumers load to be on-grid	70 %	50%	20%	100%
Public Service Customer	Base	Base	Base	Extreme High
GDP Growth Rate	7.5 %	7.5 %	7.5 %	11.5 %

Source: JICA Report of Electricity & Geothermal MP

Where, the electrification rate for the high case is 48 % which is the target value in 2017/2018 of Energy Sector Strategic Plan (ESSP) issued in 2014, and ones for the medium and low cases are 42 % and 35 % respectively in case of the target unachieved. The GDP growth rate is based on the value of IMF who estimates Rwanda's GDP growth rate for the next 5 years to be 7.5 % per year in the "Rwanda Seventh Review Under the Policy Support Instrument, Request for a Three-Year Policy Support Instrument and Cancellation of Current Policy Support Instrument" (November 2013). Since there is no data forecasting the long-term GDP growth issued by the government or other agencies, GDP growth scenarios were created for the next 20 years for the forecasting purposes, including the high case with the growth rate of +1.0 %, the low case with -1.0 %, and the extreme high case which adopted 11.5 % per year, the GDP growth target of the government listed in EDPRS2.

The forecasted load was corrected based on the information regarding the Large-scale Customers which are now undergoing rapid development compared to Rwanda's economic growth rate up and cannot be understood through the macro forecast. Those of which are listed in Table 2-2-2-2.2 and the scenarios considered are in Table 2-2-2-2.3.

Table 2-2-2.2 Large-scale Customer Data extracted for correction

Load name	Year	Demand MW	2014	2015	2016	2017	2018	Load necessary to be added on Demand Model as Large Scale Consumers (Yes=1 or No=0)
Cimerwa	2014	15	15	0	0	0	0	1
Bugesera Steel Industrial Park	2014	10	10	0	0	0	0	1
Bugesera Industrial Park	2015	5	0	5	0	0	0	1
Bugesera Industrial Park	2016	5	0	0	5	0	0	1
Bugesera Industrial Park	2017	5	0	0	0	5	0	1
Rwamagana Ind Park (Steelwa)	2015	8	0	8	0	0	0	1
Rwamagana Ind Park (AKS Steel)	2015	8	0	8	0	0	0	1
Rwamagana Ind Park	2016	5	0	0	2	0	0	1
Rwamagana Ind Park	2017	5	0	0	0	2	0	1
Rwamagana Ind Park	2018	5	0	0	0	0	2	1
Airport	2016	3	0	0	3	0	0	1
Airport	2017	3	0	0	0	3	0	1
Rutongo Mine	2015	8	0	8	0	0	0	1
Bugarama Ind Park	2016	5	0	0	5	0	0	1
Huye Ind Park	2016	2	0	0	2	0	0	1
Rusizi Industrial Park	2015	2	0	2	0	0	0	1
Nyabihu Ind Park	2016	2	0	0	2	0	0	1
Gahanga Sport Stadium	2016	2	0	0	2	0	0	1
SEZ Free zone Kigali	2015	2	0	2	0	0	0	1
SEZ Free zone Kigali	2016	2	0	0	2	0	0	1
SEZ Free zone Kigali	2017	2	0	0	0	2	0	1
SEZ Free zone Kigali	2018	2	0	0	0	0	2	1
ICC (Convention centre)	2014	6.5	6.5	0	0	0	0	1
Irrigation load Mpanga Sector	2015	2	0	1	1	0	0	0
Irrigation load Mahama Sector	2016	4.8	0	0	4.8	0	0	0
Irrigation load Rusumo Falls	2017	3.4	0	0	0	3.4	0	0
Irrigation load Mugesera Sector	2015	1	0	1	0	0	0	0
Irrigation load Matimba Sector	2014	0.3	0.3	0	0	0	0	0
Irrigation load Kabare Sector		0.486	0	0	0	0	0	0
Irrigation load Kamabuye Sector		6	0	0	0	0	0	0
Irrigation load Kibilizi Sector		0.325	0	0	0	0	0	0
Irrigation load Masaka Sector		0.469	0	0	0	0	0	0
Irrigation load Nasho Sector		0.84	0	0	0	0	0	0
Irrigation load Ndego Sector		0.726	0	0	0	0	0	0
Irrigation load Ngeruka Sector		1.2	0	0	0	0	0	0
Irrigation load Nyamugari Sector		3.45	0	0	0	0	0	0
Loads for Mines1		11.8	0	0	0	0	0	0
Loads for Mines2		11.8	0	0	0	0	0	0
Loads for Mines3		11.8	0	0	0	0	0	0
Loads for Mines4		11.8	0	0	0	0	0	0
Nyabihu Tea Factory	2016	1	0	0	1	0	0	0
Rubaya Tea Factory	2016	1	0	0	1	0	0	0
SORWATHE Tea Factory	2016	1	0	0	1	0	0	0
Mulindi Tea Factory	2016	1	0	0	1	0	0	0
Mata Tea Factory	2016	2	0	0	2	0	0	0
Nshili Kivu Tea Factory	2016	1	0	0	1	0	0	0
Pfunda Tea Factory	2016	3	0	0	3	0	0	0
Gisovu Tea Factory	2016	3	0	0	3	0	0	0
Gisakura Tea Factory	2016	3	0	0	3	0	0	0
Kitabi Tea Factory	2016	3	0	0	3	0	0	0
Shagasha Tea Factory	2016	3	0	0	3	0	0	0
Karongi Tea Factory	2016	2	0	0	2	0	0	0
Mushubi Tea Factory	2016	2	0	0	2	0	0	0
Gatare Tea Factory	2017	2	0	0	0	2	0	0
Rutsiro Tea Factory	2017	3.8	0	0	0	3.8	0	0
Muganza-Kivu Tea Factory	2017	3.8	0	0	0	3.8	0	0
Karumbi New tea site	2017	3.8	0	0	0	3.8	0	0
Sovu new Tea site	2018	3.8	0	0	0	0	3.8	0
Rugabano new tea site	2018	3.8	0	0	0	0	3.8	0
Munini new tea site	2017	3.8	0	0	0	3.8	0	0
Kibeho new tea site	2018	3.8	0	0	0	0	3.8	0

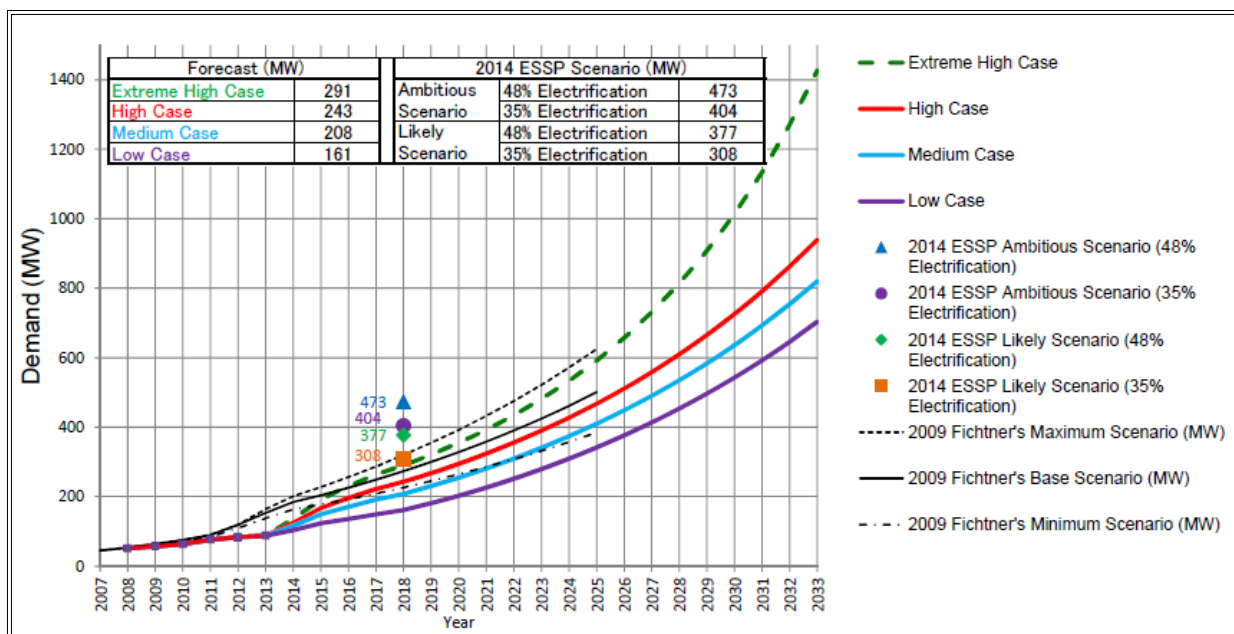
Source: JICA Report of Electricity & Geothermal MP

Table 2-2-2.3 Large-scale Customer development scenarios

Bulk Load Scenario (Country-Level)		2014	2015	2016	2017	2018
Case Scenario						
Extreme High Case	100% to be installed as scheduled	31.5	33	23	12	4
High Case	70% to be installed, comparing with the original schedule	22.1	23.1	16.1	8.4	2.8
Medium Case		15.8	16.5	11.5	6.0	2.0
Low Case		6.3	6.6	4.6	2.4	0.8

Source: JICA Report of Electricity & Geothermal MP

Figure 2-2-2.5 shows load forecast results compared with existing demand forecasts.



Source: JICA Report of Electricity & Geothermal MP

Figure 2-2-2.5 Demand forecast comparison with the existing ones

5) Power Demand Forecast Allocated to Zones

The high case demand was used to divide the country-level load by five zones of East, West, South, North and Central for further studies for the development plan in the project of Electricity & Geothermal MP.

For the Normal Customer, the demand is calculated by multiplying the future number of customers by Specific consumption scenario for each zone based on the Combined Design Report of Electricity Access Rollout Program by Sofreco. Next for the Medium Customer, of 2013 electricity sale, 57% is sold in Kigali City and 43% is sold outside of the city; however, 20 years later after the development of local regions, the electricity sold in Kigali City is forecasted to be 47% and that outside 53%, with 10% shift from the city to outside the city. For the division of regional electricity sales by zones (East, West, South, North and Central), calculations were done by referring to their respective share from 2013. As for the Public Service Customer, the calculations were done in the same manner as those for the Medium Customer. In other words, in 2013, 83% of the power in the country is sold in Kigali City and 17% was sold outside of the city; however 20 years later after the development of the local regions, 73% is forecasted to be sold in Kigali City and 27% outside, indicating 10% shift in sales. The electricity sold was divided to each zone in the same manner by referring to their respective share from 2013.

6) Demand Forecast of Central Zone including Kigali City

As mentioned above, the high case forecasted demand was allocated to five zones of East, South, North and Central in the studies of Electricity & Geothermal MP. The demand of Central zone including Kigali City which is deeply related to the Project was forecasted in three high, medium

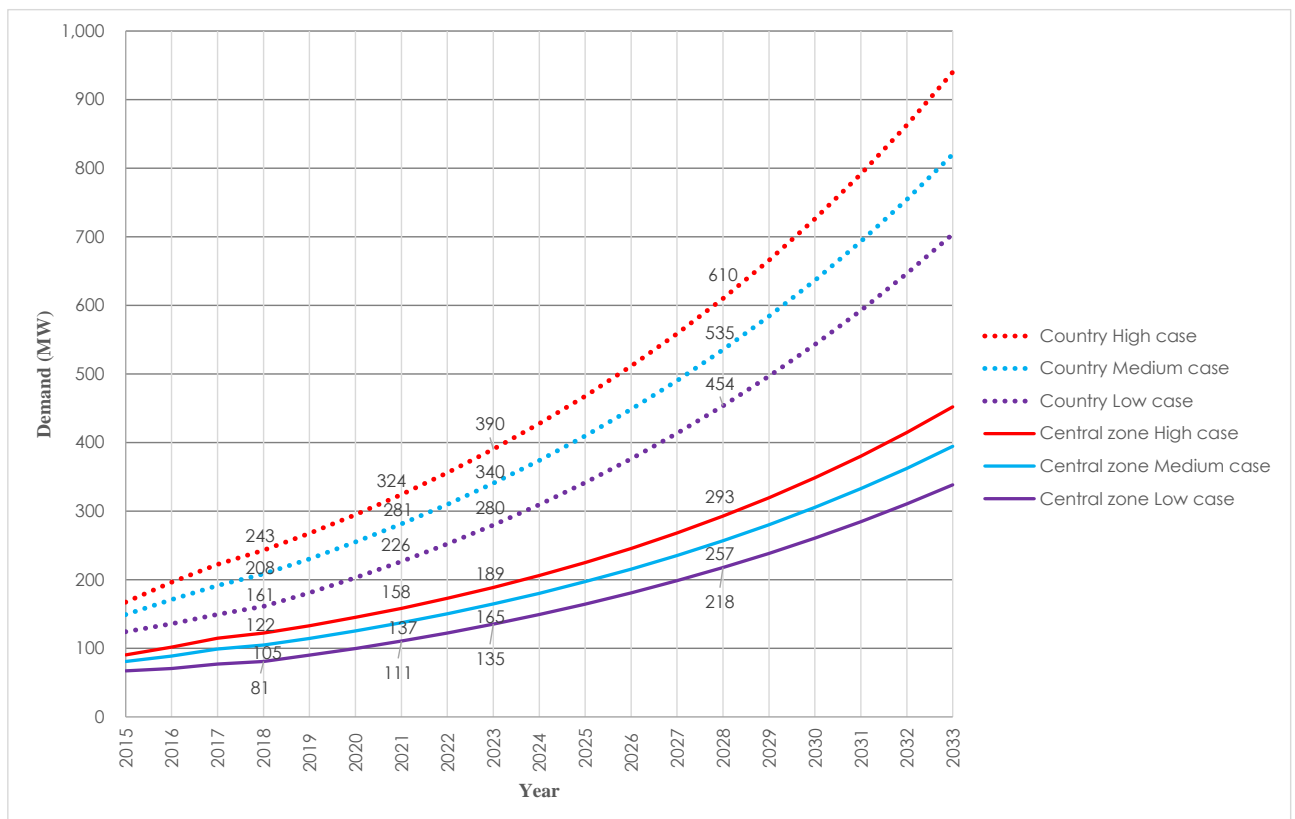
and low cases by extracting from the forecasted results of Electricity & Geothermal MP. The results are listed in Table 2-2-2-2.4 and the comparison between nation and central zone is shown in Figure 2-2-2-2.6.

Table 2-2-2-2.4 Demand forecast of central zone

		(Unit: MW)									
Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
High case	90	102	115	122	133	145	158	173	189	206	
Medium case	81	89	99	105	114	125	137	150	165	180	
Low case	67	70	77	81	90	100	111	122	135	149	
Year	2025	2026	2027	2028	2029	2030	2031	2032	2033		
High case	225	246	268	293	319	348	380	415	452		
Medium case	197	215	235	257	280	305	333	362	394		
Low case	164	181	190	218	238	261	285	311	338		

Source: JICA Study Team

The corresponding years to yellow colored cells in Table 2-2-2-2.4 show the supply limits with existing distribution transformers, and ones to thin red colored cells indicate the supply limits with transformers which include planned by REG for strengthening of the distribution network. (Refer to next (2) explanation)



Source: JICA Report of Electricity & Geothermal MP modified by JICA Study Team

Figure 2-2-2-2.6 Demand forecast comparison between country and central zone

(2) Capacity of Distribution Transformer in Central Zone

1) Capacity of Existing Distribution Transformers

In order to supply electricity to distribution network sufficiently, it is necessary to install greater capacity of distribution transformers than the demand. The total capacity of distribution transformers at present in the central zone, where Kigali city accounts for main demand, is 105 MVA. It is approximately 100 MW supply capability when the power factor assumed 0.95, which is almost average value of actual loads at present, and if the capacity compares to the value forecasted in Table 2-2-2.5, the supply limit of the transformers will reach in 2015 or 2019 in the high or the low case respectively. Therefore, it can be seen that planned reinforcement is essential immediately. This is only if the load on the distribution lines has been shared commensurate with each substation transformer capacity, and about the necessity of separate reinforcement is described later in the next section (3) of power system analysis.

Table 2-2-2.5 Capacity of existing distribution transformers

Substation	Tr. Capacity (MVA)	Quantity	Total Tr. Capacity (MVA)	Voltage ratio (kV)
Gikondo	15	3	45	110/15
Jabana	10	2	20	110/15
Birembo	20	1	20	110/15
Gasogi	10	1	10	110/15
Mt. Kigali	10	1	10	110/30 (10MVA) and 30/15(5MVA)
Total Capacity			105	MVA

Source: Investigated REG facilities by JICA Study Team

2) Reinforcement Plan of Distribution Transformers

There is a grid reinforcement plan in REG based on the report of “Review of Grid Strengthening Projects For 2014 -2018” which was studied by WB support and the Project of Ndera substation construction is included in the report. Furthermore, the Kigali ring project that will construct new transmission lines from existing Jabana substation to Gahanga substation (to be constructed newly) through Mount Kigali substation (to be reinforced) under the support of EU. Those are the main strengthening plan in Kigali city and taking into consideration of those projects in the report, the planned configuration of transformers is as Table 2.2.2.2-6 below.

Table 2-2-2-2.6 Capacity of distribution transformers after completion of reinforcement

Substation	Tr. Capacity (MVA)	Quantity	Total Tr. Capacity (MVA)	Voltage ratio (kV)	Supported by
Gikondo	15	3	45	110/15	
Jabana	10	2	20	110/15	
Birembo	20	1	20	110/15	
Gasogi	15	1	15	110/15	
Mt. Kigali	20	2	40	110/30 (20MVA) and 110/15(20MVA)	EU
Ndera	20	2	40	110/15	JICA
Nyabugogo	20	2	40	110/15	(EU)
Gahanga	20	1	20	110/15	EU
Muhima	20	2	40	110/15	
Total Capacity			280	MVA	

Source: Prepared by JICA Study Team based on Review of Grid Strengthening Projects for 2014 -2018

The red colored portions in Table 2-2-2-2.6 are the ones for reinforcement projected in the report, and the projects are being designed or underway of which name of donors are indicated in right columns. However, it is not clear by the document provided whether or not the EU project includes Nyabugogo substation construction. Further, columns are colored, however, no indication in the right column “supported by” in Table 2-2-2-2.6 means that the donors have not decided yet for the projects.

Even though all transformers listed in Table 2-2-2-2.6 are reinforced including the ones of donors undecided, total capacity of the transformers will be 280 MVA, it would be 266 MW when the load power factor assumed 0.95 as same as mentioned before. This capacity 266 MW can supply until 2026 in the high case and 2030 in the low case according to the demand forecast in the Table 2-2-2-2.4 so that the continuous development planning and its execution should be surely implemented.

(3) Power System Analysis

It is said that the consideration of development necessity in terms of distribution transformers capacity in the above (2) is a kind of broad power system analysis, in addition it was studied utilizing an application software for the power system analysis to verify the specification of facilities to be supplied in the network. Specifically, two kinds of calculation, that is a power flow calculation and a fault current calculation, were made entering the data collected during the site survey into the power system analysis software ETAP.

As the component of the Project is mainly composed of Ndera substation and its related transmission lines, the model building of system analysis is mainly central zone. The power flows from outside Kigali like existing power stations and ones through 220 kV transmission lines such as the power import from neighboring countries and Rusumo hydro power station, etc. were simulated as contraction power sources in consideration of inflow locations. Refer to Figure 2-1-2.1.

Demand loads were connected to the distribution 15 kV and 30 kV buses of substations and it was verified under the load flow calculation that the burden on the facilities such as distribution transformer and transmission line, etc. and in terms of maintaining the bus voltage within allowable limit.

The analysis was made in the years of 2018 when the component will start operation, of 2021 (after three years operation) when the evaluation of the Project will be conducted and of 2028 (after ten years operation) when the target year for the facility planning. Furthermore, the additional analysis for the years of 2023 and 2026 was made to confirm when facilities have to be reinforced for safe operation of the network.

1) Allocation of Load to Substations

The forecasted demand load of the high case has been allocated to the substations in the system analysis model as listed in Table 2-2-2-2.7. The load allocation results of the medium and low cases are shown in Attachment – 8.

Since there is no seasonality on electricity load in Rwanda, the latest actual load data of each substation in January 2015, which were collected in March 2015 during the site survey, were used as base data for future load of each substation. The forecasted demand load which was previously explained were allocated for substations taking into account of the large scale customer information listed in Table 2-2-2-2.2. The partial distribution load transfers such as from Gikondo substation to Ndera substation, etc. to maintain voltage of electricity to be distributed to customers have been also considered for allocation.

Table 2-2-2-2.7 Load demand allocation to substations (High case)

High case	2015 (Jan. act.)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Gikondo SS	25.06	37.0	41.4	25.0	27.2	29.6	32.3	35.3	38.5	42.1	46.0	50.2	54.8	59.8	65.2	71.2	77.6	84.7	92.3
Jabana SS	14.45	21.4	23.6	24.4	26.5	28.9	31.5	34.4	37.6	41.1	44.8	49.0	53.5	58.3	63.7	69.5	75.8	82.6	90.1
Birembo SS	6.18	9.9	11.2	11.7	12.7	13.9	15.1	16.5	18.0	19.7	21.5	23.5	25.6	28.0	30.5	33.3	36.3	39.6	43.2
Gasogi SS	3.89	7.0	7.8	8.2	8.9	9.7	10.6	11.6	12.6	13.8	15.1	16.5	18.0	19.6	21.4	23.3	25.5	27.8	30.3
Mont Kigali SS(15kV)	4.22			6.9	7.5	8.2	8.9	9.7	10.6	11.6	12.7	13.8	15.1	16.5	18.0	19.6	21.4	23.4	25.5
Mont Kigali SS(30kV)	3.06			8.9	9.7	10.5	11.5	12.6	13.7	15.0	16.4	17.9	19.5	21.3	23.2	25.3	27.6	30.1	32.9
Mont Kigali SS(Total)	7.28	26.3	30.5	15.8	17.2	18.7	20.4	22.3	24.4	26.6	29.0	31.7	34.6	37.8	41.2	45.0	49.1	53.5	58.4
Ndera SS				9.5	10.3	11.3	12.3	13.4	14.6	16.0	17.5	19.1	20.8	22.7	24.8	27.0	29.5	32.2	35.1
Gahanga SS				3.8	4.1	4.5	4.9	5.4	5.9	6.4	7.0	7.6	8.3	9.1	9.9	10.8	11.8	12.9	14.0
Nyabugogo SS				8.2	8.9	9.7	10.6	11.6	12.6	13.8	15.1	16.5	18.0	19.6	21.4	23.3	25.5	27.8	30.3
Rlima SS				15.8	17.2	18.7	20.4	22.3	24.4	26.6	29.0	31.7	34.6	37.8	41.2	45.0	49.1	53.5	58.4
Central Zone Load	57	102	115	122	133	145	158	173	189	206	225	246	268	293	319	348	380	415	452
Musha SS	2.6	18.0	20.5	18.2	19.5	21.2	23.2	25.2	27.4	29.7	32.2	35.0	37.9	41.0	44.5	48.1	52.1	56.5	61.2
+ Ngarama SS load				4.1	4.4	4.8	5.2	5.7	6.2	6.7	7.3	7.9	8.5	9.2	10.0	10.8	11.7	12.7	13.8
Kbarondo SS	4.924	7.8	9.1	9.5	10.2	11.1	12.1	13.2	14.3	15.5	16.8	18.2	19.8	21.4	23.2	25.1	27.2	29.5	31.9
Rwinkwavu SS	0.427	1.8	2.5	2.8	3.0	3.3	3.6	3.9	4.2	4.6	5.0	5.4	5.8	6.3	6.8	7.4	8.0	8.7	9.4
+ Kirehe SS load				2.8	3.0	3.3	3.6	3.9	4.2	4.6	5.0	5.4	5.8	6.3	6.8	7.4	8.0	8.7	9.4
East Zone Load		28	32	37	40	44	48	52	56	61	66	72	78	84	91	99	107	116	126

Source: JICA Study Team

The two projects, both of which are under planning at present, of Kigali ring transmission lines and substations construction which is supported by EU, and Rulindo substation modification and 110 kV transmission line ring construction (from Rulindo SS to Musha SS through Ngarama SS)

which is supported by African Development Bank are assumed to be in operation in 2018.

2) **Preconditions of Power System Analysis**

Power system analysis that are power flow calculation and fault current calculation was conducted under the preconditions below:

- Calculation model was configured in accordance with the area description in Fig. 2-1-2.1, and power generation capacity that is supplied from outside the model shall be sufficiently presence or developed appropriately.
- The two projects of Kigali ring transmission lines and substations construction, and Rulindo substation modification and 110 kV transmission line ring construction (from Rulindo SS to Musha SS through Ngarama SS) shall be completed until 2018.
- Main power source from outside of the model will be flowed from the 220 kV network so that Shango substation shall be major power supply station to Kigali area. Therefore, existing 110 kV transmission network was assumed to supply power to Kigali area to remain about actual capacity of 2015.
- Power flow calculation is conducted at the peak load of the year for analysis.
- Network voltage range is 95 % to 105 % in normal operation.
- Power factor of load is assumed 0.95 in consideration of average value of actual operation data in January 2015
- Since exact value of three phase short circuit capacity of outside simulation model required for the calculation is not able to obtain in view of near future international network connection with neighboring countries, the following premises were made for the sake of safety.
 - Three phase short circuit capacity of 220 kV Shango substation bus is equivalent to the rated breaking current of 220 kV circuit breaker in Shango substation.
 - For 110 kV network, bus of the nearest substation located outside of the model, which is interconnected to the model network, is infinite bus for short circuit calculation (For example, Rulindo substation 110 kV bus is infinite bus in case the contraction power source connects to Jabana substation in the model) and the short circuit capacity of contraction power source was decided with some margin taking into account of impedance of the transmission line from the infinite bus defined above to the model.

3) **Power Flow Calculation Results**

Upon the power flow calculations, it is confirmed that the facilities to be supplied for Ndera substation and its related transmission lines under the Project are appropriate in terms of capacity

and maintaining of voltage under the normal operation for ten years from the starting of operation of 2018.

However, it was found that several transmission lines and substation for central and east zones have to be reinforced to meet increasing demand for preventing overload and/or low voltage operation. The required reinforcements are summarized in Table 2-2-2-2.8 below.

Table 2-2-2-2.8 Required reinforcements for central and east zone

Required Year	Facilities to be reinforced	Reason
2018 or before	Musha SS 20 MVA 110/15 kV Transformer (first expansion)	To supply mainly Rwamagana industrial park (to avoid overload of the operating transformer)
2018 or before	220/110 kV Shango SS , 110 kV double circuit Transmission Line from Shango SS to Birembo SS	To supply power of imported and from power stations outside Kigali area such as Rusumo hydro, etc. to Kigali area
2018	Ndera Diesel PS (KSEZ) at least 10MW (planned 50MW) to be operated	To avoid overload of a 90 MVA 220/110 kV transformer in Shango SS
2019	Kabarondo SS 10 MVA 110/30 kV Transformer (first expansion)	To supply increasing distribution network load (to avoid overload of the operating transformer)
2019	Ndera Diesel PS (KSEZ) 50MW	To avoid overload of a 90 MVA 220/110 kV transformer in Shango SS
2020	New Gasogi SS 15 MVA 110/15 kV transformer	To supply increasing distribution network load, new substation with future transformer bay should be constructed. (The configuration of this new substation should be as presented to JICA team by REG in March 2015.)
2020	Jabana SS 20 MVA 110/15 kV Transformer (first expansion)	To supply increasing distribution network load (to avoid overload of the operating transformers)
2021	Musha SS 5 Mvar 15 kV Capacitor bank	To compensate voltage drop in east area network
2021	Kabarondo SS 3 Mvar 30 kV Capacitor bank	To compensate voltage drop in east area network
2021	Shango SS 90 MVA 220/110 kV Transformer (first expansion)	To strengthen power supply capability to Kigali load from 220 kV network (to avoid overload of the operating transformer)
2023	Conductor replacement of 110 kV transmission line from Birembo SS to Gasogi SS ACSR 157/25 to ACSR 240/40 Conductor replacement of 110 kV transmission line from Gasogi SS to Musha SS ACSR 157/25 (single) to ACSR 240/40 (double)	To compensate voltage drop in east area network If additional capacitor banks in Musha SS & Kabarondo SS are installed, over compensation will be occurred so that replacement of conductors are planned. Because of long distance between Gasogi SS and Musha SS, double conductor is selected to obtain high voltage compensating effect and it will be helpful to accommodate load for future increase.
2024	Birembo SS 20 MVA 110/15 kV Transformer (first expansion)	To supply increasing distribution network load (to avoid overload of the operating transformers)
2024	Musha SS 20 MVA 110/15 kV Transformer (second expansion)	To supply increasing distribution network load (to avoid overload of the operating transformers)

Required Year	Facilities to be reinforced	Reason
2025	Gikondo SS 30 MVA 110/15 kV Transformer (first expansion)	To supply increasing distribution network load (to avoid overload of the operating transformers) <i>When 30 MVA transformer is installed additionally in parallel with existing ones, short circuit capacity may exceeds 15 kV circuit breaker capability. Countermeasures have to be carefully studied such as replacement of SWGR, 15 kV bus coupler breaker always open operation, etc.</i>
2025	New Gasogi SS 15 MVA 110/15 kV Transformer (first expansion)	To supply increasing distribution network load (to avoid overload of the operating transformers)
2025	Shango SS 90 MVA 220/110 kV Transformer (second expansion)	To strengthen power supply capability to Kigali load from 220 kV network (to avoid overload of the operating transformers)
2026	Jabana SS 20 MVA 110/15 kV Transformer (second expansion)	To supply increasing distribution network load (to avoid overload of the operating transformers)
2026	Conductor replacement of 110 kV transmission line from Birembo SS to Jabana SS ACSR 157/25 (single) to ACSR 240/40 (double)	To strengthen power supply capability to western part of Kigali from 220 kV network (to avoid overload operation of transmission line)
2026	Musha SS 5 Mvar 15 kV Capacitor bank (first expansion)	To compensate voltage drop in east area network
2026	Kabarondo SS 3 Mvar 30 kV Capacitor bank (first expansion)	To compensate voltage drop in east area network
2028	Conductor replacement of 110 kV transmission line from Musha SS to Kabarondo SS ACSR 157/25 (single) to ACSR 240/40 (double)	To compensate voltage drop in east area network
2028	Rwinkwavu SS 1 Mvar 15 kV Capacitor bank	To compensate voltage drop in east area network
2028	Kabarondo SS 10 MVA 110/30 kV Transformer (second expansion)	To supply increasing distribution network load (to avoid overload of the operating transformers)
2028	Mt. Kigali SS 20 MVA 110/30 kV Transformer (first expansion)	To supply increasing distribution network load (to avoid overload of the operating transformers)

Source: JICA Study Team

Figure 2-2-2-2.7 shows the load flow calculation results of 2021 when the Project supplied facilities has been operated for three years on the single line diagram, and Figure 2-2-2-2.8 shows the ones of 2028 after ten years operation of the facilities. These calculations are carried out in the state to reflect the reinforcements listed in Table 2-2-2-2.8 up to the respective year.

As shown in the Table 2-2-2-2.8, the present network in Rwanda is so weak for forthcoming future load and it is necessary to reinforce transmission lines and substations to accommodate increasing forecasted load accordingly. As for new Gasogi substation construction that was requested to include in the scope of the Project, however, not included in finally, it was verified

necessary in 2020. The required year of facilities mentioned above is based on the high case of the demand forecast, however, it can be delayed approximately two years in the medium case and four years in the low case.

If the Project is not executed

- It is impossible to meet the rising demand of the area timely for supply electricity.
- Some long distance distribution lines, which are planned to changeover to Ndera substation partially, are being imposed to carry heavy load more and more that will make difficult to maintain voltage within allowable range.
- Gikondo substation that supply electricity for approximately half of Kigali city consumption have to be reinforced to meet the demand in 2023. When the Project is executed it can be extended to 2025. If Kigali ring project supported by EU will not completed before 2019, Gikondo reinforcement shall be performed in 2019.
- It is impossible to interconnect the Ndera diesel power station (50 MW), that is planned to construct in KSEZ in 2018, to the 110 kV network because Ndera substation and its related transmission lines are the corridor to the network for the power station.

Therefore, the Project is positioned to play a great important role for stable power supply to Kigali area in Rwanda.

4) Fault Current Calculation Results

The three phase short circuit current was calculated at each substation bus in the model used for the load flow analysis under the conditions described in 2) above. The calculation was made with the required reinforcements listed in Table 2-2-2-2.8 for respective year. The calculation results of three phase short circuit current at buses of Ndera substation and of major substations are shown in Table 2-2-2-2.9 below. Figure 2-2-2-2.9 shows the three phase short circuit current for each substation bus in the single line diagram in 2028. The detail calculation results are shown in Attachment – 8.

Table 2-2-2-2.9 Three phase short circuit current

(Unit: kA)

		2018	2021	2028	Rated breaking current of circuit breaker
Ndera SS	110kV bus	10.4	12.1	14.2	31.5 (planned)
	15kV bus	15.0	15.5	16.4	25 (planned)
Gikondo SS (for reference)	110kV bus	15.4	16.0	17.0	31.5
	15kV bus	20.1	20.6	32.1	25
Birembo SS (for reference)	110kV bus	14.3	17.8	23.0	40
	15kV bus	8.1	8.4	16.6	25

Source: JICA Study Team

It is predicted that when 30 MVA transformer is installed additionally in parallel with existing ones in Gikondo substation, the short circuit capacity at 15 kV bus exceeds interrupting capability of 15 kV circuit breaker so that the countermeasures have to be carefully studied such

as replacement of SWGR with upgraded one, 15 kV bus coupler breaker always open operation, etc.

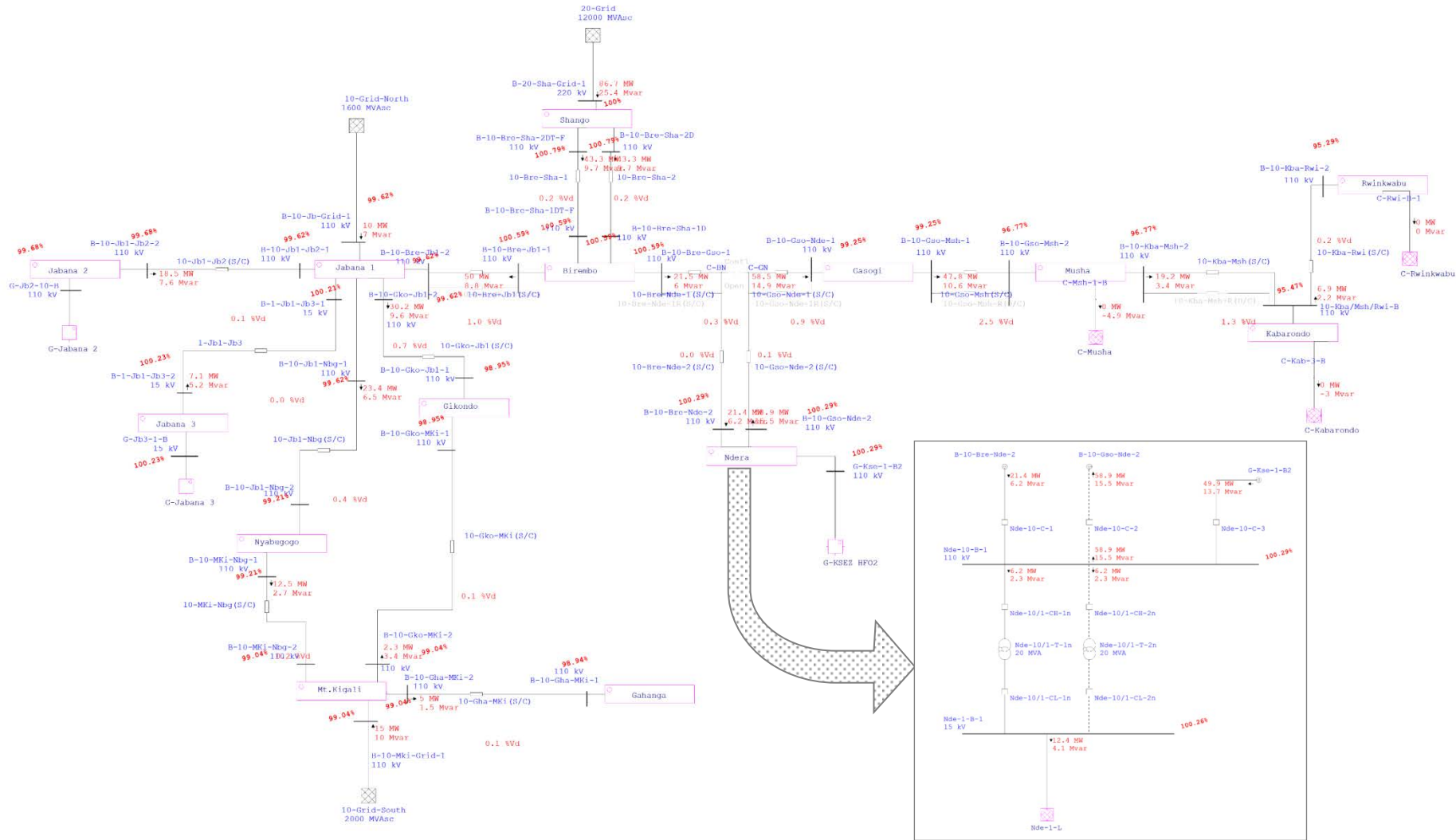


Figure 2-2-2-2.7 Load flow calculation results in 2021 (after 3 years operation)

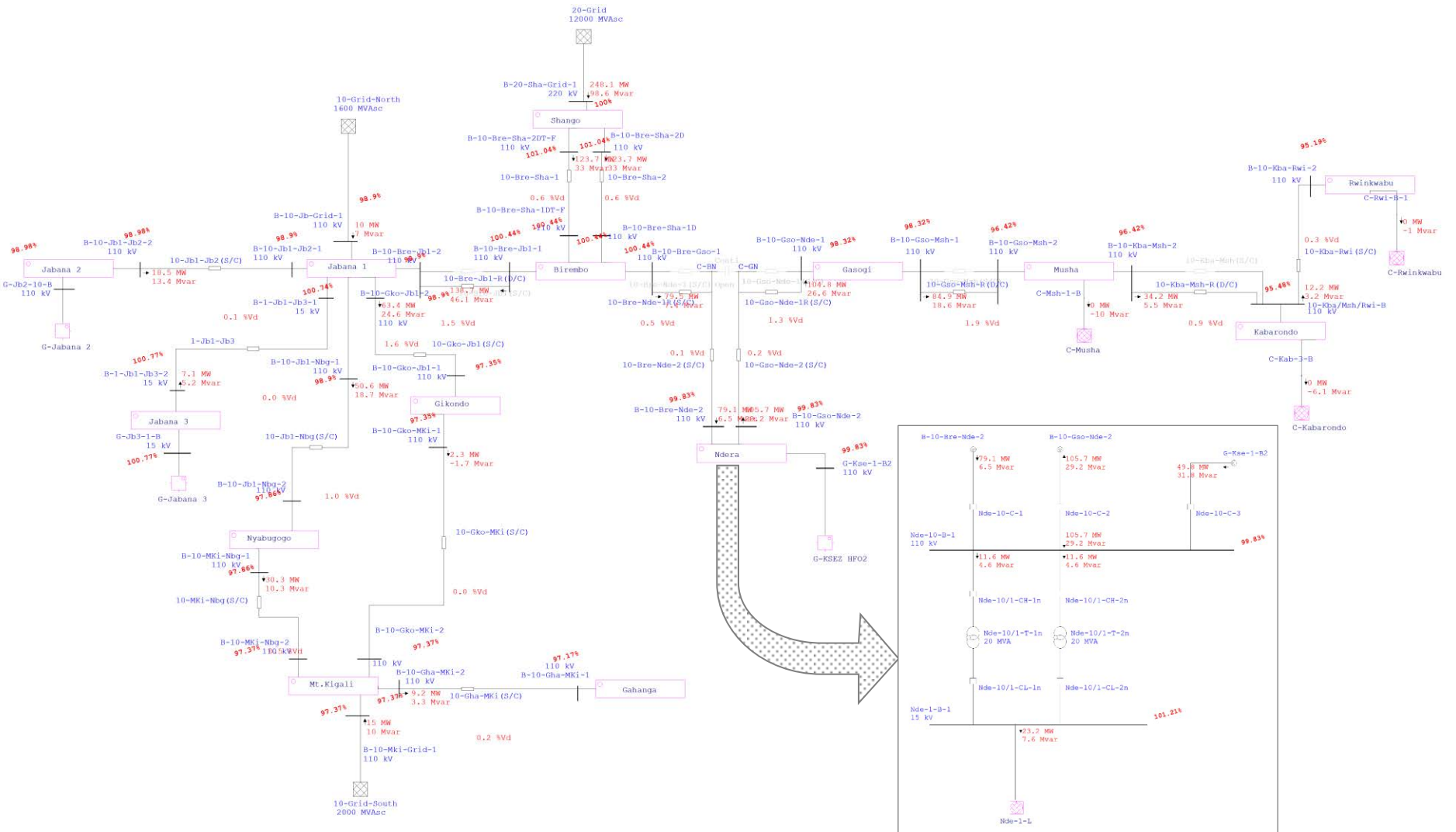


Figure 2-2-2-2.8 Load flow calculation results in 2028 (after 10 years operation)

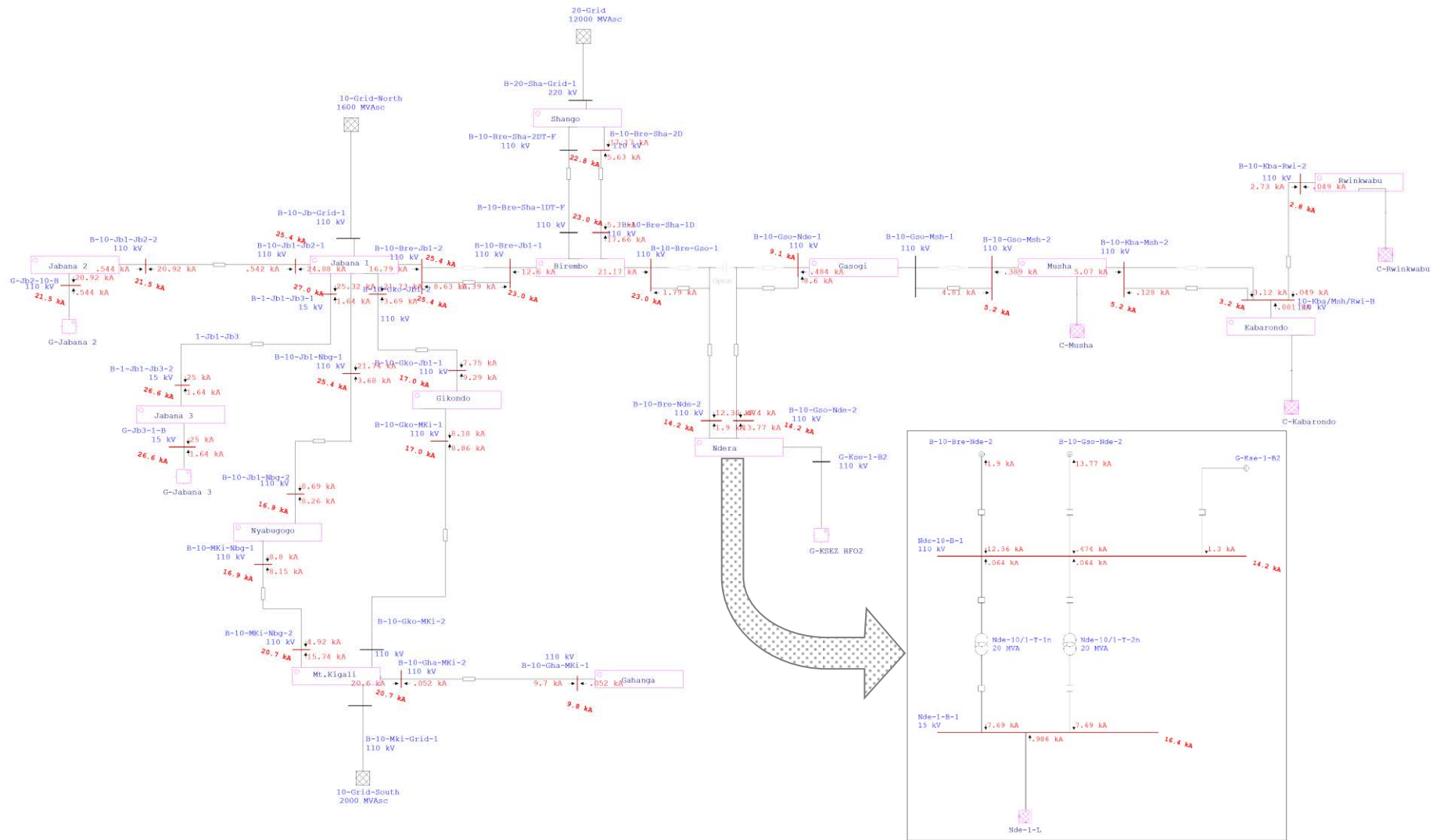


Figure 2-2-2.9 Three phase short circuit current calculation results in 2028 (after 10 years operation)

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 and buildings facilities and foundations are as shown in Table 2-2-2-3.1, for transmission and distribution line design conditions are shown in table 2-2-2-4.10.

Table 2-2-2-3.1 Design Conditions (Weather)

Area		Kigali city
Altitude		Not more than 2,000 m
Ambient temperature	Maximum	40 degree C
	Minimum	5 degree C
	Average	20 degree C
Maximum Wind Velocity		34 m/s
Annual Rainfall		1,450 mm
Seismic Factor		0.10 G
Soil bearing capacity		150 KN/m ²

Source: JICA study team

2) System voltage

Transmission Line 110 kV system:	110 kV +/- 10%
Distribution Line 30 kV system:	30 kV +/- 10%
Distribution Line 15 kV system:	15 kV +/- 10%

Regarding Distribution voltage in Rwanda, EUCL has applied 2 kinds of voltage for the Distribution line with 15 kV and 30 kV. As concept of EUCL, all of 15 kV switchgears and distribution lines on the Project shall be recommended to applied specification with 30kV.

3) System frequency 50 Hz +/- 0.2 Hz

4) System short circuit current

110 kV system:	31.5 kA
15 kV system:	25 kA

5) System earthing

110 kV system:	Solidly earthing system
15 kV system:	Solidly earthing system

6) Insulation Level

Level-1, Light of IEC standard (IEC 60815)

(2) Applicable Standards and Units Used

Substation systems and transmission and distribution facilities are generally designed in

accordance with IEC standards, JEC standards or equivalent standards. International system of Units (SI units) should be used.

2-2-2-4 Basic Plan Overview

As mentioned previously, this project is meant to help to enhance distribution facilities in the Kigali Special Economic Zone (SEZ) to be developed in Ndera district and to enhance distribution facilities around Kabuga Center and Murindi Areas.

(1) Ndera Substation (New Construction)

1) Basic concept

- Existing 110 kV transmission line between Birembo and Gasogi is separated at tower no. 212 and 110 kV double circuit transmission lines are connected to Ndera substation, one is from Birembo and the other is from Gasogi (Musha) substation.
- Conventional type 110 kV outdoor switchgear equipment is installed at 110 kV switchyard in Ndera substation. Single busbar configuration should be applied to 110 kV system. 110 kV switchgears are consisting of two bays of Incoming feeder and two bays of Transformer feeder. Space for one bay of Incoming feeder should be considered for future 50 MW diesel power plant next to the substation.
- Two sets of 20 MVA transformer are installed and parallel operation of two transformers should be done. The connection of the transformers should be of overhead conductors on 110 kV side and cables on 15 kV side, respectively. Further, a fire wall should be installed between transformers to prevent fire spread from the other.
- SF₆ gas insulated type 15 kV switchgear should be adopted with double busbar system installed in the control building. The rated voltage of 15 kV system shall be of 36 kV in consideration of the interchangeability of the equipment, since the distribution voltage of the whole country is 30 kV, although it is 15 kV in Kigali city.
- Micro SCADA system is employed in the substation to have monitoring and control the substation equipment. In addition, the operation of the equipment should be done at National Electricity Control Center (NECC) through optical fiber network in the country.
 - Remote Terminal Unit (RTU): All data of the equipment inside the substation shall be transmitted to RTU panel through Bay Control Unit (BCU), Switching-hub units, etc., utilizing various I/O data in a substation, such as status of switchgears, protection relays, local control facilities and other facilities.
 - Micro SCADA system: Substation Micro SCADA system by Control and monitoring servers utilizing the information of RTU via local area network (LAN).
 - Work Station for supervision and control: the Work Station consisting of display, keyboard, mouse, etc., will control each measurement, supervision and control of all circuit conditions in the substation.

- Communication equipment between the substation and NECC through optical fiber network, to enable the operation and monitoring the substation from NECC
- Entire earthing system in the substation should be considered. Lightning protection of 110 kV switchyard and 20 MVA transformers should be done by overhead grounding wires.
- The rated voltage should be 145 kV, since the altitude of the site is approximately 1,500 m above sea level.

Details are shown in the preliminary drawings for Ndera substation as below.

- SS-01 ; Single Line Diagram
- SS-04-1 ; Control System Diagram
- SS-06-1 ; Arrangement Drawing (Plan) of 110 kV Switchyard
- SS-06-2 ; Arrangement Drawing (Section) of 110 kV Switchyard
- SS-07 ; Arrangement Drawing of Equipment in Control Building
- SS-11 ; Arrangement Drawing of Cable Trays (Basement Floor)

2) Planned details for substation equipment

Equipment and materials to be supplied by the Japanese side for Ndera substation is given in Tables 2-2-2-4.1.

Table 2-2-2-4.1 Equipment List supplied by Japanese side in Ndera Substation

No.	Equipment	Specifications	Q'ty
1.	110/15 kV Transformer		2 units
	- Applied Standards	IEC, JIS, JEC, JEC or equivalent	
	- Type	Outdoor, On-load Tap Changer, hermetically sealed	
	- Rated Capacity	20 MVA	
	- Rated Frequency	50 Hz	
	- Number of Phase	3	
	- Rated Primary Voltage	110 kV	
	- Rated Secondary Voltage	15 kV	
	- Tap Changer		
	• Type	Vacuum bulb type, On-Load Tap Changer (LTC)	
	• Tap Voltage	110 kV +/- 16%	
	• Number of Taps	27 Taps	
	• Step Voltage	1.23%	
	• Output of Tap position indication	For local and remote indication, for parallel operation of Transformers	
	- Cooling	ONAN	
	- Vector Group	YNyn0(d)	
	- % Impedance	Approximately 9 - 10%	
	- Rated Lighting Impulse Withstand Voltage	110 kV : 650 kV 15 kV : 95 kV	
	- Rated Power Frequency Withstand Voltage (1 min.)	110 kV : 275 kV 15 kV : 38 kV	
	- Bushing type Current Transformers	110 & 15 kV Neutral : 38 kV 110 kV Neutral : 200/1 A, class 5P20 15 kV Neutral : 1,200/1 A, class 5P20	
	- Neutral Grounding System	110 kV : Solidly grounding 15 kV : Solidly grounding	
	- Connections	110 kV : Overhead conductors	

No.	Equipment	Specifications	Q'ty
	<ul style="list-style-type: none"> - Color - Accessories - Particular conditions - Lightning Arresters - Current transformer - Parallel Operations - Fire Wall - Oil Pit 	<p>15 kV : Cable connection (2 x 185 mm² or bigger/phase)</p> <p>N7</p> <p>Insulation oil, Cable duct for 15 kV cables, 15 kV Lightning arresters (LA) with counters (LA to be installed in the cable ducts), Buchholz relay with alarm contact, LTC oil flow relay, Oil level gauge with alarm contact, Oil temperature indicator with alarm contact, Winding temperature indicators with alarm contact, Oil and Winding temperature elements for remote indication, Pressure relief device with alarm contact, Dehydrating breathers, Ladder for maintenance, Handle for LTC operation, and all other necessary accessories and fittings</p> <p>Lightning arresters shall be installed at both HV and LV sides.</p> <p>For 87T located on HV/LV of the transformer</p> <p>A parallel operation of the transformers shall be conducted.</p> <p>A fire wall shall be installed between transformers.</p> <p>An oil pit with the capacity of 120% of the total oil volume of the Transformer shall be designed under each transformer.</p>	
2.	<p>110 kV Switchgear Equipment</p> <p>(1) Composition and Quantity</p> <ul style="list-style-type: none"> - Applied Standards - Bus bars - Quantity <p>(2) Common specifications</p> <ul style="list-style-type: none"> - Rated Voltage - Rated Current - Rated Interrupting Current - Rated Short-time Withstand Current - Rated Lightning Impulse Withstand Voltage - Rated Power Frequency Withstand Voltage (1 min.) - Creepage distance (for insulator) 	<p>(Outdoor)</p> <p>IEC, JIS, JEC, JEM or equivalent</p> <p>Aluminum pipes, Single Bus bar System, 1,250 A</p> <p>a) Transmission line bays: 2 sets, 1 set comprising of;-</p> <ul style="list-style-type: none"> - Disconnecting Switch (DS) (for bus bar side) - Circuit Breaker (CB) - Current Transformers (CT) - DS with Earthing Switch (ES) (for line side) - Voltage Transformers (VT) - Lightning Arresters (LA) <p>b) Transformer bays: 2sets, 1 set comprising of;-</p> <ul style="list-style-type: none"> - Disconnecting Switch (DS) (for bus bar side) - Circuit Breaker (CB) - Current Transformers (CT) - Lightning Arresters (LA) <p>c) 110 kV Bus bar: 1 set</p> <ul style="list-style-type: none"> -Voltage Transformers <p>145 kV</p> <p>Bus bar : 1,250 A</p> <p>Transmission line bay : 1,250 A</p> <p>Transformer bay : 1,250 A</p> <p>31.5 kA</p> <p>31.5 kA (2 sec.)</p> <p>650 kV</p> <p>275 kV</p> <p>16 mm/kV or longer</p>	1 lot

No.	Equipment	Specifications	Q'ty
	- Accessory	Space heater, indoor light, key on door, support structure, necessary material to be fitted	
(3)	Equipment specifications		
1)	Circuit Breaker (CB)		
	- Type	Outdoor, Live tank type, three phase, GCB	
	- Rated Current	3,150 A	
	- Rated Interrupting Time	Less than 3 cycles	
	- Operating Duty	O-0.3 sec.-CO-3 min.-CO	
	- Control Voltage	110 V DC	
	- Accessories	Local operation box, Operation counters, Spring charge handle	
	Particular condition	CB for transmission lines shall be equipped with single phase auto reclosing function	
2)	Disconnecting Switch (DS)		
	- Type	Outdoor, three phase, Horizontal double-break or single-break type	
	- Rated Current	1,250 A	
	- Control Voltage	110 V DC	
	- Accessories	Operation handle for opening and closing	
	- Particular Condition	- 110 kV Earthing Switch shall be equipped with the line side DS on each transmission line bay. - Operating mechanism	
3)	Current Transformer (CT)		
	- Type	Outdoor, single phase	
	- Transmission line bays	200-400/1/1/1 A, class 0.5/5P20/5P20	
	- Transformer bays	120-240/1/1/1 A, class 0.5/5P20/5P20	
4)	Voltage Transformer (VT)		
	- Type	Outdoor, single phase	
	- Ratings	110/ $\sqrt{3}$ kV / 110/ $\sqrt{3}$ V / 110/3 V, class 1T/3G, 200 VA/200 VA	
5)	Lightning Arrester (LA)		
	- Type	Outdoor, single phase, Zinc metal oxide type	
	- Transmission line bays	120 kV, 10 kA	
	- Transformer bays	120 kV, 10 kA	
	- Accessories	Surge counters in each phase	
6)	110kV bus bar		
	- 110 kV bus bar	Aluminum pipes	
	- Steel Structures	Steel materials, Hot-dipped galvanized	
	- Supporting Insulators	Porcelain	
	- Conductors	AAC 250 mm ² or more	
	- Supporting Insulators for conductors	For 110 kV bus bar	
	- Dead-end Tower	Steel materials, Hot-dipped galvanized	
	- Steel Towers for Grounding Wires	Steel materials, Hot-dipped galvanized	
	- Grounding Wires	GSW55mm ²	
	- Other	- Lighting fixtures on the end of tower	
3.	15 kV Switchgear	(GIS)	1 lot
(1)	Composition and Quantities:		
	- Applied Standards	IEC, JIS, JEC, JEM or equivalent	
	- Type	Indoor type, SF ₆ gas insulated metal-clad switchgear	
	- bus bar Configuration	Double bus bar System	
	- Control and Protection	Bay Control Unit (BCU) type	
	- Quantity	110/15 kV Transformer Panel : 2 panels 15 kV Distribution Feeder Panel : 7 panels Bus Coupler Panel : 1 panel Station Transformer Panel : 1 panel Voltage Transformer Panel : 1 panel	

No.	Equipment	Specifications	Q'ty
(2)	Common Specifications - Rated Voltage - Rated Frequency - Rated Busbar Current - Circuit Breaker (CB) - Type - Rated Interrupting Current - Auto-reclosing - Operating Duty - Rated Short-time Withstand Current - Rated Lighting Impulse Withstand Voltage - Rated Power Frequency Withstand Voltage (1 min.) - Control Voltage - Control & protection - Connection - Accessories	36 kV 50 Hz 2,500 A VCB or GCB with DS and ES 25 kA 3 phase reclosing O-0.3 sec.-CO-3 min.-CO 25 kA (2 sec.) 170 kV 70 kV DC 110 V and AC 230 V OC, OCG, BCU type Bottom of the panels Name plates, testing terminals, Space heaters with thermostat, MCCB with alarm contact, Handle with key, Testing plug, Handle for spring-charge, ODA sticker and all other necessary accessories and fittings	
(3)	Equipment		
1)	110/15 kV Transformer Panel - Rated Current - CT - VT - Voltage Detector	1,250 A 36 kV, 1,000-2,000/1/1/1 A, class 0.5/5P20/5P20 15/√3 kV/110/√3 V, class 1.0 Lamp indication at bay outlet	
2)	15 kV Distribution Feeder Panel - Rated Current - CT - VT - Voltage Detector	1,250 A 36 kV, class 0.5/5P20/5P20 15/√3 kV/110/√3 V, class 1.0 Lamp indication at bay outlet	
3)	Bus Coupler Panel - Rated Current - CT - Particular Condition	2,500 A 36 kV, 1,000-2,000/1/1/1 A, class 0.5/5P20/5P20 DS wit ES shall be equipped at Bus-bar side of CB	
4)	Station Transformer Panel - Rated Current - CT ratio - Voltage Detector	630 A 36 kV, 100-200/1/1/1 A, class 0.5/5P20/5P20 Lamp indication at bay outlet	
5)	Voltage Transformer Panel - VT	15/√3 kV/110/√3 V, class 1.0	
4.	Control and Protection System		1 lot
(1)	Composition and Quantities - Applied Standards - Quantity of Panels - Other requirement	IEC, JIS, JEC, JEC or equivalent For 110 kV transmission line 2 bays For 110/15 kV transformer 2 bays For 15 kV switchgear 11 circuits - Spare terminals more than 10% of whole terminals in the panel shall be provided. - Alarm indicator and MCCB on each system	
(2)	Equipment		
1)	110 kV Transmission line - Control and Protection - Protection Relay	BCU type Main : Current differential protection system Back-up : Impedance relay system	
2)	110/15kV Transformer		

No.	Equipment	Specifications	Q'ty
	<ul style="list-style-type: none"> - Control and Protection - Voltage Regulating Control - Protection Relay 	BCU type Control of 20 MVA Transformer On-load tap changer (including Parallel operation control) Main : Transformer differential protection system Back-up : Over current protection system	
3)	15 kV Switchgear <ul style="list-style-type: none"> - No. of bays 	<ul style="list-style-type: none"> - 20 MVA Transformer: 2 circuits - 15 kV Feeder : 7 circuits - Bus coupler : 1 circuit - Station transformer : 1 circuit - Station transformer : 1 circuit 	
	<ul style="list-style-type: none"> - Control and Protection 	BCU type	
5.	Micro SCADA Communication System		1 lot
(1)	Micro SCADA System <ol style="list-style-type: none"> ① Composition and Quantities <ul style="list-style-type: none"> - Applied Standards - Composition ② Remote Terminal Unit (RTU) <ul style="list-style-type: none"> - Control Voltage ③ Micro SCADA system <ul style="list-style-type: none"> - Control Voltage ④ Workstation for Control and Monitoring <ul style="list-style-type: none"> - Components - Control Voltage - Measurement & Display - Monitoring - Operation - Power source - Accessories ⑤ Local Area Network System 	IEC, JIS, JEC, JEM or equivalent IEC 61850 or equivalent standards Remote Terminal Unit: 1 lot Micro SCADA system: 1 lot Workstation: 2 sets LAN network 1 lot 110 V DC 110 V DC Display, keyboard, mouse , printer and others 230 V AC (Uninterruptible Power Supply) Voltage, current, active power, reactive power, etc. of all 110 kV and 15 kV circuits Position indications of 110 kV and 15 kV equipment, alarms on the transmission lines, Transformers and other information of the substation Open/close operation of 110 kV and 15 kV switchgear at Workstation 230 V AC (Uninterruptible Power Supply) - two sets of Operator's desk and chairs - Spare terminals more than 10% of whole terminals in the panel shall be provided. - The consumables of the printer shall be available at local market. LAN cables, optical fiber cables and other necessary materials for overall Substation communication system	
(2)	Communication Equipment <ul style="list-style-type: none"> - Applied Standards - Multiplexer <ul style="list-style-type: none"> • Type • Control Voltage • Others - Telephone System <ul style="list-style-type: none"> • Type • Control Voltage 	IEC, JIS, JEC, JEC or equivalent Existing system (ECI/BG-20) or equivalent 48 V DC Optical fiber cables and its splicing boxes, Router for Internet, and other necessary materials for their installation IP PBX (with 4 sets of telephone) 48 V DC and 230 V AC (UPS)	

No.	Equipment	Specifications	Q'ty
6.	Station Power Supply System		1 lot
(1)	Common Requirement	IEC, JIS, JEC, JEM or equivalent	
	- Applied Standards	Station Transformer	1 unit
	- Composition and Quantity	110 V DC system	1 set
		48 V DC system	1 set
		UPS System	1 set
(2)	Equipment		
1)	15/0.4 kV Station Service Transformer		
	- Type	Outdoor, No-load Tap Changer, hermetically sealed	
	- Rated Capacity	250 kVA	
	- Rated Frequency	50 Hz	
	- Number of Phase	3	
	- Rated Primary Voltage	15 kV AC	
	- Rated Secondary Voltage	400-230 V AC (3P4W)	
	- Tap Changer		
	• Tap Voltage	15 kV +/- 2.5%, +/- 5%	
	• Number of Taps	5 Taps	
	• Step Voltage	2.5%	
	- Cooling	ONAN	
	- Vector Group	Dyn11	
	- Rated Lightning Impulse Withstand Voltage	15 kV : 95 kV	
	- Rated Power Frequency Withstand Voltage (1 min.)	15 kV : 38 kV	
	- Connections	15 kV : Cable connection 400 V : Cable connection	
	- Color	N7	
	- Accessories	Cable ducts for primary and secondary connection, Oil level gauge, Oil temperature indicator, etc.	
	- Particular Condition	• Fence around the transformer shall be installed for safety measures.	
2)	110 V DC system		
a)	Battery Charger		
	- Rated Voltage	110 V DC	
	- Rated Capacity	100% continuous	
	- Type	Indoor use, metal enclosed self-standing type, Duplicate charger system (2 sets of 100% capacity charger, Dumpless transfer system)	
	- Input Voltage	400/230 V AC	
	- Output Voltage	110 V DC +/-3V	
b)	Battery		
	- Type	Valve regulated lead acid (VRLA) type or equivalent	
	- Capacity	300 Ah/10 Hr	
c)	110 V DC Distribution panel		
	- Type	Indoor use, metal enclosed self-standing type	
	- Output Circuit No.	More than 20% of spare feeder circuits with MCCBs shall be provided.	
	- Accessories	Lighting inside, Meters (voltage, current, etc.), Protective relays, Annunciators, MCCB with auxiliary contacts, Voltage regulators (Silicon droppers or equivalent), etc.	
3)	DC 48 V System		
a)	Charger		
	- Rated Voltage	48 V DC	
	- Capacity	100% continuous	

No.	Equipment	Specifications	Q'ty
	<ul style="list-style-type: none"> - Charger <ul style="list-style-type: none"> • Type • System • Input Voltage • Output Voltage b) Battery <ul style="list-style-type: none"> - Type - Capacity c) 48 V DC Distribution panel <ul style="list-style-type: none"> - Type - Output Circuit No. - Accessories <p>4) AC Distribution panel</p> <ul style="list-style-type: none"> - Type - Rated Voltage - Rated Short-time Withstand Current - No. of Feeder - Accessories <p>5) Uninterruptible Power Supply (UPS)</p> <ul style="list-style-type: none"> - Type - Rated Voltage <ul style="list-style-type: none"> • Input Voltage • Output Voltage - Rated Output - Battery - Accessories - Distribution panel for UPS <ul style="list-style-type: none"> - Type - Rated Output Voltage - Output Circuit No. 	<p>Indoor use, metal enclosed self-standing type Single charger system (1 set of 100% capacity charger) 400/230 V AC 48 V DC +/-3V</p> <p>Valve regulated lead acid (VRLA) type or equivalent 100 Ah</p> <p>Indoor use, metal enclosed self-standing type More than 20% of spare feeder circuits with MCCBs shall be provided. Lighting inside, Meters (voltage, current, etc.), Protective relays, Annunciators</p> <p>Indoor use, metal enclosed self-standing type 400/230 V AC (3 phase 4 wires) 25 kA (1 sec.) More than 20% of spare feeder circuits with MCCBs Lighting inside, Meters, Protective relays, Annunciators</p> <p>Indoor use, air insulated, metal enclosed self-standing type, Inverter type or equivalent</p> <p>230 V AC (110 V DC) 230 V AC +/- 5% 100% continuous output, dumpless change-over in case of AC or DC input failure, one hour continuous output at the time of DC supply only 110V DC Lighting inside, Meters (voltage, current, etc.), Protective relays, Annunciators</p> <p>Indoor use, metal enclosed self-standing type (The power supply circuit may be fitted inside UPS panel) 230 V AC single phase More than 20% of spare feeder circuits</p>	
7 (1)	<p>15 kV Cables and associated materials</p> <p>15kV Power Cable</p> <ul style="list-style-type: none"> - Applied Standards - Type - Conductors - Cable sealing end <p>15kV Distribution Cable</p> <ul style="list-style-type: none"> - Rated voltage - Size 	<p>IEC, JIS, JEC, JEC or equivalent Cross-linked Polyethylene insulated PVC sheathed cable, Triplex type, three core type or single core type cable Steel armored cables for direct burial case Compacted copper stranded Outdoor use : Heat shrinkable type Indoor use : Heat shrinkable type or Prefabricated type</p> <p>18/30 kV 1c-240 mm²</p>	1 lot
(2)	<p>15 kV Lightning Arrester</p> <ul style="list-style-type: none"> - Applied Standards 	IEC, JEC, JIS, JEC or equivalent	

No.	Equipment	Specifications	Q'ty
	- Type - Rated Voltage - Rated Discharge Current	Outdoor use, Metal oxide gapless type, single phase 15 kV 10 kA	

3) Substation building and ancillary facility construction plans

The new Substation building shall be constructed at the new site where is next to the existing site of the diesel power plant. The area of the Project site is approximately 5,600 square meters. The elevation of the Project site is slope as approximately 1,540 to 1,550 meters, and so that the site leveling shall be made flat. The new premises road shall be constructed to reach to the public road. One Substation building; 1-story with basement, one foundation for 15/0.4kV Transformer, four foundations for Bus Structure, twelve foundations for Lightning Arrester, twelve foundations for Current Transformer, nine foundations for Current Voltage Transformer, six foundations for Disconnection Switch, four foundations for Circuit Breaker, two foundations for 110/15kV Transformer, two foundations for Lightning Pole, four foundations for Gantry Structure, Rain water drainages, Cable pits, Fire wall, Sewage tank, Septic tank, and etc. shall be constructed.

The main Substation building plans are follows:

Substation building : 1-story with basement, reinforced concrete structure, construction area approx. 360.00 square meters, floor area approx. 602.19 square meters

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

Table 2-2-2-4.2 Substation building

FL	Room	Area	Equipment/Specification
BF	Basement		Light Fittings, Water receiving tank, Cable Rack, Drainage
	Pit		
	Sub Total	242.19 m ²	
GF	Switchgear Room		Light Fittings, Cable Pit
	Control Room		Light Fittings, Air-condition, Cable Pit
	Battery Room		Light Fittings, Cable Pit, Sink
	Charger Room		Light Fittings, Air-condition, Sink
	Telecom Room		Light Fittings, Air-condition
	Office		Light Fittings
	Meeting Room		Light Fittings
	Kitchen		Light Fittings, Ventilation, Sink
	Toilet and Shower Room		Light Fittings, Ventilation, Toilet, Wash basin, Shower set
	Care Taker Rom		Light Fittings, Air-condition
	Corridor		Light Fittings
	Storage		Light Fittings
	Sub Total	360.00 m ²	
	Grand Total	602.19 m ²	

The main exterior finishing schedule is follows:

Table 2-2-2-4.3 Exterior Finishing Schedule

Facility	Item	Specification
Substation building	Roof (1)	Asphalt waterproofing, Styrofoam t=50, Cover concrete
	Roof (2)	Asphalt waterproofing, Styrofoam t=50, Cover concrete
	Wall	Emulsion paint
	Windows	Readymade Aluminum Window
	Doors	Steel Door
	Down spout	Vinyl pipe
	Roof Drain	Cast Iron

The main interior finishing schedule is follows:

Table 2-2-2-4.4 Interior Finishing Schedule

FL	Room	Floor	Wall	Ceiling
BF	Basement	Non-slip paint finish	Exposed concrete	Exposed concrete
	Pit	Mortar with steel trowel finish		
GF	Switchgear Room	Porcelain tile 300x300	Emulsion paint	Emulsion paint
	Control Room			
	Battery Room			
	Charger Room			
	Telecom Room	Porcelain tile 300x300	Emulsion paint	LGS joists and makeup plaster board
	Office			
	Meeting Room			
	Kitchen			
	Toilet and Shower Room			
	Care Taker Rom			
	Corridor			
	Storage	Porcelain tile 300x300	Emulsion paint	Exposed concrete

4) Work to be constructed by Rwandan side

- To construct the fences and gates
- To arrange drainage system from the end of the rain water drainage of the Ptoject
- To arrange the city water supply line to the connection point of the Project
- To construct the Security building (if necessary)

(2) Gasogi Substation (Expansion Work)

1) Basic concept

- One additional 15 kV switchgear panel is extended to the existing 15 kV switchgear panels (Model: ABB ZX1.5). The panel is the feeder for Kabuga RMU Switching Station.
- The existing 15 kV switchgear room including cable trench is extended by the Rwanda side (EUCL) to accommodate one additional switchgear panel supplied by Japanese side. And existing cable trench for new control panel should also be extended by Rwanda side.

- A Bay control unit (BCU) is installed on the additional switchgear panel for its control and protection.
- In order to enable the operation of this additional switchgear panel, the BCU is connected to the existing RTU panel using additional new card and communicated with NECC through the existing SDH equipment (Multiplexer with new card) utilizing new optical fiber network along the new distribution line. See drawing No. SS-04-3 “Communication System Diagram for Gasogi Substation and Kabuga RMU Switching Station”
- The existing station power supply is used, such as 230 V AC, 110 V and 48 V DC.
- The shutdown time of the existing 15 kV switchgear (ABB made ZX1.5) should be minimized at the time of implementing the extension works.

Details are shown in the preliminary drawings for Gasogi substation as below.

- SS-05 ; Single Line Diagram
- SS-04-3 ; Communication System Diagram for Gasogi Substation and Kabuga RMU Switching Station

Table 2-2-2-4.5 Equipment List supplied by Japanese side in Gasogi Substation

No.	Equipment	Specifications	Q'ty
1.	15 kV Switchgear - Extension panel - Type - Quantity - Ratings - Rated Voltage - Rated bus bar Current - Rated Frequency - Rated Short-time Withstand Current - Rated Interrupting Current - Rated Lighting Impulse Withstand Voltage - Rated Power Frequency Withstand Voltage (1 min.) - Circuit Breaker - Current Transformer - Voltage Transformer - Cable connection - Others	(GIS) Gas Insulated Switchgear type, existing switchgear: ABB/ZX1.5 ,Single bus bar System, for reference 15 kV Switchgear panel : 1 panel 40.5 kV 1,250 A 50 Hz 25 kA (2 sec.) 25 kA 170 kV 70 kV VCB or GCB with DS/ES, 40.5 kV, 800 A, 25 kA 200-400/1/1/1 A, class 0.5/5P20/5P20 15,000/ $\sqrt{3}$ /110/ $\sqrt{3}$ V Bottom - Interface for RTU - All necessary materials for extension of the panel such as SF ₆ gas handling, foundation etc. shall be included.	1 panel
2. (1)	Control and Communication panel Control panel for 15 kV extension panel - Applied Standards - Type	(1 panel) IEC, JIS, JEC, JEC or equivalent Indoor use, metal enclosed self-standing type Note; New panel should be of slender type with suitable height for operation and monitoring of BCU, due to limited space of existing control room.	1 lot

No.	Equipment	Specifications	Q'ty
-2	<ul style="list-style-type: none"> - Control, monitoring and Protection - Control Voltage - RTU card and its optical fiber cable - RTU card - Optical Fiber Cable 	<p>BCU type, Existing: ABB/REF670 for reference The operation, control, measurement and monitoring of the extended 15 kV switchgear shall be done using the control function of BCU. The protection elements (OC and OCG) in BCU is used. Existing 110 V DC shall be used.</p> <p>ABB made RTU card type "23OK24" The card shall be installed in the existing RTU panel. Between BCU and the extended RTU card "23OK24" (Tx and Rx)</p>	
(3)	15 kV Cables and other materials	Refer to item 6 in Table 2-2-2-4.1	1 lot

(3) 15kV RMU Switching Stations (New Construction)

1) Basic concept of Kabuga RMU Switching Station

- Kabuga RMU Switching Station is connected to Gasogi Substation by newly installed 15 kV distribution line (single circuit).
- Three more 15 kV feeder panels are installed in addition to the feeder from Gasogi substation. (One feeder among three is spare feeder.)
- A 15/0.4 kV, 630 kVA Transformer is installed for supply 400-230 V power to the station and the surrounding area.
- A SF₆ gas insulated type switchgear should be adopted for the 15 kV switchgear with single bus bar system installed in the Control building. The rated voltage of 15 kV system shall be of 36 kV in consideration of the interchangeability of the equipment, since the distribution voltage of the whole country is 30 kV, although it is 15 kV in Kigali city.
- All data of the equipment inside the Switching station are collected to the RTU panel through Bay Control Units (BCU), Switching-hub units, etc., and transmitted and received to NECC through optical fiber network, such that the operation and monitoring of the station is enabled from NECC.
- Entire earthing system in the substation should be considered.

Details are shown in the preliminary drawings for Kabuga RMU Switching Station as below.

- SS-02 ; Single Line Diagram
- SS-04-2 ; Control System Diagram
- SS-09 ; Arrangement Drawing of Equipment

2) Basic concept of Murindi RMU Switching Station

- The existing 15 kV overhead distribution line between Gasogi and Kigali International Airport is split and the line is connected to Murindi RMU Switching Station by underground cables.
- Four more 15 kV feeder panels are installed in addition to the feeder originating in Gasogi substation. (One feeder among four is spare feeder.)
- A 15/0.4 kV, 630 kVA Transformer is installed for supply 400-230 V power to the station and the surrounding area.
- A SF₆ gas insulated type switchgear should be adopted for 15 kV switchgear with single bus bar system installed in the Control building. The rated voltage of 15kV system shall be of 36 kV as well as the voltage of Kabuga RMU Switching Station.
- All data of the equipment inside the Switching station are collected to the RTU panel through Bay Control Units (BCU), Switching-hub units, etc., and transmitted and received to NECC through optical fiber network, such that the operation and monitoring of the station is enabled from NECC.
- Entire earthing system in the substation should be considered.

Details are shown in the preliminary drawings for Murindi RMU Switching Station as below.

- SS-03 ; Single Line Diagram
- SS-04-2 ; Control System Diagram
- SS-08 ; Arrangement Drawing of Equipment

3) Planned details for substation equipment

Equipment and materials to be supplied by the Japanese side for both RMU switching stations is given in Table 2-2-2-4.6.

Table 2-2-2-4.6 Equipment List supplied by Japanese side in Kabuga and Murindi Switching Station

No.	Equipment	Specifications	Q'ty/ Station
1. (1)	15 kV Ring Main Unit (RMU) Composition and Quantity - Applied Standards - Type - bus bar System - Control and Protection - No. of Feeders	IEC, JIS, JEC, JEC or equivalent Indoor, SF ₆ gas insulated metal-clad switchgear, RMU type Single bus bar System Bay Control Unit (BCU) type a) 15 kV Feeders - Kabuga RMU Switching Station : 4 panels - Murindi RMU Switching Station : 5 panels b) 15/0.4 kV Transformer : 1 panels c) Voltage Transformer : 1 panels	1 lot
(2)	Common Specifications		

No.	Equipment	Specifications	Q'ty/ Station
(2)	- Rated Voltage	36 kV	
	- Rated Frequency	50 Hz	
	- Rated Busbar Current	1,250 A	
	- Circuit Breaker (CB)	VCB or GCB with DS/ES	
	- Type	VCB or GCB with DS/ES	
	- Rated Interrupting Current	25 kA	
	- Auto-reclosing	3 phase reclosing	
	- Operating Duty	O-0.3 sec.-CO-3 min.-CO	
	- Rated Short-time Withstand Current	25 kA (2 sec.)	
	- Rated Lightning Impulse Withstand Voltage	170 kV	
	- Rated Power Frequency Withstand Voltage (1 min.)	70 kV	
	- Control Voltage	110 V DC	
1)	Equipment		
	15 kV Feeder panel		
	- Rated Current of CB	630 A	
	- CT Ratio	400-800/1/1/1 A , class 0.5/5P20/5P20	
	- VT Ratio	15/√3 kV/110/√3 V	
	- Control and Protection	BCU type, Overcurrent and Overcurrent grounding protection,	
	- Voltage Detector	Lamp indication at bay outlet	
2)	15/0.4 kV Transformer panel		
	- Rated Current of CB	630 A	
	- CT ratio	100-200/1/1/1 A, class 0.5/5P20/5P20	
	- Control and Protection	BCU type, Overcurrent and Overcurrent grounding protection	
	-		
	- Voltage Detector	Lamp indication at bay outlet	
3)	Voltage Transformer panel		
	- VT Ratio	For bus bar (3 phases) 15/√3 kV/110/√3 V, class 1.0	
2.	Communication System for SCADA		1 lot
(1)	Remote Terminal Unit (RTU)		
	a) RTU panel		
	- Applied Standards	IEC 61850 or equivalent	
	- Control Voltage	110 V DC	
	b) Network System	Using optical fiber cable	
(2)	Communication Equipment		
	a) Multiplexer		
	- Applied Standards	IEC, JIS, JEC, JEC or equivalent	
	- Equipment	Existing network: ECI /BG-20	
	- Control Voltage	48 V DC	
	- Others	Splicing boxes for Optical fiber cables, Router for Internet and other necessary materials for installation	
	b) Telephone System		
	- Applied Standards	IEC, JIS, JEC, JEC or equivalent	
	- Component	IP PBX with 1 set of Telephone	
	- Control Voltage	48 V DC	
3.	Station Power Supply System		1 lot
(1)	Composition and Quantity		
		15/0.4kV Station transformer 1 unit	
		110V DC system 1 set	
		48V DC system 1 set	
		400/230V AC Distribution Panel 1 panel	
(1)	Equipment		
1)	15/0.4 kV Station Transformer		
	- Applied Standards	IEC, JIS, JEC, JEC or equivalent	

No.	Equipment	Specifications	Q'ty/ Station
	<ul style="list-style-type: none"> - Type - Rated Capacity - Rated Frequency - Rated Primary Voltage - Rated Secondary Voltage - No-load Tap Changer (NLTC) <ul style="list-style-type: none"> - Tap Voltage - No. of Taps - Step Voltage - Cooling - Vector Group - Rated Lightning Impulse Withstand Voltage - Rated Power Frequency Withstand Voltage (1 min.) - Connection 	<p>Indoor, No-load Tap Changer, hermetically sealed</p> <p>630 kVA</p> <p>50 Hz</p> <p>15,000 V</p> <p>400-230 V (3 phase, 4 wires)</p> <p>15,000 V +/- 2.5%, +/-5.0%</p> <p>5 taps</p> <p>2.5%</p> <p>ONAN</p> <p>Dyn11</p> <p>15 kV : 95 kV</p> <p>15 kV : 38 kV</p> <p>Cable ducts for both primary and secondary cable connection,</p> <p>15 kV side : Cable connection</p> <p>400 V side : Cable connection (Neutral phase shall be connected as well)</p> <p>N7</p> <p>Oil level gauge, Oil temperature indicator</p>	
(2)	<p>110 V DC System</p> <ul style="list-style-type: none"> - Applied Standards a) Charger and Distribution Panel <ul style="list-style-type: none"> - Rated Voltage - Rated capacity - Charger <ul style="list-style-type: none"> • Type • Input Voltage • Output Voltage • Power Supply • Accessories b) Batteries <ul style="list-style-type: none"> - Type - Capacity 	<p>IEC, JIS, JEC, JEC or equivalent</p> <p>110 V DC</p> <p>100% Continuous</p> <p>Indoor use, metal enclosed self-standing type</p> <p>Duplicate charger system (2 sets of 100% capacity charger, Dumpless transfer system)</p> <p>400/230 V AC, 3P4W</p> <p>110 V DC +/- 3 V</p> <p>More than 20% of spare feeder circuits</p> <p>Meters (voltage, current, etc.), Protective relays, Annunciators, MCCB with auxiliary contacts, Voltage regulators (Silicon droppers or equivalent), etc.</p> <p>Valve regulated lead acid (VRLA) type or equivalent</p> <p>110 Ah/10 Hr</p>	
(3)	<p>48 V DC System</p> <ul style="list-style-type: none"> a) Charger and Distribution panel <ul style="list-style-type: none"> - Applied Standards - Rated Voltage - Rated capacity - Charger <ul style="list-style-type: none"> • Type • System • Input Voltage • DC Output Voltage • Power Supply • Accessories b) Batteries 	<p>IEC, JIS, JEC, JEC or equivalent</p> <p>48 V DC</p> <p>100% Continuous</p> <p>Indoor use, metal enclosed self-standing type</p> <p>Single charger system (1 set of 100% capacity charger)</p> <p>400/230 V AC</p> <p>48 V DC +/-3V</p> <p>More than 20% of spare feeder circuits with MCCBs shall be provided.</p> <p>Meters (voltage, current, etc.), Protective relays, Annunciators</p>	

No.	Equipment	Specifications	Q'ty/ Station
-2	<ul style="list-style-type: none"> - Type - Capacity 400/230V AC Distribution Panel Common Specifications <ul style="list-style-type: none"> - Applied Standards - Type - Rated Voltage <li style="padding-left: 20px;">Input <li style="padding-left: 20px;">Output Circuit - Rated Short-time Withstand Current - Accessories 	Valve regulated lead acid (VRLA) type or equivalent 40 Ah/10 Hr IEC, JIS, JEC, JEC or equivalent Indoor use, metal enclosed self-standing type 400/230 V AC <ul style="list-style-type: none"> • For station use: more than 20% of spare feeders • For Surroundings: MCCB 225AF/225AT x 10 circuits 25 kA (1 sec) or higher Lighting inside, Watt-hour meter, voltage meter, Ammeter, Earth fault relay, Annunciators	
4. (1)	15 kV Cables and associated materials 15kV Power Cable <ul style="list-style-type: none"> - Type - Quantity (Feeder information) 	Refer to Table 2-2-2-4.1 a) Kabuga RMU S/S <ul style="list-style-type: none"> - For Gasogi S/S (Imcoming) - For Kabuga Center (Outgoing) - For Riviela school(Outgoing) b) Murindi RMU S/S <ul style="list-style-type: none"> - For Gasogi S/S - For Kigali Airport 	1 lot
(2)	15 kV Lightning Arrester <ul style="list-style-type: none"> - Applied Standards - Type - Rated Voltage - Rated Discharge Current 	IEC, JIS, JEC, JEC or equivalent Outdoor use, Metal oxide gapless type, single phase 15 kV 10 kA	

4) RMU Switching Stations and ancillary facility construction plans

The new RMU Switching Stations (two buildings, each 1-story) shall be constructed in Kabuga and Murindi area. The existing site condition of Murindi has some level differences, and so that the site leveling works to be flat shall be undertaken by the Rwanda side.

The main RMU Switching Station plans are follows:

RMU Switching Station : 1-story, reinforced concrete structure, construction area approx. 80.00 square meters per a building, floor area approx. 80.00 square meters per a building

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

Table 2-2-2-4.7 RMU Switching Station

FL	Room	Area	Equipment/Specification
GF	Switchgear Room		Light Fittings, Ventilation, Cable Pit
	Battery Room		Light Fittings, Ventilation, Cable Pit
	Transformer Room		Light Fittings, Ventilation
	Sub Total	80.00 m ²	per a building
	Total	80.00 m ²	per a building

The main exterior finishing schedule is follows:

Table 2-2-2-4.8 Exterior Finishing Schedule

FL	Room	Floor
RMU Building	Roof	Asphalt waterproofing, Styrofoam t=50, Cover concrete
	Wall	Emulsion paint
	Windows	Readymade Aluminum Window
	Doors	Steel Door
	Down spout	Vinyl pipe
	Roof Drain	Cast Iron

The main interior finishing schedule is follows:

Table 2-2-2-4.9 Interior Finishing Schedule

FL	Room	Floor	Wall	Ceiling
GF	Switchgear Room	Porcelain tile 300x300	Emulsion paint	Emulsion paint
	Battery Room			
	Transformer Room	Non-slip paint finish	Emulsion paint	Emulsion paint

5) Work to be constructed by Rwandan side

- Site clear of the Site (Kabuga)
- Site clear and leveling of the Site (Murindi)
- To construct the fences and gates (Kabuga and Murindi) Gravel paving of the Site (Kabuga and Murindi)

(4) 110 kV Transmission Line (New Construction)

1) Planning

Plan for a 110 kV transmission line is to procure and build approximately 2.2km distance of the two (2) circuit type transmission line from branch point of existing 110kV transmission line of Birembo and Musha substations to new Ndera substation in SEZ Area.

The 110 kV transmission line include overhead bus facilities with 50m x 50m area at existing tower No. 212 to be replaced to tension type tower.

Two (2) communications using optical grounding wire equipped on the tower will be directory connected between Birembo and Ndera substations and between Ndera and Musha substations.

As existing substations such as Gosogi S/S, Musha S/S, etc, located downstream of planned connection point of 110kV transmission line, those area will be blackout during construction of

new tower 212, therefore, construction period for new tower 212 shall be shortly and smoothly. The construction plan of the tower will be discussed with all parties concerned.

2) Design conditions

Design conditions for 110kV transmission and 15kV distribution facilities and foundations are as shown in Table 2-2-2-4.10 and Table 2-2-2-4.11.

Table 2-2-2-4.10 Natural Conditions

Items	Design Values
Altitude	Less than 2000 m
Conductor temperature	-
Minimum temperature	5 degree C
Everyday temperature	25 degree C
Maximum temperature	80 degree C
For sag calculation	50 degree C
Wind speed	30.0 m/s
Wind Load	
For Conductor	56.3kg/m ²
For Tower	163.1kg/m ²
Soil bearing capacity	400 kN/m ² (As survey result)

Table 2-2-2-4.11 Electrical Conditions

Items	Design Values
Span Length	
Standard Span	350m (250m)
Wind Span	350m (250m)
Weight Span	450m (350)
No. of Circuit	2 (1 or 2)
Right of way	15m width (10m)
Height of conductor (see Note 1)	
- General area	7 m
- Waterway	10 m
- Road crossing	8 m
Shield angle for Lightning	30 degree
Minimum normal specific creep age distance of insulator	16 mm/kV (Pollution level 1 Light in IEC)
Equivalent salt deposit density	0.063 mg/cm ²
Standards to be applied	JEC-127 except tower No. 212

[Notes]

1. “()” in design value in above table means for 15kV distribution facilities
2. Standard span for 15kV distribution pole design is applied 130m.
3. Standard of tower design for Tower No. 212 to be rehabilitated shall be based on existing tower.

3) Facility Plan

(a) 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.

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

The following five (5) types of steel towers except gantry tower at branch point will be

used. Specification and quantity are shown in Table 2-2-2-4.14.

(b) Overhead lines (conductor)

For conductor, EUCL is to decide to apply type and size for Rwandan standard to new construction 110kV transmission line, it is to use to Conductor of Power line: Aluminum Conductors Steel Reinforced (ACSR) with DIN Germany, size of 240/40mm², to Grounding wire: Optical Ground Wire (OPGW) with DIN Germany, size 97/48mm². Detailed design quantities and procurement quantities are given in Table 2-2-2-4.12.

Table 2-2-2-4.12 Conductor (ACSR 240/40mm²) Length of Power Line

Items	Q'ty
① 110 kV Transmission line distance including - Existing tower No.211 to 212(rehabilitated) - Overhead Bus system in 110kV branch area - New tower No. 1 to 11(in S/S) double circuit	234m 38m 2,076m
② Sag (3.5%) ①x0.035 - Existing tower No.211 to 212(rehabilitated) - Overhead Bus system in 110kV branch area - New tower No. 1 to 11(in S/S) double circuit	8m 1m 73m
③ Design Quantity (①+②) x circuit condition [total] - Existing tower No.211 to 212(rehabilitated) (x1 conductor, x 3phase, 1 circuit) - Overhead Bus system in 110kV branch area (x1 conductor, x 3phase, 1 circuit) - New tower No. 1 to 11(in S/S) double circuit (x1 conductor, x 3phase, 1 circuit)	13,855m 727m 236m 12,892m
④ Jumper lines: Including in spare quantity	0m
⑤ Construction Contingency (5 %) ③x0.05 [total] - Existing tower No.211 to 212(rehabilitated) - Overhead Bus system in 110kV branch area - New tower No. 1 to 11(in S/S) double circuit	693m 36m 12m 645m
⑥ Total quantity ③+⑤	14,548m
⑦ Procurement quantity	14.5km

(c) Insulators

Insulators equivalent to IEC60383-1 specifications will be used.

(d) Overhead ground wires

For overhead ground wires, Optical ground wire (OPGW) will be used (24-core, Single mode type). Detailed design quantities and procurement quantities are given in Table 2-2-2-4.13.

Table 2-2-2-4.13 Grounding Wire (OPGW) Length

Items	Q'ty
① 110 kV Transmission line distance including - Existing tower No.211 to 212(rehabilitated) - New tower No. 1 to 11(in S/S) double circuit	234m 2,076m
② Sag (3.5%) ①x0.035 - Existing tower No.211 to 212(rehabilitated) - New tower No. 1 to 11(in S/S) double circuit	8m 73m
③ Design Quantity (①+②) x circuit condition [total] - Existing tower No.211 to 212(rehabilitated) (x1 circuit) - New tower No. 1 to 11(in S/S) double circuit (x2 circuit)	4,540m 242m 4,298m
④ Jumper lines: Including in spare quantity	0m
⑤ Construction Contingency (5 %) ③x0.05 [total] - Existing tower No.211 to 212(rehabilitated) - New tower No. 1 to 11(in S/S) double circuit	227m 12m 215m
⑥ Total quantity ③+⑤	4,767m
⑦ Procurement quantity	4.8km

Table 2-2-2-4.14 Specifications of Major Facilities

No.	Items	Specifications	Q'ty
1.	Tower 1) Style of tower 2) Type of tower 3) Materials 4) Safety factor 5) Dimension (approx.) lowest conductor arm height & weight with underground materials 6) Foundation	Steel lattice type, vertical conductor layout, double circuits, square section tower except 110-E1 • Suspension type (Type No. 110-A2) • Tension type (Type No. 110-B2) • Tension type (Type No. 110-C2) • Dear-end type (Type No. 110-D2) • Tension type (type No. 110-E1) (for new tower No. 212) (waist type tower) • Gantry type (double supports type) • Gantry type (triple support type) Rolled steel, zinc galvanizing coated Main body :1.0 Arm: :1.2 110-A2: 17m, 4.0 tons 110-B2: 15m , 5.1 tons 110-C2: 15m , 5.4 tons 110-D2: 15m, 7.4 tons 110-E1: 18m Pad & Chimney type	3 towers 2 towers 1 tower 1 tower 1 tower 4 gantries 1 gantry
2.	Overhead Line (Conductor) 1) Type 2) Size (Grinding Wire) 1) Type 2) Size	Aluminum Conductor Steel Reinforced (ACSR) 240/40 mm ² , DIN standard Optical grounding wire (OPGW) 97/48mm ²	14.5 km 4.8 km
3.	Insulator		1 lot

	1) Standards 2) Type 3) Creep age distance 4) Material 5) Number of insulators	IEC Disc type, ball and socket 280 mm/disc (min.) Porcelain 9 units/phase	
4.	Connection box for OPGW 1) Type 2) Size	Outdoor 24 core, SM	1 lot

4) Work to be constructed by Rwandan side

- To secure the land for construction and temporary storage yard
- To arrange power stoppage during construction of tower 212
- To dismantled old tower 212 during new tower 212 constructing

(5) 15 kV Distribution line (New and Re-route)

1) Planning

15 kV distribution lines will be constructed following purposes;

Concept of Kigali city distribution network operated by EUCL, all following 15kV distribution lines shall be applied with 30kV line voltage can be energized.

(a) Route-1: From Gasogi substation to Kabuga RMU switching station:

15kV distribution line route-1, single circuit shall be constructed from Gosogi substation to Kabuga RMU switching station distanced approximately 6.5km. This distribution line will be constructed conductor support with lattice type towers and/or steel tube type poles,

(b) Route-2: From Ndera substation to existing distribution line for Free zone 1 RMU switching station:

Route 2 of 15kV distribution line on the project shall be constructed from Ndera substation to existing 15kV distribution line with double circuits connected between Birembo substation to Free Zone-1 RMU switching station, approximately 6.5km line distance. One circuit of the existing 15kV distribution line double circuits shall be spirited and connected to 15kV switchgears in Ndera substation.

(c) Route-3: Rerouting of existing distribution line

110kV transmission line planning from north way of new Ndera substation, there is existing 15kV distribution tower connected between Rubungo RMU switching station to Gasha district. Therefore, to secure the space for transmission tower in front of the substation, the existing distribution tower shall be replaced to opposite side of public road. This rerouting plan will be constructed with two (2) towers and approximately 400m conducting needed.

(d) Rehabilitation of tension tower at Murindi area

Murindi RMU switching station shall be constructed at Murindi area. The station will be energized existing 15kV distribution line, between Goasgi substation and Kigali Airport RMU switching station, located near the planned site, for the station a tension tower shall be constructed for spiriting the existing distribution line.

2) Design Conditions

The design conditions are shown in the Table 2-2-2-4.11.

3) Facility Plan

(a) Towers and Poles

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.

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

Specification and quantity are shown in Table 2-2-2-4.18

(b) Overhead lines (conductor)

For conductor, EUCL is to decide to apply type and size for Rwandan standard to new construction 15kV distribution truck line, it is to use to Conductor of Power line: Aluminum Conductors Steel Reinforced (ACSR) with DIN Germany, size of 120/20mm², to Grounding wire: Optical Ground Wire (OPGW) with DIN Germany, size 46/3.9mm² or 50mm² of galvanized steel wire (GSW). Detailed design quantities and procurement quantities are given in Table 2-2-2-4.15.

Table 2-2-2-4.15 Conductor (ACSR 120/20mm²) Length of Power Line

Items	Q'ty
① 15 kV Distribution line distance including	
- Route-1	6,033m
- Route-2	583m
- Route-3	444m
② Sag (3.5%) ①x0.035	
- Route-1	212m
- Route-2	21m
- Route-3	16m
③ Design Quantity (①+②) x circuit condition [total]	23,739m
- Route-1 (x1 conductor, x 3 phases, x1 circuit)	18,735m
- Route-2 (x1 conductor, x 3 phases, x2 circuit)	3,624m
- Route-3 (x1 conductor, x 3 phases, x1 circuit)	1,380m
④ Jumper lines: Including in item ⑤	0m
⑤ Construction Contingency (5 %) ③x0.05 [total]	1,786m
- Route-1	936m
- Route-2	181m
- Route-3	69m

⑥ Sub-total quantity ③+⑤	[total]	24.8km
- Route-1		19.6km
- Route-2		3.8km
- Route-3		1.4km

(c) Insulators

Insulators equivalent to IEC60383-1 specifications will be used.

(d) Overhead ground wires and optical cables

For overhead ground wires, on the project, two (2) kinds of grounding wire with Optical Fiber Grounding Wire (OPGW) and Grounding Steel Wire (GSW) are applied, and route-1 site of construction on 15kV distribution line on the project is applied OPGW type and other sites are applied GSW type. Detailed design quantities and procurement quantities are given in Table 2-2-2-4.16.

Table 2-2-2-4.16 Length of Grounding Wire (OPGW)

Items	Q'ty
① 15 kV Distribution line distance including - Route-1	6,033m
② Sag (3.5%) ①x0.035 - Route-1	212m
③ Design Quantity (①+②) x circuit condition - Route-1 (x1 circuit)	6,245m
④ Jumper lines: Including in item ⑤	0m
⑤ Construction Contingency (5 %) ③x0.05 - Route-1	312m
⑥ Procurement quantity ③+⑤ - Route-1	6.5km

Table 2-2-2-4.17 Length of Grounding Wire (GSW)

Items	Q'ty
① 15 kV Distribution line distance including - Route-2 - Route-3	583m 444m
② Sag (3.5%) ①x0.035 - Route-2 - Route-3	21m 16m
③ Design Quantity (①+②) x circuit condition [total] - Route-2 (x1 circuit) - Route-3 (x1 circuit)	1,064m 604m 460m
④ Jumper lines: Including in item ⑤	0m
⑤ Construction Contingency (5 %) ③x0.05 [total] - Route-2 - Route-3	53m 30m 23m
⑥ Procurement quantity ③+⑤ [total]	1.13km

- Route-2	0.64m
- Route-3	0.49m

(e) Specification of Major Facilities

Table 2-2-2-4.18 Specifications for Major Facilities

No.	Items	Specifications	Q'ty
1	Tower 1) Style of tower 2) Type of tower 3) Materials 4) Safety factor 5) Dimension (approx.) lowest conductor arm height & weight with underground materials 6) Foundation	Steel lattice type, vertical/triangle conductor layout, square section tower Suspension type, 1 circuit (Type No. 15-TA1) Tension type, 1 circuit (Type No. 15-TB1) Dead-end type, 1 circuit (Type No. 15-TD1) Tension type, 2 circuits (Type No. 15-TB2) Dear-end type, 2 circuits (Type No. 15-TD2) Rolled steel, zinc galvanizing coated Main body :1.0 Arm: :1.2 15-TA1: 13m, 1.7 tons 15-TB1: 13m , 2.2 tons 15-TD1: 13m , 2.6 tons 15-TB2: 13m, 4.8 tons 15-TD2: 13m, 5.3 tons Pad & Chimney type	5 towers 4 towers 12 tower2 2 towers 2 towers
2.	Steel Pole 1) Type of pole 2) Materials 3) Safety factor 4) Dimension (approx.)	Steel round sprit type, triangle conductor layout Suspension type, 1 circuit (Type No. 15-PA1) Carbon steel tube (STK 400/490) or equivalent 1.5 height 16.5m, bottom size: t 6.9mm, 318mm dia.	28 poles
3.	Overhead Line (1) (Conductor) 1) Type 2) Size (2) (Grinding Wire) 1) Type 2) Size (3) (Grinding Wire) 1) Type 2) Size	Aluminum Conductor Steel Reinforced (ACSR) 120/20 mm ² , DIN standard Optical grounding wire (OPGW) ACS-46-3.9 Grounding Steel Wire (GSW) 50mm ²	24.8 km 6.5 km 1.13 km
4.	Insulator 1) Standards 2) Type 3) Creep age distance 4) Material 5) Number of insulators	IEC Disc type, ball and socket 280 mm/disc (min.) Porcelain 4 units/phase for single string, 8 unit/phase for double string	1 lot
5.	15kV Power Cable 1) Insulation 2) Standard 3) Conductor 4) Size 5) Type of Armor 6) Termination kit	18/30kV, XLPE IEC Cooper 1 core, 240mm ² Tape or wire Heat shrinkable type, 12sets	450m
6.	Connection box for OPGW 1) Type	Outdoor	1 lot

No.	Items	Specifications	Q'ty
	2) Size	24 core, SM	

2-2-3 Outline Design Drawings

The project outline design drawings are given in Appendix-6.

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 Rwanda 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 Rwanda side is the MoI. The project implementing body responsible for O&M after the facilities go into service is EUCL. So that the project will progress smoothly, MoI, EDCL and EUCL must appoint project representatives to stay in close contact and negotiate with the Japanese consultant and contractor.

The appointed EDCL project representative must explain project details sufficiently to MoI and EDCL 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 EDCL 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 EDCL, the project implementing body.

(3) Contractor

In accordance with Japan grant aid framework, independent Japanese contractors selected by Rwanda 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 in Ndera area, as well as construction work

on approximately 2.2 km of 110 kV transmission line and 7.55 km of 15 kV distribution lines. Construction will also require coordination with EUCL, which manages the operation of the transmission/ 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) Rwanda Construction Conditions and Technology Transfers

As explained in Section 2-2-1-4 above, there are multiple general construction and electrical contractors in the Kigali areas which can accept orders for laborers, transportation vehicles and construction equipment within Rwanda, 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.

(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 that can be procured locally is to be used to the extent possible when formulating the construction plan. However, as Rwanda 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 Rwanda 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

The Rwandan exemption procedure (including VAT) for equipment and materials procured for the Project is as follows: 1) the Contractor requests EDCL to exempt the materials, 2) EDCL requests the Ministry of Finance to issue a tax exemption letter via MoI, 3) the Ministry of Finance issues the tax exemption letter to customs, with a tax exemption letter to customs, with a copy issued to MoI and the Contractor. When procured equipment and materials arrive at port in Tanzania and Kenya, the Contractor is required to attach the above copy of the tax exemption letter with the given shipping documents to be submitted to customs for the tax exemption. Care must be taken that tax exemption delays do not impact project progress.

2-2-4-3 Scope of Works

The Japanese side will procure, install, test and adjust the 110 kV substation, 110 kV transmission lines and 15 kV distribution lines for the project in the Japanese and Rwanda construction scopes and perform the necessary civil engineering work. The Rwanda side will be responsible for site leveling at the substations, removal of the 15 kV distribution lines, etc. Detailed scopes for the Japanese and Rwanda sides are as shown in Table 2-2-4-3.1.

Table 2-2-4-3.1 Undertakings to be covered by Japan and Rwanda (Proposed)

No.	Undertakings	Work Demarcation		Notes
		Japan	Rwanda	
1*	(1) To secure of land necessary for the implementation of the Project		●	Ndera substation, Kabuga and Murindi RMU switching stations, 110kV transmission and 15kV distribution lines
	(2) To clear the sites		●	RMU switching station, etc
2*	To construct for the project site the following facilities			
	(1) Control building, TR foundations, GIS foundations, cable pit	●		
	(2) The gate and fence		●	
	(3) The Parking lot	●		No parking in RMU stations
	(4) The road within the site	●		No internal road in RMU stations
	(5) The road outside the site		●	
3*	Incidental Work for the New substation and RMU stations			
	(1) Electricity			
	a) The distributing power line to the site		●	
	b) The drop wiring and internal wiring within the site	●		
	c) Main circuit breaker and transformer	●		
	(2) Water Supply			
	a) The city water distribution main to the site		●	
	b) The supply system within the site	●		
	(3) 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	●		
	(4) Gas Supply			
	a) The city gas main to the site		●	Not necessary
	b) The gas supply system within the site	●		Not necessary
	(5) 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	●			
(6) 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.	Undertakings	Work Demarcation		Notes
		Japan	Rwanda	
	(1) Marine (Air) transportation of the Products from Japan to Rwanda	●		
	(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	●		
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		●	
12	Securing of site for temporary storage of materials and equipment, and the gates and fences		●	Temporary storage yard : approx.5,000m ²
13	Office for construction work	●		
14	Securing access roads, wayleaves and usage permissions for construction of 110kV transmission and 15kV distribution lines		●	
15	Transfer of existing underground cables and pipes, and acquisition of related permits (electricity, telephone, water, sewerage, etc.)		●	If necessary
16	Acquisition of permits for trans-road work		●	If necessary
17	Provision of places to dispose of surplus soil and waste water		●	
18	Manufacturing and procurement of materials and equipment	●		
19	Management of equipment and materials during construction work	●		
20	Installation, adjustment and tests of materials and equipment	●		
21	Removal Work of the existing 212 tower and foundation of 110kV transmission line		●	

No.	Undertakings	Work Demarcation		Notes
		Japan	Rwanda	
22	Removal Work of the existing 15 kV Distribution tower with foundation nearby Ndera substation		●	Relocating of cable and equipment on existing tower to be removed
23	Expansion of 15kV switchgear room and cable trench in existing Gasogi substation		●	Expansion of the existing cable trench for low voltage cables is included.
24	Modification of communication line at existing Gasogi substation		●	Procurement work is to be done by Japan
25	Maintenance of SCADA network for connecting to Murindi RMU switching station		●	
26	Modification of SCADA in NECC		●	For Ndera S/S, Gasogi S/S, Kabuga and Murindi RMU stations
27	Procurement and installation for LV cable from both RMU switching stations to surrounding consumers		●	
28	Initial operation guidance and operational guidance for maintenance and management of equipment procured	●		
29	Securing of the safety of persons concerned with the project at the project sites		●	
30	Response to and compensation for users of electricity in relation to outages inevitable for the work Temporary dead-line work during the work		●	
31	Announcement of outage plans to users of electricity during the work		●	

Notes: Item with sign “●” indicate the country of parties responsible . Asterisk marks on figures are 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 completes 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 EDCL and EUCL. 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

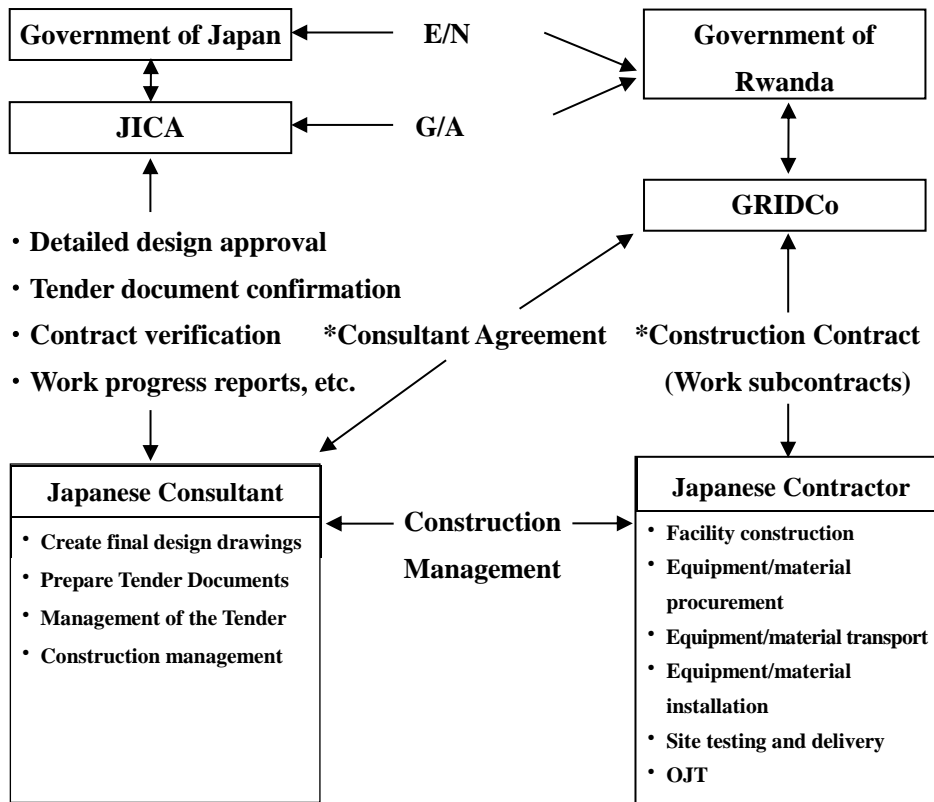
(3) Quality and Work Progress Control

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 110 kV transmission line work, as well as the related civil engineering work. Further, they will subcontract local Rwanda 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 staffs 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 Rwanda, the substation, switchboard and other power distribution facilities for Rwanda will be procured from mostly European and Japanese sources. While Indian and Chinese products have recently started being introduced into REG substation facilities, Japanese and European equipment are more reliable.

Rwanda companies such as EUCL, the company who will handle O&M after the project facilities

enter service, hold Japanese products in particularly high regard. Japanese substation and power transmission/distribution equipment procured in past Japanese grant aid projects is still operating soundly after more than 10 years in service, contributing to this opinion. REG 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 REG strongly desire Japanese products to be used for key project equipment.

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

110/15 kV Transformers, Station Service transformer, DC equipment, etc.

2) Transmission Line Equipment and Materials

110 kV Transmission and 15 kV Distribution line equipment and materials: insulator, steel materials, etc.

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

110 kV switchgears, 15 kV switchgears, 15kV 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, REG must appoint a full-time engineer to attend the OJT and keep close contact with Japanese consultants and contractors. The appointed REG engineer must build up the skill level of staff unable to attend and work to improve REG 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 implementation schedule is given in Figure 2-2-4-8.1.

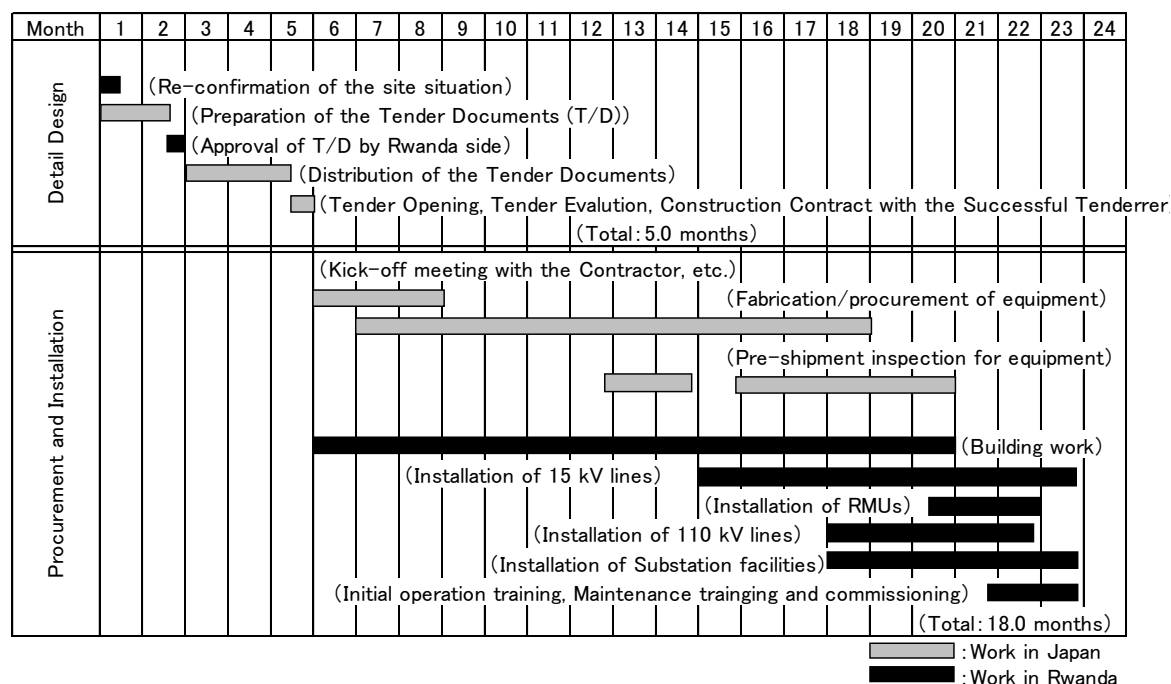


Figure 2-2-4-8.1 Project Implementation Schedule

2-3 Obligations of Recipient Country

Other than the items assigned in Section 2-2-4-3, Rwandan 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, construction and expansion of substation facilities and construction of RMU switching stations, 110 kV transmission line and 15kV distribution 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) Obtaining necessary land for substations, RMU switching stations, 110kV transmission line and 15kV distribution lines
- (14) Leveling necessary sites for constructing substations and transmission lines
- (15) Removing/relocating waste and unneeded existing structures on sites for new, expanded and enhanced substations
- (16) Obtaining wayleave for access road for 110 kV transmission and 15kV distribution lines work
- (17) Cutting down trees and crops on the routes for 110kV transmission and 15kV distribution lines

Rwandan Side Work

- (18) Modification of the NECC SCADA system and the Optical Network Management System to accommodate the new three stations so called Ndera substation and Kabuga & Murindi switching stations. This modification includes the additional network connection measures of the Multiplexer/SDH panel in Gasogi substation for the connection of new optic fiber cable from Kabuga switching station.
- (19) Procurement and construction of the communication cable (optic fiber cable) from Multiplexer/SDH panel in Murindi switching station to the existing communication network of distribution lines.
- (20) Providing the setting list of protection relays related to the Project for coordination of setting values with new relays to be supplied under the Project. The setting value change at the substations where the transmission lines connected from Ndera substation shall be conducted by the Rwanda side including necessary tests and their records shall be presented to Japan side.
- (21) Expansion of 15 kV switching room with cable trench to accommodate one additional 15 kV feeder panel supplied by the Japanese side. And expansion of the existing cable trench for low voltage cables is included.
- (22) Implementation of Environmental Management Plan and mitigation measures prepared through the environmental assessment and monitor environmental and social impacts caused by the Project with an adaptive management approach.
- (23) Construction of gate and fence for substation and branch point of 110 kV transmission line
- (24) Dismantlement of the existing towers in order to implement the Project.

After the Commencement of Operation

- (25) To monitor environmental and social impacts during the operation with an adaptive

management approach.

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 Figure 2-4-1.1. Prevention must be the focus for maintenance of equipment and facilities procured, installed and built for the project.

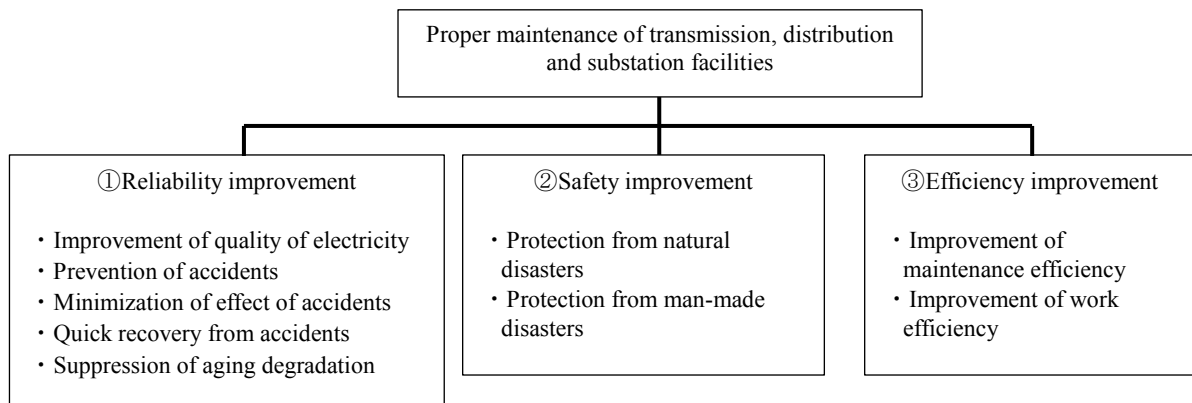


Figure 2-4-1.1 Basic Concepts for Substation, Transmission and Distribution Facility Maintenance

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

As for special training for substation facilities such as switchgears, communication system and micro-SCADA system, etc, engineers dispatched by the Japanese contractor are planned to train local engineers, for 2 months, after completion of the installation works.

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 classified as follows;

- 1) Daily inspections, which involve a sensory check to detect abnormal heat, sounds and smells from the equipment,
- 2) Regular inspections, which check equipment for loose bolts, surface dirt or damage on insulation and other energized parts, not checked on daily inspections, and
- 3) Detailed inspections, which include functional checks of interlock mechanisms between devices, and precision maintenance of instrumentation.

In general, regular inspections are conducted once every one to two years, and detailed inspections are conducted once every four years. Switchboard internal fuses, metering, relays and other components with deteriorating performance, reduced insulation, contact wear or characteristic changes, should be replaced as appropriate on regular 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	○	○	
	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	○		
Measurement 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 110 kV transmission and 15kV distribution lines, 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 Purchasing Plan

2-4-3-1 Spare Parts

Spare parts should be selected on the basis of parts which wear and deteriorate with daily operations and must be replaced regularly. The following spare parts are procured for the project, fulfilling quantities needed for one year.

- 1) Transformers
- 2) 110 kV Switchgears
- 3) 15 kV Gas-insulated switchgears
- 4) Control and Protection equipment
- 5) Station power supply equipment
- 6) Communication equipment

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 Table 2-4-3-2.1. Meanwhile, Rwanda side is responsible for preparing a budget for purchasing necessary replacement parts after one year of the completion of the project

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

Legend; pc: piece, N.A.: Not applicable

No.	Name of Spare Parts	Unit	Quantity		
			Ndera	Kabuga	Murindi
1.	Transformer				
1.1	20 MVA Transformer				
(1)	Gasket (complete set)	set	1	N.A.	N.A.
(2)	Buchholz relay set	set	1	N.A.	N.A.
(3)	Oil temperature indicator (main tank and conservator)	pc	1 each	N.A.	N.A.
(4)	Oil level indicators (main tank and conservator)	pc	1 each	N.A.	N.A.
(5)	Silica gel for Breathers	%	200	N.A.	N.A.
1.2	110/15 kV Transformer				
(1)	Oil temperature indicator	pc	1	1	1
(2)	Silica gel for Breathers	%	200	200	200
2.	110 kV Switchgear equipment				
2.1	110 kV Circuit Breaker (CB)				
(1)	Closing coil	set	1 set	N.A.	N.A.
(2)	Tripping coil	set	1 set	N.A.	N.A.
2.2	110 kV Disconnecting Switch (DS)				
(1)	Fixed and moving contact (3 phase/set for DS)	set	1 set	N.A.	N.A.

No.	Name of Spare Parts	Unit	Quantity		
			Ndera	Kabuga	Murindi
(2)	Fixed and moving contact (3 phase/set for Earthing switch)	set	1 set	N.A.	N.A.
3.	15 kV Switchgear (GIS)				
(1)	Closing coil	set	1 set	1 set	1 set
(2)	Tripping coil	set	1 set	1 set	1 set
(3)	Vacuum bulbs complete with necessary accessories for replacement (for three phase)	set	1 each	1 each	1 each
(4)	Isolating main terminals (completed one pole)	set	1 each	1 each	1 each
(5)	Fuse (each type)	pc	100%	100%	100%
(6)	Meter (each type)	pc	1 each	1 each	1 each
(7)	Auxiliary relay (each type)	pc	1 each	1 each	1 each
(8)	Necessary accessories for 15 kV cable	set	200%	200%	200%
4.	Control and Protection				
(1)	Protection relay (each type)	pc	1 each	1 each	1 each
(2)	Bay control unit	pc	1 each	1 each	1 each
(3)	Fuse (each type)	pc	100%	100%	100%
(4)	Meter (each type)	pc	1 each	1 each	1 each
(5)	Auxiliary relay (each type)	pc	1 each	1 each	1 each
(6)	Control and selector switch, if any (each type)	pc	1 each	1 each	1 each
5.	Station Power Supply Equipment				
5.1	AC Distribution Board				
(1)	MCCB (each type)	pc	1 each	1 each	1 each
(2)	Indicating lamp, if any (each type)	pc	100%	100%	100%
(3)	Fuse (each type)	pc	100%	100%	100%
(4)	Meter (each type)	pc	1 each	1 each	1 each
5.2	DC Distribution Board				
(1)	MCCB (each type)	pc	1 each	1 each	1 each
(2)	Indicating lamp, if any (each type)	pc	100%	100%	100%
(3)	Fuse (each type)	pc	100%	100%	100%
(4)	Meter (each type)	pc	1 each	1 each	1 each
5.3	Battery and Charger				
(1)	Battery	cell	2 each	2 each	2 each
(2)	Electrolyte (20 liter/tank)	tank	1	1	1
(3)	Control Card and diode module	pc	1 each	1 each	1 each
(4)	Indicating lamp, if any (each type)	pc	100%	100%	100%
(5)	Fuse (each type)	pc	100%	100%	100%
(6)	Meter (each type)	pc	1 each	1 each	1 each
6.	Communication				
(1)	RTU card		1 each	1 each	1 each

In the project, the vacuum oil purifier (including oil tank) for transformer oil is procured as necessary tool for proper maintenance of 20 MVA transformers which are newly installed at Ndera substation.

Testing Equipment and Maintenance Tools

No.	Equipment	Unit	Q'ty
(1)	Oil purifier with tank	set	1

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

(1) Costs to be borne by the Rwanda side

2,350,000 US\$ (approximately 282.4 million yen)

Rwanda itemized details and their amounts are as given below:

- 1) RAP Compensation: 262,000 US\$ (31,500,000 JPY)
- 2) Expenses for land acquisition and leveling work of Ndera substation and RMUs: 1,003,000 US\$ (120,500,000 JPY)
- 3) Expenses for communication facilities for Murindi RMU switching substation: 270,000 US\$ (32,000,000 JPY)
- 4) Removal Work of 15 kV Overhead Line around Ndera substation: 3,000 US\$ (400,000 JPY)
- 5) Expenses for stockyard: 40,000 US\$ (4,800,000 JPY)
- 6) Procurement and Installation of equipment related to SCADA system at Ndera substation 550,000 US\$ (66,100,000 JPY)
- 7) Contingency (10 % : Payment of bank commission based on banking, etc.): 222,000 US\$ (26,600,000 JPY)

(2) Estimation criteria

- 1) Time of estimation: April 2015
- 2) Exchange rate:
1 US\$ = 120.15 JPY (TTS average from January 2015 to March 2015)
1 EURO = 135.49 JPY (TTS average from January 2015 to March 2015)
- 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 EUCL operate and maintain existing substations, transmission 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 EUCL 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 EUCL 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

The Rwanda side has agreed to conduct the environmental and social considerations required by JICA Guidelines for Environmental and Social Considerations (2010). An Abbreviated Resettlement Action Plan (ARAP) must be prepared and the land acquisition should be completed by December 2015. An approval on environmental clearance, such as EIA Certificate of Authorization as well as other relevant permits/licenses required for the implementation of the Project must be obtained in a timely manner to meet the Project schedule. An Environmental Management Plan (EMP), monitoring plan and impact mitigation measures must be prepared during an environmental assessment.

3-2 Necessary Inputs by the Recipient Country

(1) Before work commencement

- To do land preparation work and leveling work before commencement of installation work by the Japanese side (refer to 2.1.7 and 2.2.2). Necessary lands are as follows;
 - 1) Ndera Substation
 - 2) 110kV connection area near tower No. 212: approx. 50 m x 50 m minimum
 - 3) 110kV transmission line: approx. 2.2 km
 - 4) 15kV distribution line for Route-1: approx. 6.5 km
 - 5) 15kV distribution line for Route-2: approx. 650 m
 - 6) 15kV distribution line for Route-3 approx. 400 m
 - 7) Kabuga RMU switching station: 20 m x 15 m
 - 8) Murindi RMU switching station: 20 m x 15 m
 - 9) Necessary access road for constructing all transmission and distribution lines
- To obtain permission from related authorities for 110 kV transmission lines and 15 kV distribution lines to go across the roads before commencement of installation work by the Japanese side.
- To resettle occupants in accordance with the resettlement plan prepared at the stage of the survey in smooth manner, if necessary.

(2) During the construction period

- To schedule both power and communication network shutdown required for construction works of the Project, and carry out in timely manner. The Rwanda side shall also manage any issue concerning the shutdown including related procedures, and compensation to and grievances from customers.
- To modify the NECC SCADA system and the Optical Network Management System to accommodate the new three stations so called Ndera substation and Kabuga & Murindi switching

stations. This modification includes the additional network connection measures of the Multiplexer/SDH panel in Gasogi substation for the connection of new optic fiber cable from Kabuga switching station.

- To procure and construct the communication cable (optic fiber cable) from Multiplexer/SDH panel in Murindi switching station to the existing communication network of distribution lines.
- To provide the setting list of protection relays related to the Project for coordination of setting values with new relays to be supplied under the Project. The setting value change at the substations where the transmission lines connected from Ndera substation shall be conducted by the Rwanda side including necessary tests and thier records shall be presented to Japan side.
- To extend 15 kV switching room with cable trench to accommodate one additional 15 kV feeder panel supplied by the Japanese side.
- To secure a temporary storage yard of approximately 5,000 m2 near the Project site during the construction period of the Project.
- To implement Environmental Management Plan and mitigation measures prepared through the environmental assessment and monitor environmental and social impacts caused by the Project with an adaptive management approach.
- To construct fence and gate for 110 kV connection site, refer to DWG No. GG-12.
- To construct fences and gates at the project sites in accordance with the layout and arrangement of the equipment and facilities of the Project.
- To dismantle the existing towers in order to implement the Project.

(3) After work completion and start of service

- To monitor environmental and social impacts during the operation with an adaptive management approach.

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 Rwandan 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.

Large-scale projects are underway in Ndera area which is specified as a special economic zone (SEZ) in Kigali city, and SEZ Phase 1 includes a lot of factories already operated, and the construction is still progressing at a fast pace. The infrastructure development in the Phase 1 is almost done, and they are supplied from Birembo substation through the 15 kV distribution network. Infrastructure development such as road in Phase 2 has already started.

The power supply is concerned due to developments in Ndera, Kabuga, Murindi, etc.

Power supply to the developing SEZ is done by Birembo substation which is approximately 6km away through 15 kV distribution network.

SEZ Phase 1 is expecting load shedding plan due to the power shortage after the completion and operation of each factories. Also, the long distance distribution lines are expected to cause the power quality issue.

Power from Birembo substation through 110 kV transmission line is mainly supplied to SEZ through Ndera substation. Ndera substation is approximately 2 km away from SEZ Phase 1 and constructed in the phase II development area. Also, rental power plant near Ndera substation (approx. 10 MW) is being operated. In the future, 50 MW HFO power plant is planned to be

construct instead of the rental power plant. The HFO power plant is planning to be connected to Ndera substation, and become the main substation in Rwanda to supply through 110 kV transmission network.

Operation of Ndera substation is planning to be December, 2017, but early operation is necessary because the demand of Birembo substation is increasing rapidly.

Moreover, urgency for the Project is considered to be high as two RMU switching station helps to reduce the load of Birembo substation.

(2) Benefit

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.

The Project is to improve electric power distribution in Kigali city in Rwanda as it faces a serious power system problem caused by supply capacity shortage due to recent rapid economic growth. The enhancement of supply capacity of power distribution facilities, which is currently insufficient, is a fundamental solution to the loss of opportunity gain due to disrupted supply and thus it is highly beneficial.

The facility capacity of the Project accounts for 14 percent of total facility capacity in the target year for project evaluation in 2021, as shown in the below formula.

(Project facility 40 MVA)÷(Project facility 40 MVA + existing facility 240 MVA)=approx. 14%

The power distribution facility to be developed in the Project is expected to supply 14 percent of the power to assist socioeconomic activities in Kigali city in the target year for project evaluation in 2021. The Project will benefit approx. 14 percent of economic activities in the area, which is very high in terms of cost-benefit ratio for the amount of aid.

(3) Operation and Maintenance Capabilities

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

As Rwanda has already introduced power facilities such as 110/15 kV substations and the skills required for operation methods, system protection functionality and other O&M issues do not greatly exceed the technical levels for equipment used that has been used in the country, although internal structure of the switchgear and other equipment to be introduced may differ

from that of traditional ones.

As such, 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 Rwandan side for the delivered equipment.

(4) Project to Contribute to Upper-Level Plans

Rwanda formulated ENERGY SECTOR STRATEGIC PLAN 2012/13-2017/18 in October 2014. For the development plan, the new Ndera substation in the Project, with the capacity of 40 MVA, is deemed to be essential for achieving the upper-level plan. It is estimated to contribute approximately 14% of the overall distribution facility capacity in Kigali city (=40 MVA (project facility capacity) ÷ 280 MVA (total facility capacity in Kigali city) in the target year for project evaluation in 2021.

(5) Consistency with Japan’s Grant Aid Policy

The contents and schedule of the Project are achievable in the scheme of a Grant Aid Project as major equipment will be sourced from Japan and the Project will be completed within the timeframe of the E/N. Therefore, the Project can be implemented with no special difficulty.

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 (2015) (Current value)	Reference Value (2021) Without the Project	Target value (2021) (3 years after the completion of the Project)
1. Facility capacity of 110 kV Transformers (MVA)*	105	195	235
2. Transformer load factor in Gikondo substation (%)	59	63 ~ 90	53 ~ 76
3. Power loss*	0.72 % (467 kW)	2.06 % (3,937 kW)	1.72 % (3,225 kW)

[Note]*: Only Kigali 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
<p>1. According to formulation of SEZ in Rwanda, the power demand in Ndera area has been rapidly increasing, but the present capacity of power transformer is not sufficient and aging. It is a major cause of the unstable power supply and transmission and distribution network loss.</p>	<p>Procurement and installation of the following equipment:</p> <ol style="list-style-type: none"> 1. 110 kV Substation equipment <ul style="list-style-type: none"> • 40 MVA = 20 MVA × 2 banks 2. 110 kV Transmission and 15 kV distribution equipment <ul style="list-style-type: none"> • 110 kV overhead line (Approx. 2.2 km) • 15 kV overhead line (Approx. 7.5 km) 	<p>Stable power supply will revitalize the industries and economic activities in Kigali and improve stable operation of public welfare facilities and healthcare services as well as the living environment of local residents.</p>
<p>2. According to formulation of SEZ in Rwanda, distribution network around Ndera area is concerned about unstable power supply due to housing land development in Kabuga area and Murindi area.</p>	<ol style="list-style-type: none"> 1. Installation of Kabuga RMU switching station and 15 kV distribution line between 110/15 kV Gasogi substation and the RMU. 2. Installation of Murindi RMU switching station and the first tower to connect to the power system. 	<p>The RMU switching stations enable to carry out stable power supply to Kabuga area and the south part of Kabuga area. The new RMU switching station is unmanned station and remotely controlled by the existing National Control Center (NCC) in Gikondo.</p> <p>The RMU switching stations enable to carry out stable power supply to Murindi area and around the international airport area. The new RMU switching station is unmanned station and remotely controlled by the existing National Control Center (NCC) in Gikondo.</p>