PREPARATORY SURVEY
FOR
POWER TRANSMISSION PROJECT
IN
THE FEDERAL REPUBLIC OF NIGERIA
(PHASE 2)

FINAL REPORT

January 2020

Japan International Cooperation Agency (JICA)
Yachiyo Engineering Co., Ltd.

Summary

1. Background Leading to the Request for Japan's Yen Loan

While Nigeria has realized strong economic growth in recent years, its power supply capacity is overwhelmingly insufficient. As a countermeasure to serious power shortages, the Transmission Company of Nigeria (TCN) has planned a project aimed toward achieving a transmission capacity of 20,000 MW by 2020 in accordance with the growth of generation capacity. In order to realizing this plan, the Government of Nigeria requested the Government of Japan to provide a Yen loan (Japanese ODA loan) to be used for the constructing of transmission lines. Following discussions between the Federal Ministry of Power (FMP), TCN, and officials on the Japanese side, it was decided to target the southwest area of the country (Lagos State and Ogun State).

This Preparatory Survey is implemented with the objectives of formulating a Yen loan project for transmission line construction.

Due to the significant shortage of power supply capacity compared to the existing demand, load allocation has been implemented nationwide in Nigeria. Installed generation capacity was increased to 11,165MW in 2014, and 12,132MW in 2015. The transmission lines running from the Niger Delta in the south to the north via Lagos, the largest demand center, are bottlenecked, causing the generating capacity in the south to be underutilized. Moreover, there are no detour routes to use when equipment accidents occur and the reliability of the system is low. Furthermore, as mentioned above, the capacity of generating equipment is expected to increase greatly in the coming years, but there is an urgent need to strengthen the transmission infrastructure because transmission capacity is unable to keep up with generating capacity.

Some expansion of transmission lines from Benin to Osogbo is planned in order to transport power from the Southern region to the Northern region. Although TCN plans to reinforce transmission facilities from Benin to Osogbo in order to transport power from the south to the north, a funding of US$7.742 million will still be needed for investment in the power transmission field by 2020; as this cannot nearly be attained, it will be necessary to conduct further fundraising.

2. Power Supply and Demand Forecast

Nigeria has the largest population among countries in Africa. With the recent rebasing of GDP, the country now has surpassed South Africa as having the largest economy in the continent. Its economy has been growing steadily in recent years, at around 4-6% annually. However, social infrastructure is far behind economic development. In particular, electricity is in extremely short supply and this is a serious impediment to economic development.

As the country aims to implement the ambitious "Economic Recovery and Growth Plan 2017-2020: ERGP," it is most urgent and essential to secure a sufficient and stable supply of electricity as the platform for economic development.

This survey sets out a hypothesis for the development of an electricity demand forecasting model and formulated them into a demand forecasting model using the modeling software "Simple-E."

The low end estimates of peak demand for Lagos region in 2020 is 2,563MW verses that for the whole national grid is 11,463MW; in 2025, 4,249MW versus 18,345MW; and in 2030 5,301MW versus 26,459.

After comparing the above peak demand forecasts for Lagos region mentioned above, and those projected by TCN substations, we consider that TCN's projected demand falls within a reasonable range of the study.

3. Candidate Components of the Project

TCN has compiled a transmission network expansion plan aimed at boosting transmission capacity and improving system reliability, and it has prepared a report entitled "Appraisal of Transmission Projects" (March 2014) (Appraisal Report) outlining its transmission projects. Candidate project components should be identified based on the TCN plans for the expansion of the transmission network. The survey here will target a transmission capacity of 10GW (Package 2) with a completion target in 2017. Specifically, the

project for the southwest area (Lagos State and Ogun State) considering the large scale of the project benefit and rather stable security situation in the area. Based on the results of the first field survey and second field survey, power flow analyses and discussions with TCN, components are selected as candidates for Japan's Yen loan project and the project benefits expected from those components are described.

4. Candidate Components of the Project

Regarding the selection of transmission routes, multiple alternative routes for each site were proposed based on satellite images, and local site surveys as necessary, while taking construction costs and transmission efficiency, environmental and social issues as well as natural conditions into consideration. Finally, the basic transmission routes were decided through consultation with TCN staff. After this, based on the environmental and society considerations and resident moving surveys conducted by TCN (EIA/RAP), routes were proposed which avoided environmental impacts and the need to move residents, and discussions were held with TCN to look into economic and technical feasibility. In principle, the steel transmission towers to be used will be types with which Nigeria already has operational experience, and four-circuit towers are being considered in order to minimize the need to move residents. As part of the transmission facility basic design, soil surveys were conducted along the transmission routes, fabrication methods, material specifications, and tower assemblies were investigated, and the locations of the towers were determined.

Regarding the specification of transmission conductor, TCN decided to consider adopting the low loss type due to the active development and production of this type of transmission conductor by cable makers all over the world, and as a result of information from the JICA Study team concerning its many merits. Generally, the superiority of the low loss type is about 25% decrease in power loss, increase in capacity of electric current at the same maximum usage temperature, to be able to use the conventional existing tools and accessories for installation. Considering the economical and energy-saving effect of selecting the low loss type for transmission line which will be in use for over 40 years in Nigeria, where power demand is expected to keep increasing, the low loss ACSR type is recommended. The size and accessories of the low loss type shall be based on TCN standard.

For substation facilities, the content of requests for changes and additions was checked, as was the interconnection with existing transmission lines, and a list of substations targeted by this project at this point in time is included.

5. Power Flow Analysis

Flow Analysis in each case

Cases of Power Flow Analysis are shown in the Table below.

Table: Case of Power Flow Analysis

Case	Target Year	Load (MW)	Description	Super grid	Project Components	Purpose
1	2025	16,356	Model without the Project in 2025 All Project components are excluded from the Power system. The load is reduced until the system is operable state with no overload, no voltage violation, etc.	No	None	To confirm Effectiveness and validity by the transmission capacity without the Project component as Zero option
2	2025	19,243	Suppressed generation model in 2025 Power generation planning in Lagos and Ogun (5,362 MW) is suppressed to 3,187 MW due to financial issue, etc., the suppressed generation is supplied from power stations outside Lagos and Ogun.	No	All	To confirm overload, voltage violation, short-circuit current and N-1 contingency of 330kV line in 2025, Suppressed generation in Lagos is expected, TCN requested a case study.
3	2030	27,277	Master plan model in 2030 Same as JICA Master Plan	Yes	All	To confirm overload, voltage violation, short circuit current and N-1 contingency in 2030

Result of analysis in each case

Result of analysis in each case is shown in the following Table. There is not overload, voltage violation, short circuit current violation N-1 contingency of 330 kV line (one circuit failure of transmission line as single facility failure) in the cases.

Table: Result of analysis in each case

Line	Peak Load per Single Circuit by Year (MVA)				
	Case 2	Case 3	JICA Master Plan 2035	JICA Master Plan 2040	
	2025	2030	2035	2040	Average
330kV line (Ejio-Likosi 48.8 km)	252	233	279	415	295
330kV line (Ejio-Ajegunle with turn-in-out of Ikeja West- Sakete 29.6 km)	328	73	132	228	190
330kV line (Ejio-Olorunsogo with turn-in-out of Ikeja West- Ayede 13.9 km)	230	199	150	150	182
330kV line (Makogi-Likosi-Ikeja West 10.8 km)	479	204	309	344	334
132 kV line (Ikorodu_Shagamu-Likosi 4.82 km)	84	72	89	111	89
132 kV line (Likosi-Abule Oba 7.78 km)	41	63	78	97	70
132 kV line (Ejio-New Abeokuta 35.5 km)	58	106	125	125	104
132 kV line (Ajegunle-Badagry 36.2 km)	45	63	76	93	69
132 kV line (Ajegunle-Agbara 21.7 km)	59	105	125	125	104
330 kV Average	**322**	**177**	**218**	**284**	**250**
132 kV Average	**57**	**82**	**99**	**110**	**87**
Total	**1576**	**1117**	**1363**	**1688**	**1436**

6. Institutional Framework for Implementation, Operation and Maintenance of the Project

<u>Features of the proposed framework for the Project Implementation</u>

The proposed framework premises the following issues for the project implementation.

- Project implementation is aimed to utilize entire the capacity of TCN.
- TCN Management exercises necessary supervisory and control over donor financed projects.
- PIU will be set up at Abuja for the purpose of practical reporting and monitoring with TCN Management.
- To reflect the regional structure and role of TCN Lagos office to enable contract administration in order to fast track the implementation at Lagos office in Lagos (Lagos office have contract implementation/administration coordinator who will report to the regional general managers and PIU. Also send monthly progress report to the program coordinator at Abuja).

7. Environmental and Social Considerations

<u>Legislation on Environment and Social aspect</u>

Environment Impact Assessment Decree 86, 1992 (EIA) is mandatory for any major development project likely to have adverse impacts on the environment. According to the Decree 86 of 1992 that governs EIA, the project shall be categorised into 3 Categories considering the degree of impact. The transmission line project is not specifically mentioned as prescribed project for EIA in EIA Decree, however, it is suggested by FME that the proposed project is subject to EIA and EIA study shall be carried for the proposed project and environmental permit shall be obtained from FME.

Based on the gap analysis for EIA system between JICA guideline and Nigerian law and regulation, the gap is only found that term of “stakeholder” or “public participation” is not clearly found in the EIA Decree in Nigeria. However, public involvement are conducted at scoping stage and draft EIA stage for the proposed project. In terms of land acquisition and resettlement, measures to fulfil gaps between local legislations and JICA Guideline as well as the World Bank’s Safeguard Policies were proposed.

<u>Condition of project site</u>

By the National Bureau of Statistics, the population of Lagos State was about 5.7million in 1991 and 9.1million in 2006. One of Ogun State was about 2.3million in 1991 and 3.5 million in 2006. Lagos State is the center of financial, commercial and industrial activities of the nation. A total GDP of Lagos State in 2010, was about USD33, 679 million and is the economic base of the nation shouldering more than 65% of all business activities in the country. A total GDP of Ogun State is USD10, 500 million and industry, commerce and agriculture are major activities. Lagos State is located on the coast line by the Atlantic Ocean and its surface area is 3,671km2. Ogun State is located in the north of Lagos state and its western boundary is shared with Benin and its surface area is 3,761 km2.

Both Lagos State and Ogun State, where the proposed project area is included, belong to tropical rainforest climate and tropical savanna climate. However, both States have rainy and dry seasons and humid and hot. However, Ogun State located in inland area is less humid than Lagos State. About 40% of the Lagos area is occupied with water bodies and island and 10% of land area prone to inundation by high wave and flooding. In Ogun State lowland plain with fertile soil suitable to agriculture and hilly area fitted to grazing spread around inland area from northern boundary of Lagos State. The type of land use within ROW is mainly agricultural land, secondary forest and residential area, and no protected area exist within ROW. Based on the environmental survey, there are some species identified as Vulnerable (VU) under IUCN category within ROW, however none are identified as Endangered (EN) or Critically Endangered (CR).

Environment and Social impact assessment

This project will bring a positive impact both during the construction and operational stage. During the construction stage, the project could generate some temporary jobs during construction of the transmission lines and substations, which would benefit to the local economy. During the operational stage, there are opportunities for businesses and economic development of the country through stabilization of electric power supply to the project area and surrounding areas.

For adverse impact expected form the project, the most of impact expected due to the project is related with construction stage. For Social item such as Land acquisition/Involuntary Resettlement, Utilization of land and local resources, Social institutions, Existing social infrastructures, Vulnerable group, Gender Cultural and historical, heritage site, Public health and Sanitation and Working condition, and for Environmental item such as Topography and Geology, Soil erosion, Groundwater, Hydrological situation, Flora and Fauna and Landscape. In addition, the construction activity is expected to cause environmental pollution including air pollution, water pollution, soil contamination, bottom sediment contamination, solid waste and noise and vibration.

During the operational stage, the impact is expected on social items including cultural and historical heritage site and accident, and on environmental items including soil erosion, flora and fauna and landscape. Environmental pollution is limited to soil contamination, solid waste and noise.

Environmental management plan and monitoring plan was prepared to mitigate and manage above identified impact. Responsibilities in the implementation and monitoring of the Environmental and Social Management Plan (ESMP) during pre-construction and construction stage are shared between multiple stakeholders, including the TCN, the EPC contractors and regulators. TCN has set up a Project Implementation Unit (PIU), who will be responsible for the project execution during this stage.

Land Acquisition and Resettlement

If all of the presently proposed components are implemented, a total of approximately 931 ha (of which, 87 ha for substations and 844 ha for transmission lines). Most of the land affected by the project is agricultural land, and it has been identified that 6,247 persons in total are expected to be affected as owners of the agricultural land, and operators of the agricultural activities in the land without entitlement for the land. Residential lands and commercial lands will be affected as well. Approximately 442 households with 2,265 family members who live in the residential land currently need resettlement to outside of RoW of the project. Also other structures owned by 1,602 households but not currently used or still under constructions need to be demolished and resettled. It should be noted that those numbers mentioned above include affected persons who own multiple lands (e.g. both residential land and agricultural land) separately.

Entitlement of the compensation is determined for each type of loss such as lands, structures, crops & economic trees, income, business and considerations on vulnerable groups. The current estimated budget for the land acquisition, resettlement, Livelihood Restoration Strategies implementation and monitoring is 6,032,892,708 Naira (ca. USD 19,710,182 when currency conversion factor is 306.08 Naira/USD).

8. Cost Estimation and Financial Plan of the Project

Components of the project cost

General components of the project cost is indicated in Figure below.

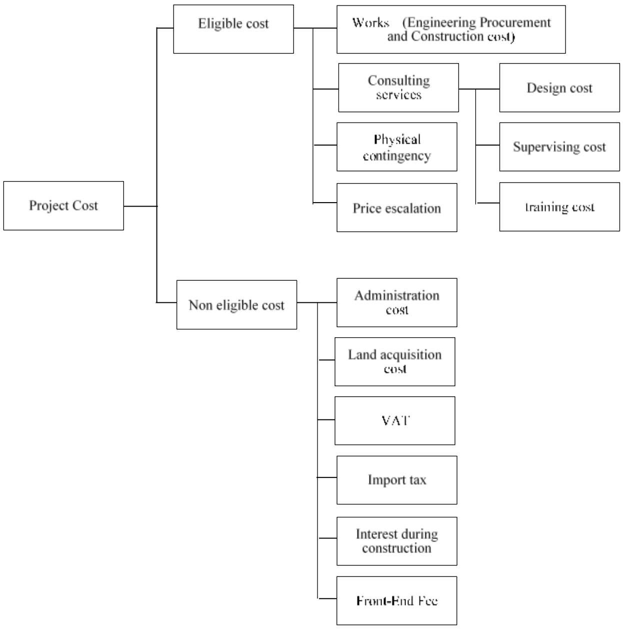


Figure: General structure of the project cost

Cost estimation of the project cost

The project cost consists of the Work cost, consultant cost (design and supervision), physical contingency, project administration cost and interest. Each cost is broken down to the foreign currency portion and local currency portion. The table shows the cost estimate of the project.

Table: Project cost estimate

Unit: Mill. JPY

No.	Item	Contents	Amount
[1]	Works		
	(1)	Engineering	21,968*
	(2)	Procurement	
	(3)	Construction	
[2]	Consulting services		
	(1)	Design	1,387
	(2)	Supervision	
	(3)	Training	
[3]	Physical contingency		1,841
	Price escalation		1,044
[4]	Administration cost		1,436
[5]	Land acquisition		2,479
[6]	VAT		1,312
[7]	Import tax		814
[8]	Interest during construction		1.299
[9]	Front-End Fee		0
[10]	Total		33,581

*: Works (Construction) was calculated applying an invar conductor as LL-ACSR.

9. Project Evaluation

Economic Evaluation

The Project is economically viable and to be implemented for the efficient development of the national economy.

Table: Estimated Indicators on Economic Validity of the Project

Economic Internal Rate of Return (EIRR)	13.8%
Benefit-cost Ratio (B/C)	1.25
Net present Value (NPV, at discount rate of 10%, USD million)	88

The Project remains economically feasible even in cases that substantial increase in the costs and decrease in the benefits happen

Table: Results of Sensitivity Analysis

Case	EIRR	B/C	NPV
24% increase in costs	10.1%	1.00	USD 2.0 million
19% decrease in benefit	10.2%	1.01	USD 3.2 million

Financial Evaluation

As shown in Table below, the Project is financially sound and to be implemented as the FIRR exceeds the cut-off rate of 9%, the B/C surpasses 1.0 and the NPV is positive.

Table: Estimated Indicators on the Financial Validity of the Project

Financial Internal Rate of Return (FIRR)	14.4%
Benefit-cost Ratio (B/C)	1.37
Net present Value (NPV, at discount rate of 9%, USD million)	154

Financial indicators in the following cases are estimated as part of the sensitivity analysis.

1) Increase in the investment and O&M costs by 36%
2) Decrease in the revenue of TSP Charge by 26%.

Results of the sensitivity analysis are shown in Table below. The Project would remain financially feasible, even the two cases.

Table: Results of the Sensitivity Analysis

Case	FIRR	B/C	NPV
36% increase in costs	9.1%	1.01	USD 3.3 million
26% decrease in revenue	9. 2%	1.01	USD 5.1 million

Project Evaluation

(1) Relevance in Terms of Technical Aspects

The degree of contribution for Project components concerning 330 and 132 kV transmission lines, 330/132/33 kV substations and 132/33 kV substations is shown according to the Project target evaluation year (2025) in Table below.

Table: Degree of Contribution of the Project Component to Lagos and Ogun Areas

in the Project Target Year (2025)

Item	Average flow per 1 cct [MW]	Transmission capacity through the Project components [MW]	Degree of contribution
330 kV transmission lines	Approx. 322 MW	Approx. 2,886 MW	41%
132 kV transmission lines	Approx. 57 MW		46%

(2) Effectiveness

The objectives of the Project is to improve transmission network in Lagos and Ogun area and it is composed of 330 kV transmission lines, 132 kV transmission line, 330/132/33 kV substations, 132/33 kV substations.

The rate of the actual load to capacity of the equipment is defined as the utilization rates of the equipment, and the utilization rate of the equipment of the Project in the target years are applied as the evaluation indicator of the Project.

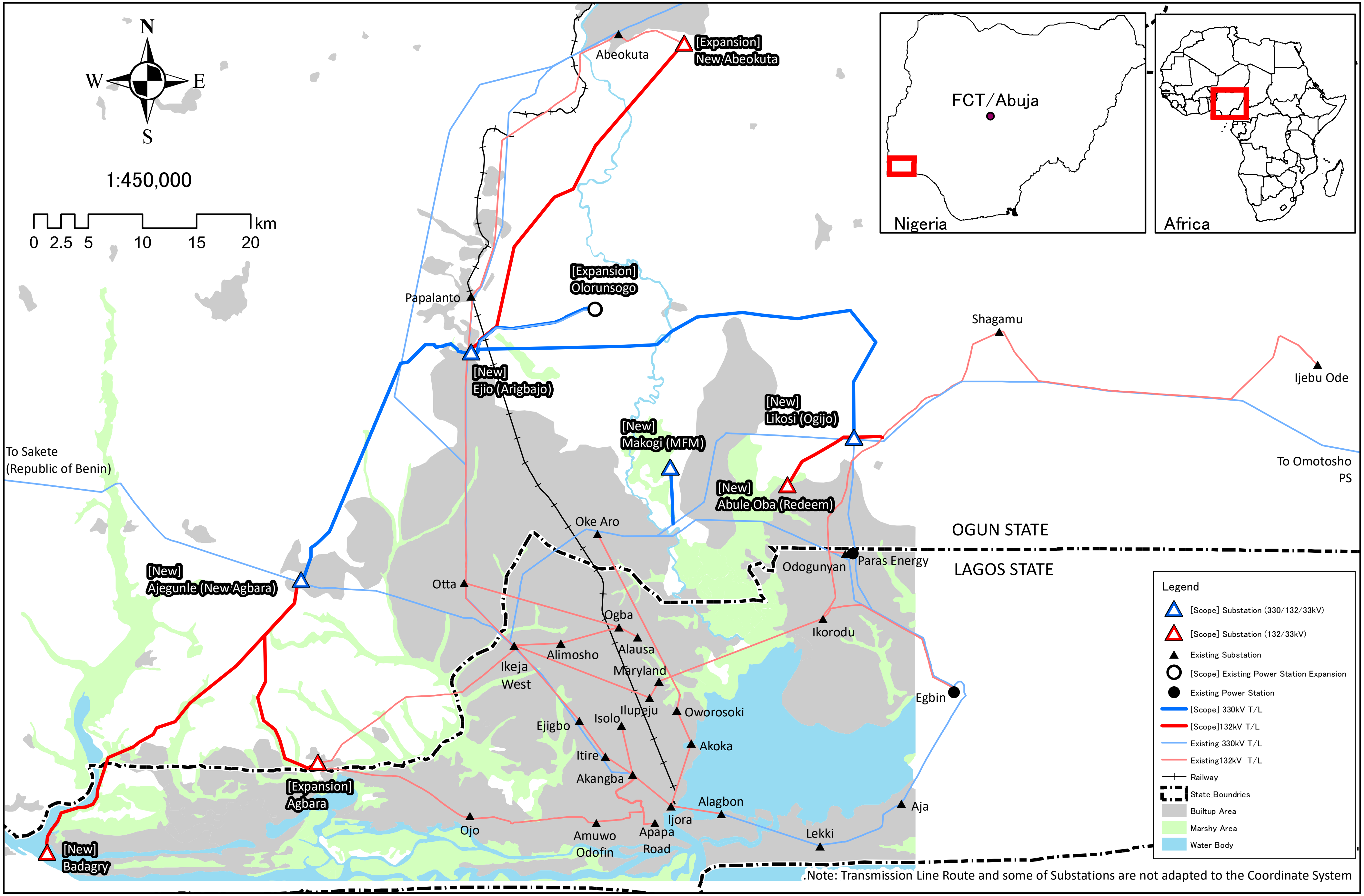
Table: Operation Indicators of the Project

Components	Equipment	Unit Capacity [MVA]	Number of Units and circuits	Capacity [MVA]	Length [km]	Load [MVA]	The target year of the Project evaluation 2025 [%]
Lot 1 330 kV Line	-	777	2	1554	110.1	322	21%
Lot 1 132 kV Line	-	125	2	250	105.4	57	23%
Lot 2a 330-132-33kV substation_Likosi	330/132/33 kV Transformer	270	2	540	-	494	91%
	132/33 kV Transformer	60	2	120	-	86	72%
Lot 2b 132-33kV substation_Abule Oba	132/33 kV Transformer	60	2	120	-	81.4	68%
Lot 3a 330-132-33kV substation_Ejio	330/132/33 kV Transformer	120	2	240	-	241.4	101%
	132/33 kV Transformer	60	2	120	-	121.2	101%
Lot 3b 330-132-33kV substation_Makogi	330/132/33 kV Transformer	120	2	240	-	110.6	46%
	132/33 kV Transformer	60	2	120	-	108.4	90%
Lot 4a 330-132-33kV substation_Ajegunle (New Agbara)	330/132/33 kV Transformer	120	3	360	-	314.4	87%
	132/33 kV Transformer	60	2	120	-	111.8	93%
Lot 4b 132-33kV substation_Badagry	132/33 kV Transformer	60	2	120	-	88.4	74%

PREPARATORY SURVEY FOR POWER TRANSMISSION PROJECT IN THE FEDERAL REPUBLIC OF NIGERIA (PHASE 2)

DRAFT FINAL REPORT

Contents



Location Map of the Project Site

as of 17th December, 2018

Abbreviations

%	Percentage
(T)	Threatened Species
AAS	Atomic Absorption Spectrometer
ACC	Area Control Center
ACCC	Aluminium Conductor Composite Core
AFD	*Agence Française de Développement* / French Agency for Development
AfDB	African Development Bank
Ag	Silver
AIDS	Acquired Immune Deficiency Syndrome
AIS	Air Insulated Substation
IS	Invasive Species
ALARP	As Low As Reasonably Practicable
AM	Ante Meridian
ANFO	Ammonium Nitrate Fuel Oil
APHA	American Public Health Association
AQN	Air Quality and Noise
ARD	Acid Rock Drainage
ASTM	American Standard and Testing Methods
ATR	Africa Traditional Religion
Ba	Barium
BAP	Biodiversity Action Plan
BAT	Best Available Technology
BCG	Bacillus Chalmette-Guerin
BMI	Body Mass Index
BODs	Biological Oxygen Demand
BREF	Best Available Technical Reference document
Ca	Calcium
CAS	Country Assistance Strategy
CBO	Community Based Organization
CCP	Cement Closure Plan
Cd	Cadmium
CDF	Community Development Fund
CDM	Clean Development Mechanism
CEMPS	Construction Environmental Management Plan
CEO	Chief Executive Officer
CHMP	Cultural Heritage Management Plan
CHSP	Community Health and Safety Plan
CITES	Convention on International Trade in Endangered Species

cm	Centimetres
CMP	Construction Management Plan
CNS	Central Nervous System
CO	Carbon Monoxide
CO2	Carbon Dioxide
COD	Chemical Oxygen Demand
CPKO	Crude Palm Kennel Oil
Cr	Chromium
CRM	Compensation and Resettlement Manager
Cu	Copper
D	Menhinick's Index (D).
D	Margalef's Richness Index (d)
dB	Decibels
DBH	Diameter at Breast Height
DC	Double Circuit
DCS	Distributed Control System
DD	Data Deficient
DisCos	Electricity Distribution Companies
DNA	Deoxyribonucleic Acid
DO	Dissolved Oxygen
DPT	Diphtheria Pertussis Tetanus
E	EASTINGs of East (used in coordinate system)
EBRD	European Bank for Reconstruction and Development
EC	Electrical Conductivity
EDS	Everyday Stress
EEMS	Engineering and Environmental Management Services Limited
Ef	Emission Factor
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EKEDC	Eko Electricity Distribution Company
EMF	Electromagnetic Field
EMP	Environmental Monitoring Plan
EMPRITP	Environmental Monitoring Programme and Resources Implementation And Training Program
EMS	Environmental Management System
EN	Endangered
END	Environmental Noise Directive
EPA	Environment Protection Act
EPC	Engineering, Procurement and Construction

EPFI	Equator Principle Financial Institution
EPRP	Emergency Preparedness and Response Plan
EPSRA	Electric Power Sector Reform Act
EPZ	Export Processing Zone
ERGP	Economic Recovery and Growth Plan 2017-2020
ESAP	Environmental and Social Assessment Procedures
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESPS	Environmental and Social Policy Statement
EU	European Union
FAS	Ferrous Ammonium Sulphate
Fe	IRON
FEPA	Federal Environmental Protection Agency (a defunct regulatory Agency replaced by FMENV)
FGDs	Focus Groups Discussions
FGN	Federal Government of Nigeria
FLS	FL Smith
FM	Frequency Modulation
FMBNP	Federal Ministry of Budget and National Planning
FMEA	Failure Mode and Effects Analysis
FMEnv	Federal Ministry of Environment
FMPWH	Federal Ministry of Power, Works and Housing
FS	Feasibility Study
FTZ	Free Trade Zones
G	Grams
GDP	Gross Domestic Product
GenCos	Generating Companies
GHG	Green House Gases
GHS	Globally Harmonized System
GIIP	Good Industry International Practice
GIS	Gas Insulated Substation
GIT	Gastro-intestinal Tract
GM	General Manager
GPS	Global Positioning System
GWP	Global Warming Potential
H2S	Hydrogen Sulphide
ha	Hectare
HIV	Human Immuno-deficiency virus
HofH	Head of Household
HPLC	High Performance Liquid Chromatograph

HRRP	Habitat Removal and Re-instatement Plan
Hs	Shannon and Wiener Diversity Index
HSD	High Speed Diesel
HSE	Health, Environment and Safety
i.e.	That is
IAA	International Atomic Agency
IAEA	International Atomic Energy Agency
IBEDC	Ibadan Electricity Distribution Company
ICCL	International Cement Company Limited
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IDB	Islamic Development Bank
IEA	International Energy Agency
IEC	Information Education and Communication
IEEE	Electrical and Electronic Engineers
IFC	International Finance Corporation
IKEDC	Ikeja Electricity Distribution Company
ILO	International Labour Organization
IMCO	Inter-governmental Maritime Consultative Organization
IMF	International Monetary Fund
IPF	Intergovernmental Panel in Forests
IPIECA	The International Petroleum Industry Environmental Conservation Association
IPP	Independent Power Producer
IPPC	Integrated Pollution Prevention and Control
IQ	Intelligence Quotient
IS	Invasive Species
ISO	International Organization for Standardization
ISQG	International Quality Sediment Guidelines
ISWMS	Integrated Solid Waste Management Scheme
ITCZ	Inter-tropical Convergence Zone
ITD	Inter-tropical Discontinuity
IUCN	International Union for Conservation of Nature
JICA	Japanese International Cooperation Agency
K	Potassium
KBA	Key Biodiversity Areas
LAMENV	Ogun State Ministry of Environment
LASEPA	Lagos State Environmental Protection Agency
LAWMA	Lagos State Waste Management Agency
LC	Least Concern
LCD	Liquid Crystal Detector
LCDA	Local Council Development Area

LCP	Large Combustion Plants
LFN	Laws of the Federation of Nigeria
LGA	Local Government Area
LIDAR	Light Detection and Ranging
Log	Logarithm
LPFO	Low Pour Fuel Oil
LRC	Local Resettlement Committee
LSG	Lagos State Government
MC	Mifor Consult
MCC	Manual Classified Count
MCTC	Manual Classified Turning Count
MDAs	Ministries, Department and Agencies
MFM	Mountain of Fire and Miracles Ministry
Mg	Magnesium
MHI	Manitoba Hydro International
MMA	Mathematical Method of Multi-criteria Analysis
MMIA	Murtala Muhammed International Airport
MMSD	Ministry of Mines and Steel Development
Mn	Manganese
MO	Market Operator
MOU	Memorandum of Understanding
MSDSs	Material Safety Data Sheets
mT	Maritime Tropical
MTPA	Million Tons Per Annum
MYTO	Multi Year Tariff Order
N	NORTHINGS or North (used in coordinate system)
NA	Not Available or Not Applicable
NAPTIN	National Power Training Institute of Nigeria
NBS	National Bureau of Statistics
NBET	Nigeria Bulk Electricity Trading Company Plc
NCC	National Control Center
NCF	Nigerian Conservation Foundation
NEEDS	National Economic Empowerment and Development Strategy
NEPA	National Electric Power Authority
NERC	Nigerian Electricity Regulatory Commission
NESREA	National Environmental Standards and Regulations Enforcement Agency
NGN	Nigerian Naira
NGO	Non-Governmental Organization
NIMET	Nigerian Meteorological Agency
NIPP	National Integrated Power Project

NPC	National Population Commission
NT	Not-Threatened
NTDF	National Technical Forum on Land Administration
ODA	Official Development Assistance
OGEPA	Ogun State Environmental Protection Agency
OGMENV	Ogun State Ministry of Environment
OHSAS	Occupational Health and Safety Assessment Series
OP	Operational Procedures
OPGW	Optical Ground Wire
OPIC	Overseas Private Investment Corporation
OSG	Ogun State Government
PAG	Management of Potentially Acid Generating
PAH	Polycyclic Aromatic Hydrocarbons
PAP	Project Affected People (the total population affected by the project, i.e. people living in households affected)
PCR	Physical Cultural Resources
PH	Power of Hydrogen (Hydrogen Ion)
PHCN	Power Holding Company of Nigeria
PIU	Project Implementation Unit
PM	Post Meridian
PM	Particulate Matter
PMU	Project Management Unit
PNS	Peripheral Nervous System
PO_4^{2-}	Phosphates
PPE	Personal Protective Equipment
PPP	Public-Private Partnership
PSD	Particulate Size Distribution
PTDF	Petroleum Trust Development Fund
PVC	Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Check
QHSE	Quality Health Safety and Environment
RAA	Registry of Affected Assets
RAP	Resettlement Action Plan
RBDPKO	Refined Bleached Deodorized Palm Kernel Oil
RBDPO	Refined Bleached Deodorized Palm Oil
RCC	Regional Control Center
REDD	Reducing Emissions from Deforestation and Forest Degradation
RL	Reduced Level
ROW	Right of Way

RP	Regeneration Potential
RTI	Respiratory Tract Infection
SC	Single Circuit
SCADA	Supervisory Control and Data Acquisition
SDOS	Sustainable Development Organizational Structure
SDP	Sustainable Development Plan
SE	Species Equitability
SEMA	State Emergency Management Agency
SEPA	State Environmental Protection Agency
SIA	Social Impact Assessment
SMCL	Secondary Maximum Contaminant Level
SNCR	Selective Non-catalytic Reduction
SO	System Operator
SO_2	Sulphur Dioxide
SO_4^{2-}	Sulphates
SoI	Sphere of Influence
SOPs	Standard Operating Procedures
SPL	Sound Pressure Level
SPM	Suspended Particulate Matter
SPO	Special Palm Oil
SPSS	Statistical Package for the Social Sciences
SQM	Square Meter
STDs	Sexually Transmitted Diseases
SUVs	Sport Utility Vehicles
T	Turbidity
TBA	Traditional Birth Attendants
TC	Tropical Continental
TC	Total Coliform
TCN	Transmission Company of Nigeria
TDS	Total Dissolved Solids
TFR	Total Fertility Rate
THB	Total Heterotrophic Bacteria
THC	Total Hydrocarbon Content
THF	Total Heterotrophic Fungi
THUB	Total Heterotrophic Utilizing Bacteria
THUF	Total Heterotrophic Utilizing Fungi
TLV	Threshold Limit Value
TOC	Total Organic Carbon
TOR	Terms of Reference
TPM	Total Particulate Matter

TSC	Time Species Count
TSP	Transmission Services Provider
TSS	Total Suspended Solid
TT	Tetanus Toxoid
TUOS Charge	Transmission Use of System Charge
UDHR	Universal Declaration of Human Rights
UN	United Nations
UNCBD	United Nations Convention on Biological Diversity
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEM	United Cement
UNIDO	United Nations Industrial Development Organization
USD	United States Dollar
USDA	United States Department of Agriculture
USEIA	U.S. Energy Information Administration
USEPA	United States Environmental protection Agency
UV	Ultra-Violet
V	Vanadium
VOCs	Volatile Organic Compounds
VU	Vulnerable
WB	World Bank
WCMC	World conservation Monitoring Centre
WHO	World Health Organizations
WMF	Waste Management Facility
WRC	Watersheds Regulation Committee
WTI	West Texas Intermediate
YF	Yellow Fever
Zn	Zinc

Chapter 1 Background of the Project

Chapter 1 Background of the Project

1-1 Background Leading to the Request for Japan's Yen Loan

The Federal Republic of Nigeria (hereafter referred to as "Nigeria") has a population of approximately 186 million (2016, World Bank), making it the most populous country in Africa. According to the latest economic statistics[1], Nigeria has also overtaken South Africa as the largest Eco nerves in Africa, the country enjoys healthy growth in non-petroleum sectors to help it achieve sound economic growth overall. In addition to being the largest producer of crude oil and natural gas rese country faces impediments to development such as a growing gap between the rich and poor, a fragile social and economic infrastructure, social instability caused by anti-government forces, and so on.

In the power sector, insufficient generation facilities and a lack of power maintenance have produced a huge deficit with respect to latent demand. This has led to daily planned outages and frequent power interruptions across all systems. In response, the Government of Nigeria has decided to utilize the country's Excess Crude Account[2] to construct new thermal power stations and transmission lines and implement the National Integrated Power Project (NIPP). It is also promoting privatization of the power sector with a view to improving efficiency and reducing the government's investment burden.

Installed generation capacity[3] increased to 11,165MW in 2014 and 12,132MW in 2015. However, since the transmission capacity currently stands at around 5,000MW, there is an urgent need to bolster the transmission capacity in order to make use of the growing generation capacity.

Against this background, the Transmission Company of Nigeria (TCN) compiled a project plan geared to achieving a transmission capacity of 20,000MW by 2020. With a view to realizing this plan, the Government of Nigeria requested the Government of Japan to provide a Yen loan (Japanese ODA loan) to construct transmission lines. Following discussions between the Federal Ministry of Power, Works and housing (FMPWH), TCN, and officials on the Japanese side, the southwest area of the country (Lagos State and Ogun State) was selected as the target area for the planned project.

This Preparatory Survey is performed with the objectives of formulating a Yen loan project for transmission line construction, collecting information, and preparing examination materials concerning the project goals, contents, costs, implementation setup, operation and maintenance setup, environmental and social considerations, and other components of an implementation review under the Government of Japan's Yen loan scheme.

---

1 According to the results of a recalculation of the GDP from 2010 to 2013 (announced on April 6, 2014) by the Nigerian National Bureau of Statistics, the nominal GDP of Nigeria in 2011 exceeded 63.2586 trillion Naira (US$408.8 billion). Nigeria has thus overtaken South Africa as the largest economy in Africa.

2 The Excess Crude Account was established in 2004 with the chief objective of protecting planned budgets against shortfalls due to volatile crude oil prices by delinking government expenditures from oil revenues.

3 Installed generation capacity: The total of the rated power of all introduced generators.

1-2 Current Power Supply Conditions in the Project Area

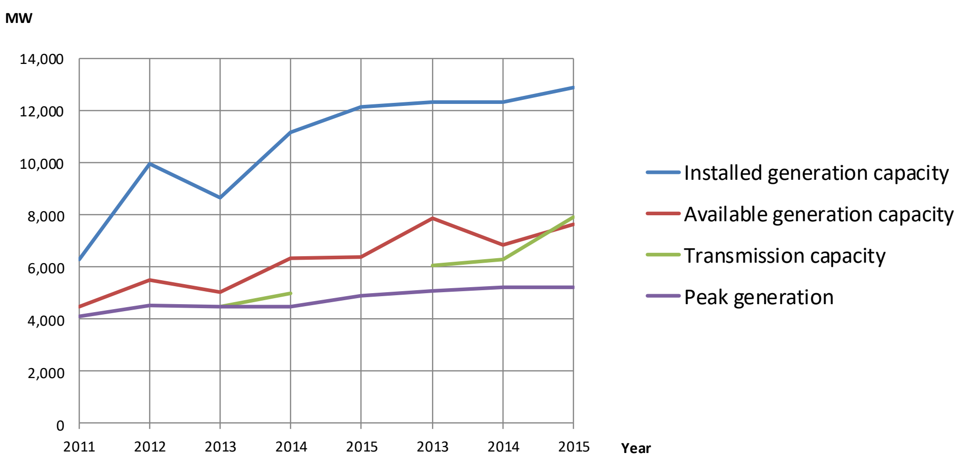
1-2-1 Power Supply Situation

Although the current national electrification rate is about 59.3% (2016, World Bank) and the peak demand forecast is approximately 14,630MW[4], power supply availability in both generation and transmission falls far short of sufficient levels. Table 1-1 and Figure 1-1 show the power supply situation from 2011 to 2018. The lack of growth between 2013 and 2014 resulted from constraints in fuel (natural gas) supply and limitations in the transmission capacity and margin of the spinning reserve for instantaneous demand fluctuation. The country has thus been unable to supply all of the available generation capacity[5].

Table 1-1 Recent Power Supply Availability

Recent Power Supply	Unit	2011	2012	2013	2014	2015	2016	2017	2018
Installed Generation Capacity	MW	6,113,40	9,955.40	8,664.0	1,165.40	12,132.40	12,310.40	12,324.00	12,910.40
Available Generation Capacity	MW	4,479.20	5,516.30	5,050.99	6,317.70	6,401.20	7,877.99	6,871.25	7,652.6
Transmission capacity	MW	-	-	4,500.00	5,000.00	-	6,059.00*	6,300*	7,900*.
Peak Generation	MW	4,089.30	4,517.60	4,458.20	4486.70	4884.70	5,074.7	5,222.3	5,222.3

Source: World Bank (2011-2014), "Annual Technical Report 2015" by TCN (2015), * is simulation value by TCN



Source: World Bank, and TCN (2011-2014), "Annual Technical Report 2015" (2015)

Figure 1-1 Recent Power Supply Situation

Table 1-2 shows the operation and maintenance situation of power supply facilities from 2011 to 2015.

Table 1-2 Recent Operation and Maintenance Situation

Operation Record	Unit	2011	2012	2013	2014	2015
Energy Generated (TCN)	GWh	18,350.00	17,804.58	16,165.01	16,542.87	18,707.64.
Energy Generated (IPP)	GWh	8,441.10	9,381.10	8,309.47	8,003.71	6,228.26

[4] TCN, "Transmission Expansion Plan, Development of Power System Master Plan for the Transmission Company of Nigeria," December 2017

[5] Available generation capacity: Actual output from all generators when considering faults and performance degradation.

Operation Record	Unit	2011	2012	2013	2014	2015
Energy Generated (NIPP)	GWh	900.73	2,387.10	5,154.21	5,579.48	5,656.68
Energy Generated (Total)	GWh	27,691.83	29,572.78	29,628.69	30,126.06	31,514.87
Generation Utilization Factor	%	50.07%	33.91%	39.04%	30.80%	29.65%
Energy Sent Out (without loss)	GWh	-	28,890.18	-	29,406.35	30911.18
Transmission Loss Rate	%	10.35%	12.13%	10.04%	10.95%	10.31%
Forced Power Outages (330kV power system)	times/year	538	437	520	651	613
Forced Power Outages (132kV power system)	times/year	1,085	1,021	951	1,070	1,048

Source: Annual Technical Report 2012, 2014and 2015, TCN

Because of the significant shortage of power supply capacity as compared to demand, load allocation has been implemented nationwide in Nigeria. The Eko distribution company and Ikeja distribution company, both of which cover Lagos state, are to receive power on a 24-hour basis under the current plans, while the Ibadan distribution company covering Ogun state can receive power for only 12 hours a day. Even in the center of Lagos, where 24-hour power supply is forced, frequent load shedding is experienced every day. The distribution of power access per customer is limited to 5-6 hours per day in the central and western areas of Lagos.

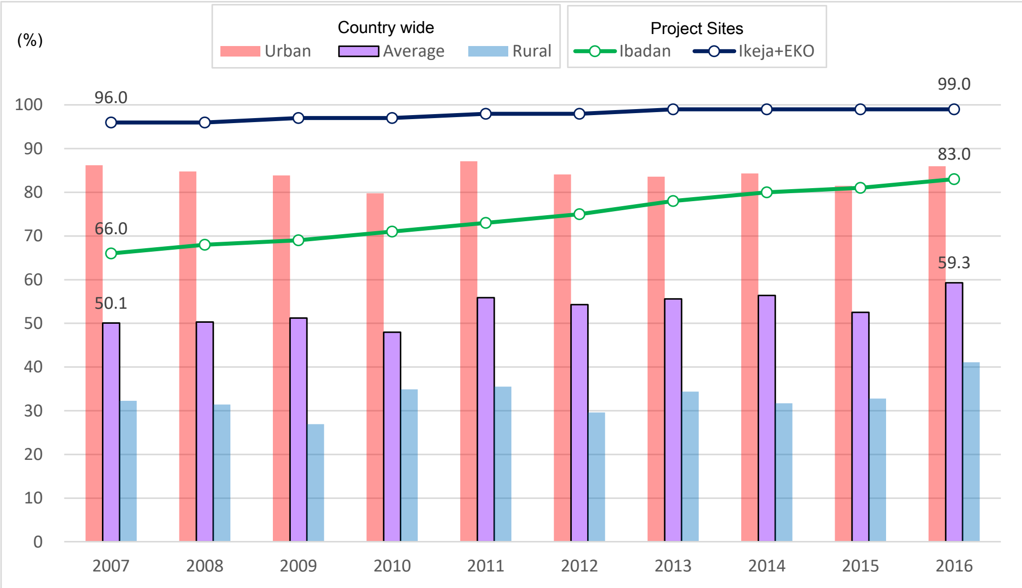
Table 1-3 Load Allocation to Distribution Companies

S/No	DISTRIBUTION COMPANY	AREA	LOAD ALLOCATION BASED ON PROJECTED GENERATION FOR THE DAY (MW)		
			GROUP 1 12:00 - 24:00HRS (B1)	GROUP 2 00:00 - 12:00HRS (B2)	00:00 - 24:00HRS (B3)
1	ABUJA	KATAMPE (ABUJA COMPLEX)			312.99
		SHIRORO	40.94		-
		JEBBA	7.04		-
		AJAOKUTA	18.55		-
2	IBADAN	OSOGBO			208.66
		OTTA	35.83		-
		PAPALANTO	11.52		-
		GANMO	60.88		-
		AYEDE	97.78		-
		ABEOKUTA	29.43		-
3	KANO	KANO 2(KUMBOTSO, DAKATA 132/33KV)	79.14		-
		KANO 1 (DAN-AGUNDI, HADEJIA, DUTSE/ AZARE, KANKIA/KATSINA, KUMBOTSO, DAKATA 132/33KV)	194.67		-
		KANO INTERNATIONAL AIRPORT			11.59
4	YOLA	YOLA	65.80		-
		MAIDUGURI 1	46.80		-
		MAIDUGURI 2			11.59
5	KADUNA	BIRNIN-KEBBI (INCLUDING SOKOTO & TALATA-MAFARA)		66.70	-
		KADUNA (1): KADUNA TOWN/ZARIA		146.80	-
		KADUNA (2): FUNTUA-GUSAU		83.02	-
6	BENIN	BENIN 1 (IRRUA, EFFURUN AND AMUKPE)		187.97	-
		BENIN 2			142.05
7	JOS	JOS		94.53	-
		GOMBE		109.33	-
8	EKO	LAGOS- 1 (AJA; AKANGBA)			397.74
9	ENUGU	ALAOJI			96.85
		ONITSHA			122.68
		NEW HEAVEN			105.89
10	IKEJA	LAGOS- 2 (IKEJA WEST & EGBIN AREA)			542.37
11	PORT HARCOURT	CALABAR			30.68
		PORT HARCOURT			140.18
		UYO-ITU-EKET			64.17
		AUXILIARY CONSUMPTION IN POWER STATIONS			45.00
		SPINNING RESERVE			40.00
		SUB-STATION SERVICES .			40.00
		SAKETE			150.00
		NIGER {NIAMEY (60MW), GAZAOUA (27MW),GAYA (4MW) AND DAMASAK/BISSA (4MW)}			95.00
SUB TOTAL			688.36	688.36	2557.44
TOTAL			(B1+B3) or (B2+B3)		3245.80

[Remarks] No power supply, 24 hours power supply

Source: National Control Centre, As of August 2015

Figure 1-2 shows rural electrification rate for country wide, urban and rural areas in Nigeria in bar charts. Average of the country wide electrification has increased approximately 9 % in the past 10 years. Electrification rate for Lagos (Ikeja + EKO DisCo area) and Ogun states (Ibadan DisCo Area) is shown in lines and both states have higher rate compare with the rate of the country wide average electrification. Especially increase of Ibadan is significant. It is estimated that this is because of spreading build up area from Lagos to Ogun states widely.



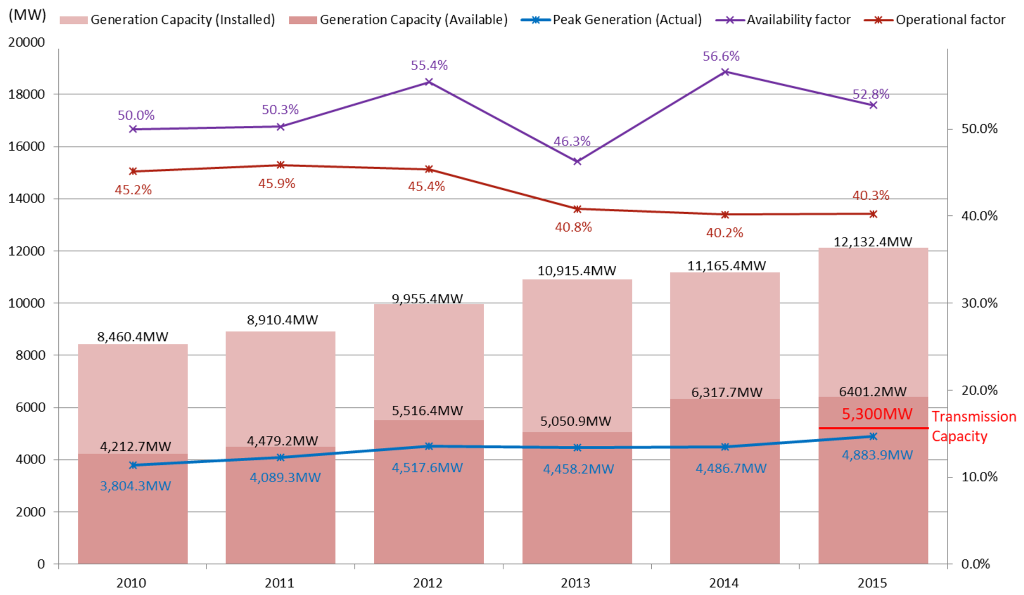
Source: World Bank and MYTO 2.1 2015- 2018

Figure 1-2 Rural Electrification in Nigeria

1-2-2 Generating Facilities

Actual power supply from 2010 to 2016 in Nigeria, ratio of available generation capacity for installed generation capacity has recorded around 50% of low values. The national peak demand is the index for Nigeria's potential power demand without any restriction of power supply. However, there is a wide gap between the national peak demand forecast and available capacity. Due to the restriction of power supply such as planned outages, actual power supply doesn't satisfy the national peak demand in Nigeria. While the available capacity was 7,743MW, the peak demand forecast was 14,630 MW[6] in 2017. This means that examination of cause of generation constraint is an urgent issue in addition to new power generation planning.

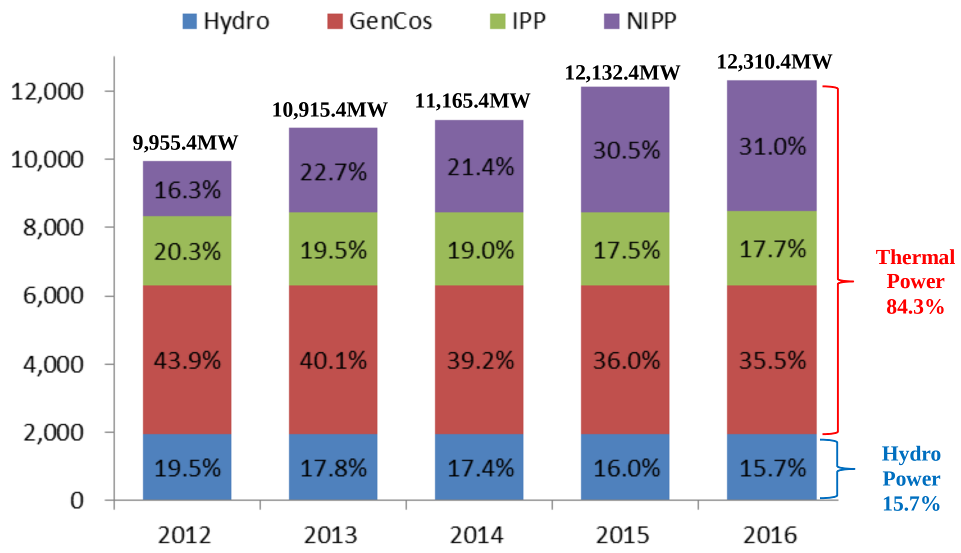
[6] TCN, "Transmission Expansion Plan, Development of Power System Master Plan for the Transmission Company of Nigeria", December 2017



Source: TCN

Figure 1-3 Power Supply Record in Nigeria (2010-2015)

Figure 1-4 and Table 1-4 show the ratio and capacity according by operators. The ratio of thermal generation has increased from 2012 to 2016 gradually and the trend seems to continue with increasing of NIPP ratio. Six out of ten power plants of NIPP have been 100 percent completed. Gbarain in Bayelsa State has attained 90 percent completion, Alaoji in Abia State 80 per cent, Omoku in Rivers State 71 per cent while Egbema achieved 67 per cent completion level.



Source：TCN Annual Technical Report 2012-2016

Figure 1-4 Ratio of Power Generation (2012-2016)

Table 1-4 Installed Capacity of Power Generation (2012-2016)

		Unit	2012	2013	2014	2015	2016
Total	Total Installed Capacity	MW	9,955.4	10,915.4	11,165.4	12,132.4	12,310.4
Hydro	Hydro (Total)	MW	1,938.4	1,938.4	1,938.4	1,938.4	1,938.4
	Hydro (Total)	%	19.5%	17.8%	17.4%	16.0%	15.7%

		Unit	2012	2013	2014	2015	2016
Thermal	GenCos	MW	4,375.0	4,375.0	4,375.0	4,375.0	4,375.0
	IPP	MW	2,017.0	2,127.0	2,127.0	2,119.0	2,177.0
	NIPP	MW	1,625.0	2,475.0	2,725.0	3,700.0	3,820.0
	Thermal (Total)	MW	8,017.0	8,977.0	9,227.0	10,194.0	10,372.0
	Thermal (Total)	%	80.5%	82.2%	82.6%	84.0%	84.3%

Source: TCN

Table 1-5 shows the thermal power plants and hydro power plants that are currently interconnected to the national grid system as of the end of 2016 in Nigeria.

The total available capacity of thermal power generating facilities is 6,669 MW, which comprises more than 80% of all power generating facilities including hydropower (total 7,878 MW) connected to the national grid system in Nigeria. The breakdown of total available capacity for thermal power plants is 2,245 MW by seven private companies, 2,689 MW by eight NIPP projects and 1,243 MW by nine IPP-A (existing plants) projects.

For various reasons, including the proneness to power failure among generators, maintenance difficulties due to inadequate organization and a lack of spares, an inadequate gas supply due to the delay in constructing the pipeline, the ratio of available capacity to installed capacity (availability factor) is less than 50% in some power plants, hence the urgent need to boost available capacity.

Table 1-5 Existing Thermal Power Plants and Hydro Power Plants

Category	Power Plant	Installed Capacity (MW)	Available Capacity (MW)	Availability Factor (%)
FGN Successor Companies (Privatized Hydro Station)	Kainji	760	320	42
	Jebba	578	441	76
	Shiroro	600	448	75
	Sub-Total	1,938	1,209	62
Total (Hydro)		**1,938**	**1,209**	**62**
FGN Successor Companies (Privatized Thermal Station)	Egbin (ST)	1,320	1002	76
	Afam (IV & V) (GT)	351	88	25
	Delta (GT)	900	585	65
	Sapele (ST)	720	234	32
	Gerugu (GT)	414	237	57
	Olorunsogo I (GT)	335	281	84
	Omotosho (GT)	335	301	93
	Sub-Total	4,375	2,737	63
NIPP (Thermal Station)	Olorunshogo (Combined)	750	584	78
	Alaoji (Combined)	500	280	56
	Gerugu (GT)	450	410	91
	Ihovbor (GT)	500	311	62
	Omotosho (GT)	500	439	88
	Sapele (GT)	500	337	67
	Odukpani (GT)	500	272	54
	Gbarain (GT)	120	55	46
	Sub-Total	3,820	2,689	70
IPP-A (Thermal Station)	Rivers (GT)	180	113	63
	Omoku (GT)	150	74	49
	ASCO (ST)	110	2	2
	Trans-Amadi (GT)	100	52	52
	Okpai (Gas)	480	323	67

Category	Power Plant	Installed Capacity (MW)	Available Capacity (MW)	Availability Factor (%)
	Ibom (GT)	155	111	72
	Afam VI (GT)	650	533	82
	Paras (GT)	58	36	61
	AES (GT)	294	0	0
	2,119	2,177	1,243	57
Total (Thermal)		**10,372**	**6,669**	**64**
Grand Total (Thermal + Hydro)		**12,310**	**7,878**	**64**

Note: Availability Factor = Available Capacity / Installed Capacity x 100 (%)
Source: TCN Annual Technical Report 2016

Table 1-6 shows power generation facilities interconnected to the national grid system in Nigeria, and the future schedule of the additional power generation capacity from 2017 till 2030. Current total installed capacity of all power plants is 7,743MW in 2017 and it is expected to reach 41,247MW up to 2030. The ratio of thermal power installed capacity is 86% in 2017. It will be decrease to 72% in 2030. Also, approximately 21,000 - 28,000 MW additional power generation capacity increase after 2017 was scheduled in 2013, but it was revised in 2014 to lower increase, the less than 15,000 MW additional power generation capacity increase even after 2020. This is because of not only transmission constraints such as power evacuation difficulties, heat capacity limitation of transmission line and capacity limitation of transformer, but also generation constraints such as inadequacy of gas supply, often power failure of generators, many equipment failures affecting many power plants for long months, long span O&M of generation facilities due to insufficient organization or dearth of spares, etc. Especially, equipment failures and insufficient O&M are very serious problems resulting in unavailability of many generators the whole year in many power plants.

Table 1-6 Future schedule of the additional power generation capacity

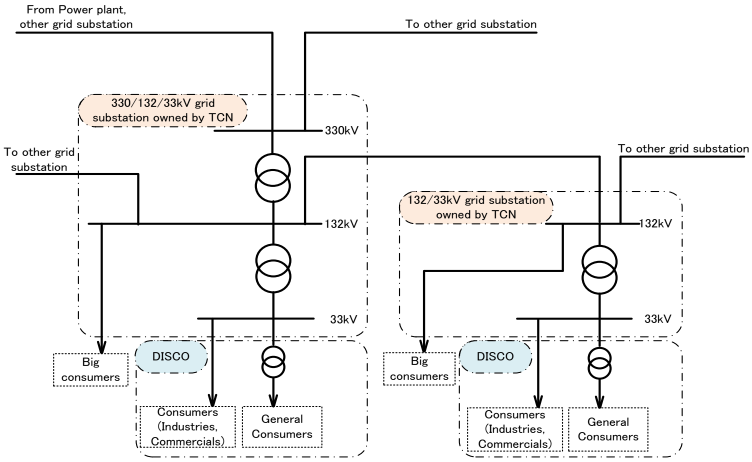
Generation type	Category	Installed Capacity (MW)	Available Capacity (MW)			
			2017	2020	2025	2030
Thermal	Existing	10549	6534	8099	9245	7925
	Under construction	1418	113	1343	1418	1418
	Proposed	25307	0	966	12301	20452
	Total	**37274**	**6647**	**10408**	**22964**	**29795**
Hydro	Existing	1938	1056	1807	1967	1842
	Under construction	809	30	809	809	809
	Proposed	5096	0	0	1163	4181
	Total	**7843**	**1086**	**2616**	**3939**	**6832**
Nuclear	Existing	-	-	-	-	-
	Under construction	-	-	-	-	-
	Proposed	2400	0	0	1,200	2,400
	Total	**2400**	**0**	**0**	**1200**	**2400**
PV・Wind	Existing	-	-	-	-	-
	Under construction	10	10	10	10	10
	Proposed	2230	0	1080	1410	2210
	Total	**2240**	**10**	**1090**	**1420**	**2220**
Grand Total		**49786**	**7743**	**14114**	**29523**	**41247**

Source: JICA Study Team base of information by TCN and other related agency

IPP of new thermal power plants with private investment was started from 2001 in Nigeria, Nigeria government take the policy to sell the control of each power plant to private company. Many existing power plants owned by government has so many equipment failures that many generators of those existing power plants have almost no chance to reactivate, whereas IPPs are expected to spread more widely in future. Especially, projects achieving PPA(Power Purchase Agreement) agreement such as Azura, Zuma, and projects licensed by NERC such as Bresson, Ibom, Century, has high possibility to achieve the target installed capacity in future, because evacuation studies and EIA studies of those projects have already been approved by NERC. PHCN obligate that private company would restore available capacity to installed capacity within the specified period. Private companies should prepare necessary spare parts and execute O&M in proper months by their discretion to improve equipment failures and lack of O&M organization, to restore the available capacity. Whereas, many private companies cannot improve O&M organization or purchase spare parts because necessary payments has not been executed by Nigeria government. As a conclusion, private company should formulate O&M plan after PPA agreement, Nigeria government should execute necessary payments at the approval for O&M plan of private company. At the same time, government should support the construction of natural gas pipelines and necessary infrastructure from outside of power plant for private company. After payment completion by government, private company should improve equipment failures, O&M organization and available capacity by their discretion.

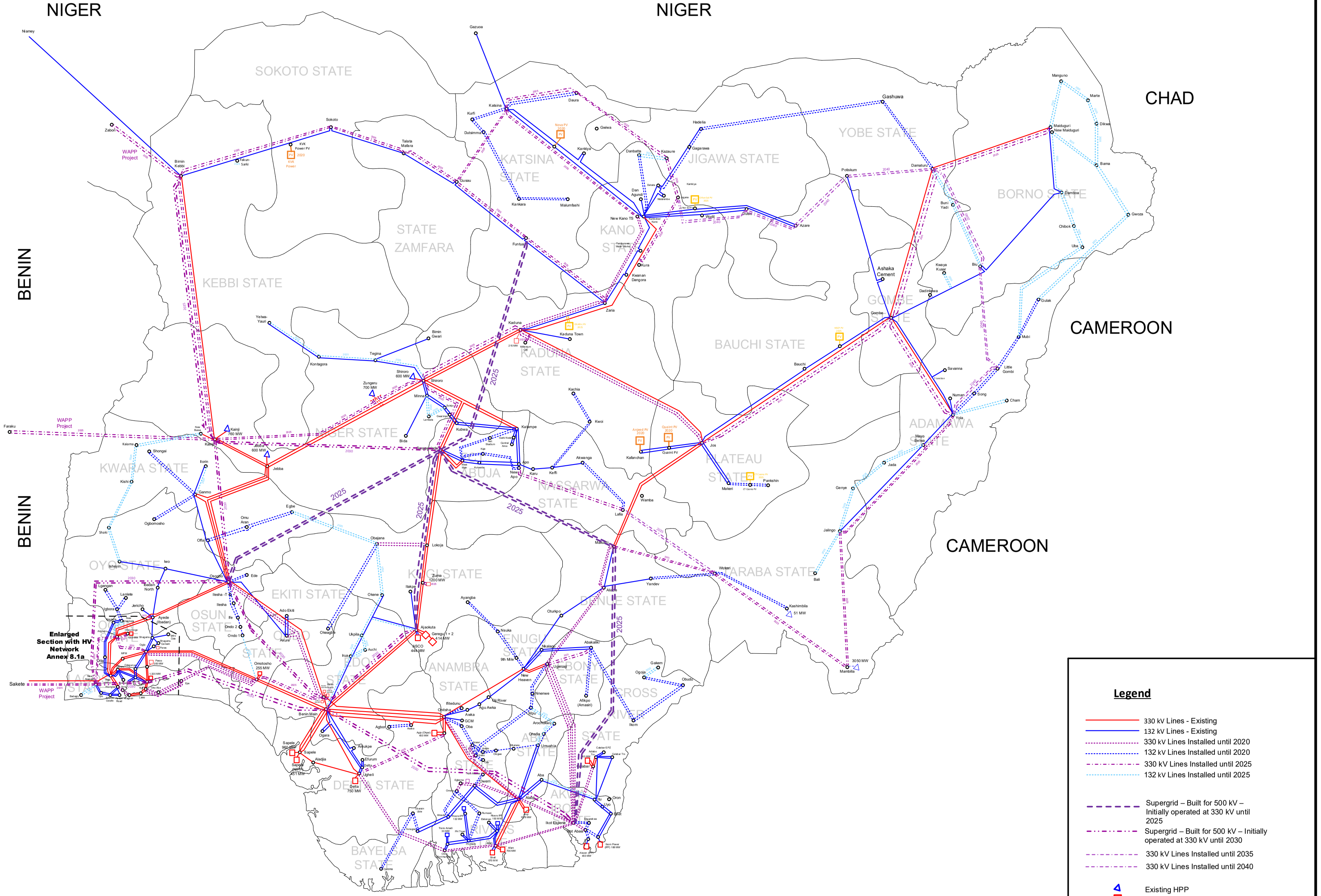
1-2-3 Transmission Facilities

Transmission systems in Nigeria are composed of 330kV transmission lines and 132kV transmission lines. The 330kV lines make up the nationwide trunk system while the 132kV lines make up the country's local systems. Figure 1-5 and Figure 1-6 respectively show the national transmission grid in Nigeria and a map of the national power transmission system with details on the transmission expansion plan as of September 2018. Seventy-percent of all generating facilities are located in the Niger Delta in the south of the country, where petroleum and gas are produced. The north of the country, meanwhile, is entirely without power sources. Because power must be transmitted over long distances from the south to the north, extreme voltage drops take place in the central and northern areas. The primary power arteries are the transmission lines running from the Niger Delta in the south to the north via the largest demand center of Lagos. These transmission lines, however, currently face bottlenecks that prevent the full utilization of the generating capacity in the south. The power systems in Nigeria, moreover, are arranged with transmission lines branching out from the main power stations and substations in a radial fashion, which degrades the system reliability by limiting the availability of detour routes for use when equipment accidents occur. And as was mentioned earlier, the capacity of generating equipment is expected to increase greatly in the coming years. Because the transmission capacity is unable to keep up with the generating capacity, there is an urgent need to strengthen the transmission infrastructure. This is one of the important improvement for Nigerian power system to become efficient and high reliable power supply system as one nationwide power system. Implementation of this project will increase and strengthen transmission line facilities in the Lagos suburbs and in Ogun state to meet the electricity demand in these areas, thereby reducing the load on the radial grid centering on Lagos. Furthermore, by creating a loop grid within the radial grid, it will be possible to secure detour transmission routes in the event of a grid breakdown, which will likely improve supply reliability. Along with this, this project will increase transmission capacity, and will relieve the power transmission bottleneck from south to north, so the power generation capacity in the south can be put to use.



Remark TCN: Transmission Company of Nigeria, DisCo: Distribution Company
Source: Created by the JICA Study Team based on information from TCN

Figure 1-5 Structure of Transmission Systems



Source: Existing facilities from TCN, Transmission Expansion Plan by the JICA Study Team based on information from TCN

Figure 1-6 National Power Transmission System (As of Sep. 2018)

1-3 Examination of necessity for Supergrid

1-3-1 Requirement for Supergrid (330, 500 or 750 kV)

The result of the load flow simulations with generation and load as detailed has shown that without major upgrade of the transmission system in future, there will be widespread under voltages and overloads throughout the system and at all voltage levels.

Consequently, the system losses will be high. It is therefore considered necessary and appropriate to introduce fully the new “supergrid”, i.e. a backbone for bulk transmission at 330, 500 or 750 kV.

With regards to the conductor necessary for each supergrid option, the following arrangements are recommended:

- At 330 kV a Double Circuit is proposed with 4-bundle (Quad) Bison conductors for each circuit.
- At 500 kV a Single Circuit is proposed with 4-bundle (Quad) Bison conductors.
- At 750 kV a Single Circuit is proposed with 5-bundle Bison conductors, which is typical at this voltage level due to corona phenomenon.

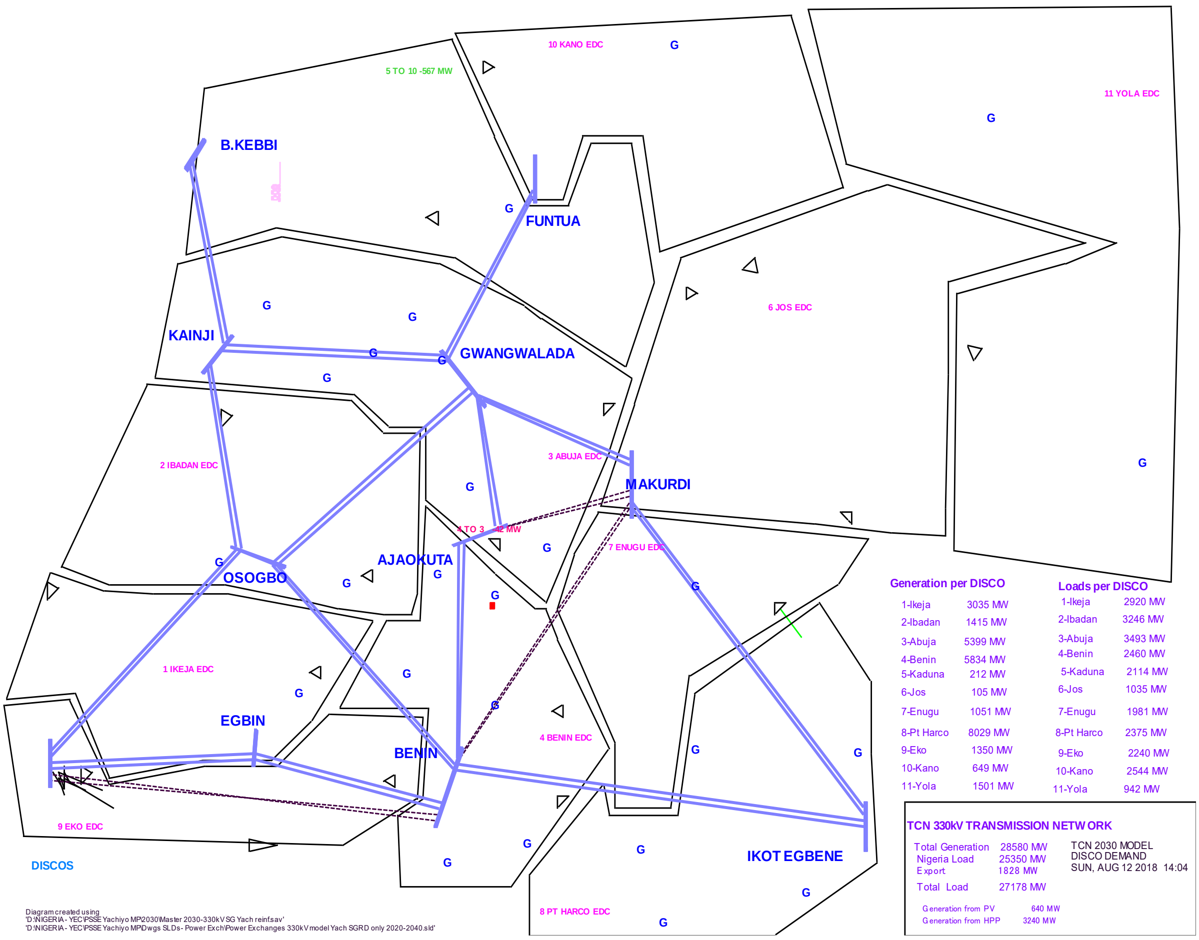
1-3-2 Conclusion on supergrid / EHV options

A number of configurations have been examined and compared in terms of their efficacy in voltage support, system losses and relieve of line loadings of existing and planned 330 kV system.

The optimum configuration of a 330, 500 or 750 kV EHV grid is shown in Figure 1-7.

Table 1-7 Evaluation of 330, 500 or 750 kV supergrid

Voltage level	Voltage support	System loss	Stability	Cost	Comprehensive evaluation
330 kV	A	A	A	B	1
500 kV	B	A	B	A	2
750 kV	B	A	B	C	3



Source: JICA Study Team

Figure 1-7 Supergrid configuration

The supergrid will encompass the following substations, Ikot Ekpene, Benin, Egbin, Ajegunle (New Agbara), Osogbo, Gwagwalada, Makurdi, Ajeokuta, Funtua, Kainji, Bernin Kebbi.

On the basis of technical considerations both the 330 and 500 kV options are adequate. Furthermore, taking into considerations that:

- Capacity of 330 kV supergrid lines: 3,100 MVA
- Capacity of 500 kV supergrid lines: 2,350 MVA
- Difference in losses between 330 and 500 kV supergrids: Marginal
- Impact on O/U voltages and overloads: 330 kV advantageous
- Higher static N-1 security of the 330 kV supergrid due to double circuit lines involved

1-3-3 Supergrid transmission lines

The following table summarizes the Double Circuit 330kV transmission lines required to complete the supergrid for the requirements of the 2030 system. Part of this supergrid transmission system is required by 2025, as mentioned in the previous sections:

Table 1-8 Supergrid lines for 2030

From	To	Thermal rating (MVA)	Length (km)	Remarks
Ikot Ekpene	Benin	2 x 1,550	300	
Ikot Ekpene	Makurdi	2 x 1,550	320	Required in 2025
Benin	Egbin	2 x 1,550	230	
Egbin	Ajegunle (New Agbara)	2 x 1,550	50	
Benin	Osogbo	2 x 1,550	200	
Ajegunle (New Agbara)	Osogbo	2 x 1,550	150	
Osogbo	Kainji	2 x 1,550	200	
Benin	Ajeokuta	2 x 1,550	150	
Ajeokuta	Gwagwalada	2 x 1,550	150	Required in 2025
Gwagwalada	Makurdi	2 x 1,550	180	Required in 2025
Gwagwalada	Kainji	2 x 1,550	250	
Gwagwalada	Funtua	2 x 1,550	260	Required in 2025
Gwagwalada	Osogbo	2 x 1,550	250	Required in 2025
Kainji	Bernin Kebbi	2 x 1,550	300	

Source: JICA Study Team

1-4 Trends in Transmission Network Development by Other Donors and Nigeria's Own Funds

1-4-1 Transmission System Expansions by AFD 1st Finance

The transmission system expansions included in the AFD 1st Finance project is in place for the transmission system in the Greater Abuja area.

The project aim strengthen the 330/132 kV system for power supply of the capital Abuja. Installation of New Apo 330/132/33 kV Substation, construction of new 132 kV double circuit transmission line (172 km) between New Apo 330/132/33 kV Substation and the Lafia 330 kV Substation, establishment of a 3rd power line for power supply to the Abuja 132 kV ring from the power plants in the Delta Area and the planned Mambilla Hydro Power Plant and else are planned.

Table 1-9 Transmission System Expansions by AFD 1st Finance

No.	Project	Substation	State
AFD	**Reinforcement of the High-voltage Transmission Ring Around the Abuja Project**		
A	Procurement of Design, Supply, Installation and Commissioning of 330kV and 132kV HV Transmission Lines in the Federal Capital Territory (FCT).	-	-
Lot1	Construction of about 143 km of new 330kV double circuit line from the Lafia 330kV Substation (new) to the proposed New Apo (Pigba) 330/132/33kV Substation.	-	Abuja (FCT) /Nasarawa
Lot2	Construction of about 81 km of new 132kV double circuit lines, including:	-	-
	i) Construction of about 11 km of a new 132kV double circuit line from New Apo (Pigba) 330/132/33kV Substation to Old Apo 132/33kV Substation;	-	Abuja (FCT)
	ii) Construction of 42 km of a new 132kV double circuit line from New Apo 330/132/33kV Substation to the proposed Kuje 132/33kV Substation.	-	Abuja (FCT)
	iii) Construction of 29 km of a new 132kV double circuit line from the proposed Kuje 132/33kV Substation to the West Main (Lugbe) 330/132/33V Substation.	-	Abuja (FCT)
B	Procurement of Design, Supply, Installation and Commissioning of 330/132/33kV Substations and 132/33kV Substations in the Federal Capital Territory (FCT).	-	-
Lot3	Construction of 2 No. 150MVA, 330/132/33kV Substations at New Apo (Pigba) equipped with 2X330kV Line Bays, 3 No. 60MVA 132/33kV Transformers including 6 X 132kV Line Bays with 3 X 132kV Line Bay Extensions at the Old Apo 132kV Substation and 2x 330kV Line Bay Extensions at Lafia.	New Apo Old Apo Lafia	Abuja (FCT)

No.	Project	Substation	State
Lot4	Construction of completely new 2 No. 150MVA, 330/132/33kV AIS Substations at West Main (Lugbe) to be equipped with 2 x 330kV Line Bays, and 3 No. 60MVA, 132/33kV Transformers with 132kV outdoor GIS Switchgear including 4X132kV Line Bays and 33kV indoor metal clad switchgears.	West Main	Abuja (FCT)
Lot5	(a) Construction of completely new 3 No. 60MVA, 132/33kV Substations at Kuje including 4 x 132kV Line Bays.	Kuje	Abuja (FCT)
	(b) Construction of completely new 2 No. 60MVA, 132/33kV Substations at Wumba / Lokogoma, to be equipped with 2 X 132kV Line Bays, including the laying of 2 x 5 km underground 132kV XLPE Cables from New Apo to Wumba/Lokogoma.	Wumba /Lokogoma	Abuja (FCT)
Lot6	Construction of completely new 2 No. x 60MVA, 132/33kV GIS Substations at Gwarimpa, including the laying of 4x1 km 132kV Underground XPLE Cable and termination of the same on the Existing 132KV DC Katampe – Suleja Transmission line.	Gwarimpa	Abuja (FCT)

Note: DC (Double Circuit)
Source: Transmission Company of Nigeria (2014.3) “Appraisal of Transmission Projects”

1-4-2 Transmission System Expansions by AfDB Phase 1

With financed by African Development Bank (AfDB) Phase 1, it is planned to build in the North West region of Nigeria a 330 kV double circuit line between Kaduna and Kano, two 330/132 kV substations and two 132/33 kV substations.

In the South region the reconstruction of two 330 kV transmission lines is planned. The 330 kV lines Delta-Benin and Alaoji-Ihiala-Onitsha shall be replaced by double circuit lines with quad conductors.

Furthermore, environmental impact assessment for various transmission lines is included in the scope.

Table 1-100 Transmission System Expansions to be financed by AfDB Phase 1

No.	Project	Substation	State
AfDB Phase 1	**NIGERIA TRANSMISSION EXPANSION PROJECT to be financed by IDB**		
1	Construction of Double Circuit 330kV Quad Conductor Kaduna-Kano Transmission line.	-	Kaduna
2	Turn-In/Turn-Out and Installation of 2x150MVA 330/132/33kV Transformers, 6x330kV Bay Extension, 2x60MVA 132/33kV Transformers, Associated 132kV Line Bays, and 6 No. 33kV Feeder Bays at Zaria.	Zaria	Kaduna
3	Turn-In/Turn-Out and Installation of 2x150MVA 330/132/33kV Transformer, 2 x330kV Bay Extension, and 2x60MVA 132/33kV Transformer and 2x3 No. Associated Outgoing 33kV Feeders.	Millennium City Kaduna	Kaduna
4	Turn-In/Turn-Out and Installation of 2x60MVA 132/33kV Transformer and 5 No. Outgoing 33kV Feeders.	Rigasa town, Kaduna	Kaduna
5	Turn-In/Turn-Out and Installation of 2x60MVA 132/33kV Transformer and 6 No. Outgoing 33kV Feeders.	Jaji, Kaduna	Kaduna
6	Reconstruction of 1xDelta-Benin 330kV Transmission Line Double Circuit to Quad Conductor 330 Double Circuit Line.	-	Benin
7	Double Circuit Alaoji-Ihiala-Onitsha to Quad Conductor 330kV Transmission Line.	-	Port Harcourt
8	Double Circuit (DC) 132kV Ahoda-Gilli-Gilli DC Transmission Line and 2x60MVA 132/33KV Transformers at Gilli plus associated 6 No. Outgoing 33kV Feeders and DC 132kV Sapele - Odilli DC Transmission Line and 2x60MVA 132/33KV Transformer at Gilli plus associated 6 No. Outgoing 33kV Feeders. (Environmental Impact Assessment and Resettlement Action Plan and Payment of Compensation).	-	Ahoda, Gilili and Sapele
9	132kV Line and associated Substations: Maiduguri-Manguno- Marte-Dikwa-Bama,Maiduguri-Bama-Gwoza; Hadeja-Nguru- Gashua-Damaturu; Biu-Miringa-Buni Yadi-Damaturu; Dambua-Chibok-Askira-Uba-Mubi; Mayo Belwa-Jada-Ganye. (Environmental Impact Assessment and Resettlement Action Plan and Payment of Compensation).	-	Bauchi

Source: Transmission Company of Nigeria (2014.3) "Appraisal of Transmission Projects"

1-4-3 Transmission System Expansions to be financed by AfDB Phase 2

To improve the electricity supply from the national grid to north-east of Nigeria, TCN is planning to install 132 kV transmission lines and new 132/33 kV substations as shown in Table 1-111.

Table 1-111 Transmission System Expansions to be financed by AfDB Phase 2

No.	Project	Substation	State
AfDB Phase 2	**Proposal for the Northeast Transmission Infrastructure Project to be financed by AfDB Phase 2**		
Package1 Substations		-	-
Lot1	Construction of 2 x 60MVA 132/33kV Complete Substations including 2 x 132kV Line Bay Extensions at the Old Maiduguri 132/33kV Substation.	Manguno	Bauchi
	Construction of 2 x 60MVA 132/33kV Complete Substations.	Marte	Bauchi
	Construction of 1 x 60MVA 132/33kV Complete Substation.	Dikwa	Bauchi
	Construction of 2 x 60MVA 132/33kV Complete Substations including 2 x 132kV Line Bay Extensions at the New Maiduguri 330/132kV Substation.	Bama	Bauchi
	Construction of 1 x 60MVA 132/33kV Complete Substation including 2 x 132kV Line Bay Extensions at the Gulak132/33kV Substation.	Gwoza	Bauchi
Lot2	Construction of 2 x 60MVA 132/33kV Complete Substations including 2 x 132kV Line Bay Extensions at the Mayo Belwa 330/132kV Substation.	Jada	Bauchi
	Construction of 2 x 60MVA 132/33kV Complete Substations including 2 x 132kV Line Bay Extensions at the Mayo Belwa 330/132kV Substation.	Ganye	Bauchi
	Construction of 2 x 60MVA 132/33kV Complete Substations including 2 x 132kV Line Bay Extensions at the Mayo Belwa 330/132kV Substation.	Jada	Bauchi

No.	Project	Substation	State
	Construction of 2 x 60MVA 132/33kV Complete Substations including 2 x 132kV Line Bay Extensions at the Mayo Belwa 330/132kV Substation.	Ganye	Bauchi
Lot3	Construction of 2 x 60MVA 132/33kV Complete Substations including 2 x 132kV Line Bay Extensions at the Mubi 132/332kV Substation.	Uba	Bauchi
	Construction of 1 x 60MVA 132/33kV Complete Substation	Chibok	Bauchi
	Construction of 1x 60MVA 132/33kV Complete Substation including 2 x 132kV Line Bay Extensions at the Biu 132/33kV Substation.	Biu	Bauchi
	Construction of 1 x 60MVA 132/33kV Complete Substation including 2 x 132kV Line Bay Extensions, one at the Damaturu 330kV Substation and one at the Biu 132/33kV Substation.	Bunyadi	Bauchi
	Construction of 1 x 60MVA 132/33kV Complete Substation including 2 x 132kV Line Bay Extensions, one at the Damaturu 330kV Substation and one at the Biu 132/33kV Substation.	Kwaya Kusar	Bauchi
Package 2 New 132kV Double Circuit Transmission Lines		-	-
2-A	Construction of a New 321 km, 132kV Double Circuit Line Between Maiduguri - Manguno - Marte - Dikwa -Bama (Maiduguri - Manguno - Marte - Dikwa - Bama).	-	Bauchi
	Construction of a New 165 km, 132kV Double Circuit Line from Maiduguri - Bama - Goza - Gulak (Maiduguri - Bama - Goza - Gulak).	-	Bauchi
2-B	Construction of a New 78 km, 132kV Double Circuit Line from Mayo Belwa - Jada - Ganye. (Mayo Belwa - Jada - Ganye).	-	Bauchi
	Construction of a New 134 km, 132kV Double Circuit Line from Biu - BuniYadi - Damaturu (Biu - BuniYadi - Damaturu).	-	Bauchi
	Construction of a New 130 km, 132kV Double Circuit Line from Dambua - Chibok - Uba - Mubi (Dambua - Chibok - Uba - Mubi).	-	Bauchi

Source: Transmission Company of Nigeria (2014.3) “Appraisal of Transmission Projects”

1-4-4 Transmission System Rehabilitations and Reinforcements/Upgrading by World Bank

Under the Nigeria - Electricity Transmission Project (NETAP), it is planned to carry out a large number of rehabilitations / reinforcements of existing substations and transmission lines, financed by World Bank.

The scope of the project includes reinforcement and upgrading of substations, reconductoring of transmission lines.

Table 1-122 Transmission System Rehabilitations and Reinforcements/Upgrading to be financed by World Bank

No.	Project	Substation	State
WB	**PROPOSED NETAP PACKAGE to be financed by the World Bank**		
	SUBSTATION REINFORCEMENT AND REHABILITATION	-	-
Lot1	Reinforcement with 1 x 300MVA 330/132kV Power Transformer, High-voltage Switchgears and associated equipment, Replacement of Control and Relay Panel with Digital Control System.	Kumbotso	Kaduna
	Reinforcement with 1 x 100MVA 132/33kV Power Transformer, Switchgears, associated equipment, Digital Control System. Supply & Installation of Additional 3 No. Feeder Bays and Control Room Rehabilitation.	Dakata	Kaduna
	Replacement of Faulty 1 x 30MVA and Upgrading of 1 x 30MVA Transformers to 2 x 60MVA 132/33kV Transformers, High-voltage Switchgears, and associated equipment, Including a Digital Control System.	Kankia	Kaduna
	Reinforcement of 1 x100MVA 132/33kV Transformer, High-voltage Switchgears, and associated equipment, including a Digital Control System and Control Room Rehabilitation.	Dan Agundi	Kaduna
	Reinforcement with 2 x150MVA 330/132kV and Installation of 1 x 60MVA 132/33kV Power Transformers with Associated 3no. Outgoing 33kV Feeders and Control Room Rehabilitation.	Birnin Kebbi	Shiroro
	Replacement of Obsolete Control and Relay Panels with a Control System, High-voltage 330kV Switchgears, and associated equipment.	Shiroro	Shiroro
	Upgrading of 2 x 45MVA with 2 x 100MVA 132/33kV Power Transformers, High-voltage Switchgears, and associated equipment, Including a Gas-Insulated Substation. Rehabilitation of the Civil Structures of the Control Room and Digital Control System.	Abuja Central Area	Shiroro
	Rehabilitation of the 330kV Substation, High-voltage Switchgears, and associated equipment. Control Room Rehabilitation with Digital Control System.	Kainji	Shiroro
Lot2	Rehabilitation of 330kV Substation, 330kV Control room, and Digital Control System, and Replacement of High-voltage Switchgears and associated equipment.	Alaoji	Port Harcourt
	Rehabilitation of 132kV Substation, 132kV Control room, and Digital Control System, and Replacement of High-voltage Switchgears.	Aba	Port Harcourt
	Reinforcement with 1 x 100MVA 132/33kV Power Transformer, Control Room, High-voltage Switchgears, and associated equipment.	Port Harcourt Main	Port Harcourt
	Reinforcement with 1 x 100MVA 132/33kV Power Transformer, Control Room, High-voltage Switchgears and associated equipment.	Port Harcourt Town	Port Harcourt
	Reinforcement with 1x 60MVA 132/33kV Power Transformer, High-voltage Switchgears, and associated equipment. Control Room Rehabilitation with Digital Control System.	ItuTS	Port Harcourt
	Reinforcement with 1 x 150MVA 330/132/33kV, 2 x 60MVA Transformers with associated equipment, Replacement of High-voltage Switchgears, and Control Room Rehabilitation with Digital Control System.	New Heaven, Enugu	Enugu
	Reinforcement of 1 No. 60MVA 132/33kV Power Transformer, High-voltage Switchgears, and associated equipment.	G C M TS, Onitsha	Enugu
	Upgrade of 1x30MVA to 60MVA 132/33kV Power Transformer, High-voltage Switchgears, and associated equipment.	Abakaliki	Enugu
	Reinforcement of 1 No. 60MVA 132/33kV power Transformer, Switchgears, associated equipment, and devices.	Orji river	Enugu
	Supply and Installation of 1x75MVar Reactor and 1 x 60MVA 132/33kV High-voltage Switchgear, and associated equipment.	Ugwuaji	Enugu
	Upgrading of 7.5MVA Power Transformer to 1x 60MVA 132/33kV Transformer, High-voltage Switchgears, and associated equipment.	Otukpo	Enugu
	Reinforcement with 1x150MVA 330/132/33kV and 1x 60MVA 132/33kV Power Transformers, High-voltage Switchgears, and associated equipment.	Apir, Makurdi	Enugu
	Reinforcement with 100MVA 132/33kV Power Transformers and Extension of 132kV Bus with 3 No. Additional Feeder Bays.	Umuahia	Enugu
Lot3	Reinforcement with 1 x 150MVA 330/132kV and 2x 100MVA 132/33kV Power Transformers, High-voltage Switchgears, and associated equipment with 3 No. Additional Feeder Bays.	Yola	Bauchi

No.	Project	Substation	State
	Reinforcement with 1 No. 150MVA 330/132kV Power Transformer, High-voltage Switchgears, and associated equipment with 3 No. Additional Feeder Bays.	Mayo Belwa	Bauchi
	Upgrading from 132kV to 330kV Substation with 1x150MVA, 330/132/33kV Power Transformers and 1 x 100MVA 132/33kV Transformer, High-voltage Switchgears, and associated equipment. Construction of 330/132kV Control Room.	Jalingo	Bauchi
	Reinforcement with 1 No. 150MVA 330/132kV power Transformers, High-voltage Switchgears, and associated equipment with 3 No. Additional Feeder Bays.	Damaturu	Bauchi
	Reinforcement of 1 x 60MVA 132/33kV Power Transformer, High-voltage Switchgears, associated equipment, and Complete Substation Rehabilitation.	Biu	Bauchi
Lot4	Reinforcement of 2x 60MVA 132/33kV Power Transformers, High-voltage Switchgears, associated equipment, and Complete Substation Rehabilitation.	Damboa	Bauchi
	Reinforcement with 1 x 300MVA 330/132kV and 1x 100MVA 132/33kV Transformers with High-voltage Switchgears and associated equipment. Bus with 3 No. Additional Feeder Bays.	Gombe	Bauchi
	Reinforcement of 1x 300MVA 330/132/33kV & 1 x 100MVA Power Transformer, 330kV High-voltage Switchgears and associated equipment. Rehabilitation of Civil Structures of the Control Room and Digital Control System.	Jos TS	Bauchi
	Reinforcement with 1 No. 150MVA 330/132kV Power Transformer, High-voltage Switchgears, and associated equipment with 3 No. Additional Feeder Bays.	Maiduguri	Bauchi
	Upgrading of 22.5MVA and 30MVA Transformers to 2X 60MVA 132/33kV Transformers, Control Room Rehabilitation with Digital Control System and Associated High-voltage Switchgears.	Bauchi	Bauchi
Lot5	Upgrading of 1x 90MVA with 1x300MVA 330/132kV and Reinforcement with 1x100MVA Power Transformers, High-voltage Switchgears, associated equipment, and 75MX Reactor, including Renovation of Control Room.	Osogbo	Osogbo
	Reinforcement of 2 x100MVA 132/33kV Power Transformers, High-voltage Switchgears, and associated equipment. Construction of New Control Room with Digital Control System (DCS).	Ilorin	Osogbo
	Upgrading of 2x 30MVA with 2x 60MVA,132/33kV Power Transformers, Replacement of High-voltage Switchgears, Conversion of 6 No. 33kV Indoor to Outdoor type. Control Room Rehabilitation with Digital Control System, and Perimeter Fencing.	Ondo	Osogbo
	Supply and installation of 100MVA 132/33KV power Transformer and associated Switchgears.	Irrua	Benin
	Reinforcement with 1 x 150MVA 330/132kV Interbus Transformer, 1 x 100MVA Power Transformer, High-voltage Switchgears, and associated equipment. Replacement of Obsolete Control and Relay Panels with Digital Control System.	Delta IV TS	Benin
	Replacement of defective 1x 60MVA 132/33kV Power Transformer with a new 1x 1000MVA 132/33KV Power Transformer, High-voltage Switchgears, and associated equipment with 4 No. Additional Feeder Bays.	Effurun	Benin
	Reinforcement with 1 x 150MVA 330/132kV Power Transformer and 100MVA 132/33KV Power Transformer, High-voltage Switchgears, and associated equipment. Replacement of Obsolete Control and Relay Panels with Digital Control System.	Benin TS	Benin
Lot6	Upgrading of 2 x 30MVA with 2 x 100MVA 132/33kV. Rehabilitation of Civil Structures of the Control Room, Digital Control system, and associated equipment.	Ijora	Lagos
	Supply and installation of 1x 300MVA 330/132kV Power Transformer, 2 x 100MVA 132/33kV Power Transformers, High-voltage Switchgears, and associated equipment.	Lekki	Lagos
	Supply and Installation of 1x 300MVA 330/132kV Power Transformer, 2x 100MVA 132/33kV Power Transformers, Switchgears, associated equipment and devices.	Alagbon	Lagos
Lot7	Reinforcement of 1x 100MVA 132/33kV Power Transformer, High-voltage Switchgears, and associated equipment.	Alausa	Lagos
	Complete Rehabilitation of the Gas-Insulated Substation (GIS).	Akoka	Lagos
	Complete Rehabilitation of the Gas-Insulated Substation (GIS).	Amowu Odoffun	Lagos
	Complete rehabilitation of the Gas-Insulated Substation (GIS).	Itire	Lagos
	Upgrading of 1x 30MVA Power Transformer and 1x 40MVA Power Transformers with 2x 100MVA 132/33kV Power Transformers, High-voltage Switchgears, and associated equipment.	Otta TS	Lagos
	Upgrading of 2 x 30MVA Power Transformers to 2 x 100MVA 132/33kV Power Transformers, High-voltage Switchgears, and associated equipment.	Maryland	Lagos

No.	Project	Substation	State
	Replacement of Obsolete Control and Relay Panels with Digital Control System, Control Room Rehabilitation, High-voltage Switchgears, and associated equipment.	Egbin	Lagos
	132kV LINE RECONDUCTORING	-	-
A	Reconductoring of 150 km, 132kV Line Between Osogbo - Offa/Omuaran to Ganmo and Ilorin TS.	Osogbo- Offa - Ganmo - Ilorin	Osogbo
	Reconstruction and Conversion of SC to Double Circuit Ayede-Ajebo-Ishara-Shagamu 132kV Line (54 km) and Creation of Additional Bays, 132kV Line Bays at Ayede, Ajebo, Ishara, and Shagamu.	Ayede - Shagamu	Osogbo
	Reconstruction and Conversion to Double Circuit Osogbo - Ife/Ilesha 132kV Line (39.21 km) and Osogbo - Ilesha 132kV Line Tie-Off (22.1 km) and Creation of Additional 132kV Line Bays at Osogbo and Ilesha.	Osogbo- Ife / Ilesha	Osogbo
	Reconstruction of Existing Double 132kV Line Circuit to 4 x 132kV Line Circuits Using the Same Right of Way from Afam to Port Harcourt Main (37.8 km), Creating Additional 3 x 132kV Line Bays.	Afam - PH Main	Port Harcourt
	Reconductoring of 132kV Double Circuit of Port Harcourt Main to Port Harcourt Town 132kV Line (6 km).	PH Main - PH Main	Port Harcourt
B	Reconductoring of Kumbotsho - Hadeji 132kV Line (165 km).	Kumbotso - Hadelja	Kaduna
	Reconductoring of Kumbotsho - Kankia 132kV Line (100 km).	Kumbotso - Kankia	Kaduna
	Reconductoring of Onitsha - Orji 132kV Line (87 km) with Turn-In/Turn-Out Tower at Nibo (Agu Awka) in Awka 132kV Substation.	Onitsha - Oji River	Enugu
	Reconductoring of Alaoji - Aba Town Double Circuit 132kV line (8 km) Including Rehabilitation of 2 No. Towers along the Line.	Alaoji to Aba Town	Enugu
	Reconductoring of Irrua - Benin 132kV line (81 km).	Irrua - Benin	Benin
	Reconductoring of Irrua - Okpilai 132kV line (43 km).	Irrua - Okpila	Benin
	Reconductoring of Okpilai - Okene 132kV line (65 km).	Okpila - Okene	Benin
	Reconductoring of Ajakuta - Okene 132kV line (60 km).	Ajakuta- Okene	Benin
	Reconductoring of the Entire Route Length from Gombe - Biu -Damboa - Maiduguri 132kV line of 356 km Route Length.	Gombe- Biu- Damboa- Maiduguri	Bauchi

Source: Transmission Company of Nigeria (2014.3) “Appraisal of Transmission Projects”

1-4-5 Transmission System Expansions by AFD 2nd Finance

It is planned to build new transmission lines and substations and to rehabilitate transmission lines and substations in various in the northern areas of TCN, in order to improve power transmission in the northern transmission corridor.

Table 1-13 Transmission System Expansions by AFD-2nd finance

No.	Project	Substation	State
AFD	**NORTHERN CORRIDOR TRANSMISSION PROJECT to be financed by AFD**		
1	Kainji - Birnin Kebbi 330kV Double Circuit (DC) Line (310 km).	-	SHIRORO
2	(1) Birnin Kebbi-Sokoto 330kV DC Transmission Line on the existing 132KV Birnin-Kebbi Sokoto ROW and reconductoring the existing 132kV Single Circuit Birnin-Kebbi Line to double its capacity (Birnin Kebbi-Sokoto 330kV Double Circuit (DC) Line (130 km)).	-	SHIRORO
3	Construction of Length of 330kV DC Twin line between Katsina-Daura-Gwiwa-Jogana- Kura (Katsina-Daura-Gwiwa-Minjibir-Kura (234 km)).	-	Kaduna
4	Turn-In/Turn-Out Mina - Suleja 132KV DC and construction of 1 x 60MVA 132/33kV Complete Substation.	Lambata (Mina-Suleja Rd)	SHIRORO
5	Turn-In/Turn-Out on Brinin Kebbi-Sokoto 132KV Line and construction of 2 x 60MVA 132/33kV Complete Substations.	Fakon Sarki-Argungu	SHIRORO
6	Construction of 1 x 60MVA 132/33kV Complete Substation, High-voltage Switchgears, and associated equipment.	Yelwa-Yawuri	SHIRORO
7	Construction of 1 x 60MVA 132/33kV Complete Substation, High-voltage Switchgears, and associated equipment.	Birnin Gwari	SHIRORO
8	Installation of 2x150MVA 330/132/33KV Double Circuit Substations with associated 132kV Bay Extension and Installation of 2x60MVA 132/33kV Transformers, 6 No. Outgoing 33kV Feeder Bays	Daura-Katsina State	Kaduna
9	Installation of 2x150MVA 330/132/33KV Double Circuit Substations with associated 132kV Bay Extension and installation of 2x60MVA 132/33kV Transformers, 6 No. Outgoing 33kV Feeder Bays	Jogana-Kano	Kaduna
10	Installation of 2x150MVA 330/132/33KV Transformers at Sokoto New 330 Double Circuit Substation with associated 132kV Bay Extension and installation of 2x60MVA 132/33kV Transformers, 6 No. Outgoing 33kV Feeder Bays	-	SHIRORO
11	Reconstruction and upgrading of 2 Single Circuit 330kV Transmission Lines 1 & 2 from Shiroro PS to Mando (Kaduna) to a 2 Double Circuit, Quad Conductor Shiroro-Mando (Kaduna) Transmission Lines 1 and 2. The line Bay Extension at Mando and Shiroro.	-	SHIRORO
12	Turn-In/Turn-Out of the existing 330kV SC Jos-Gombe line at Bauchi, and installation of 2x150MVA 330/132/33kV Transformers with associated 132kV Bay Extension and 2x60MVA 132/33kV Transformers, 6 No. Outgoing 33kV Feeder Bays (Bauchi 330kV Transmission Substation (2 km))	-	BAUCHI
13	Urgent replacement of Kainji/Jebba 330kV line 1 - 330kV Circuit Breaker at Kainji TS. (Rehabilitation work at Kainji TS)	-	SHIRORO
14	Replacing the existing, very old (1968) Marilli 80MVA 330/132/13.8kV, 2T1 Transformer with 1x150MVA 330/132/33kV plus 1X60MVA, 132/33kV Transformer and 3 No. 33KV Feeder Control and Protection Panels. (Rehabilitation Work at Jebba TS)	-	SHIRORO
15	Urgent replacement of 1 No. Jebba T/S 75MX Reactor 2R2 CB (the reactor exploded). (Rehabilitation Work at Jebba TS)	-	SHIRORO
16	Replacement of 11 No. 330KV Circuit Breakers at Jebba 330kV Switchyard. The existing CB's are obsolete and no parts or spares are available. (Rehabilitation Work at Jebba TS)	-	SHIRORO
17	Replacement of 9 Spans of Sky Wire for 330kV Jebba- Osogbo Lines 1 & 2 and 330kV Jebba-Ganmo Lines. (Rehabilitation Work at Jebba TS)	-	SHIRORO
18	Replacement of 8 No. 330KV obsolete Circuit Breakers. The existing CB's are obsolete and no parts or spares are available. (Rehabilitation Work at Jebba Power Station Transmission Switch Yard)	-	SHIRORO
19	Replacement of 330KV obsolete Hydraulic SF6, Circuit Breakers and associated Motorized Isolators at Shiroro TS. (Rehabilitation work at Shiroro TS)	-	SHIRORO
20	Replacement of 28 Spans of Sky Wire for 330kV Shiroro-Jebba Line 2. (Rehabilitation Work at Shiroro TS)	-	SHIRORO

No.	Project	Substation	State
21	Reinforcement of Minna with 1x60MVA 132/33kV Transformer to relieve the existing overloaded 1x30MVA 132/33kV Transformer with a complete 132kV Bay Extension and Additional 3 No. 33kV Feeder Control and Protection Panels. Control Room Rehabilitation. (Rehabilitation work at Minna TS)	-	SHIRORO
22	Replacement of 32 Spans of Sky Wire for 132kV Minna-Bida Line. (Rehabilitation work at Minna TS)	-	SHIRORO
23	Reconductoring of 132kV SC Karu-Keffi-Akwanga Transmission Line. (Karu-Keffi-Akwanga 132kV Transmission line (103 km))	-	SHIRORO
24	Replacement of 36 Spans of Sky Wire for 132kV Apo-Keffi Line. (Keffi TS Transmission Line Rehabilitation)	-	SHIRORO

Source: Transmission Company of Nigeria (2014.3) "Appraisal of Transmission Projects"

1-4-6 Nigeria's Own Projects for Investment in Transmission Equipment

In addition to the above donor funded projects, TCN has planned some transmission expansion plan as shown in Table 1-14.

Table 1-14 Nigeria's Own Projects for Investment in Transmission Equipment

No.	Project	State
TCN		
1	2 x 60MVA, 132/33kV Substations at Odogunyan and Ayobo with 132kV DC Tline Ikeja West - Ayobo.	Lagos
2	New Abeokuta - Igboora - Lanlate 132kv DC Line and Tee- Off at Igboora - Igangan	Ogun
3	2x30/40 MVA, 132/33kV Substations at Lanlate plus 2 x132KV Line Bays at New Abeokuta 132/33kV Substation	Ogun
4	Ikorodu - Odogunyan - Shagamu 132kV DC Transmission Line	Lagos/Ogun
5	Transmission - 2x60MVA 132/33KV Substation at Igangan & 132kV Switching Station at Igboora	Ogun
6	Omotosho-Epe-Aja 330KV DC Line.	Lagos
7	Provision of an Additional 2x150MVA 330/132KV Transformer Capacity at Olorunsogo T/S.	Ogun
NIPP		
1	132KV DC Oke Aro-Alausa	Ogun/Lagos
2	132KV DC Oke Aro-(Ikorodu/Maryland)	Ogun/Lagos
3	132KV Alausa SS (Line bay ext.)	Lagos
4	132/33KV Agbara SS (Ext.)	Lagos
5	132/33KV Ikeja West SS (Ext.)	Lagos
6	132/33KV Ojo SS (Ext.)	Lagos
7	132/33KV Oworonsoki SS (Ext.)	Lagos
8	330/132KV Aja G.I.S. SS (Ext.)	Lagos
9	132KV Aja G.I.S. SS (Ext.)	Lagos
10	330/132/33KV Alagbon G.I.S. SS (New and Ext.)	Lagos
11	132/33KV Lekki G.I.S. SS (New)	Lagos
12	330/132/33KV Lekki G.I.S. SS (New)	Lagos
13	132KV DC Otta-Ogba Junction-Papalanto	Lagos
14	132KV DC Papalanto-Old Abeokuta	Lagos
15	132KV DC Old Abeokuta-New Abeokuta	Lagos
16	132KV DC Lekki-Aja	Lagos
17	132/33KV New Abeokuta SS (New)	Lagos
18	132/33KV Old Abeokuta SS (New)	Lagos
19	132/33KV Papalanto SS (Ext.)	Lagos
20	132/33KV Otta SS (Ext.)	Lagos
21	330/132KV Papalanto SS (New)	Lagos
22	330KV DC Papalanto-(Ikeja West/Ayede)	Lagos
23	330KV DC Omotosho - Ikeja West	Lagos

Source: Transmission Company of Nigeria (2014.3) "Appraisal of Transmission Projects"

Chapter 2 Power Supply and Demand Forecast

Chapter 2 Power Supply and Demand Forecast

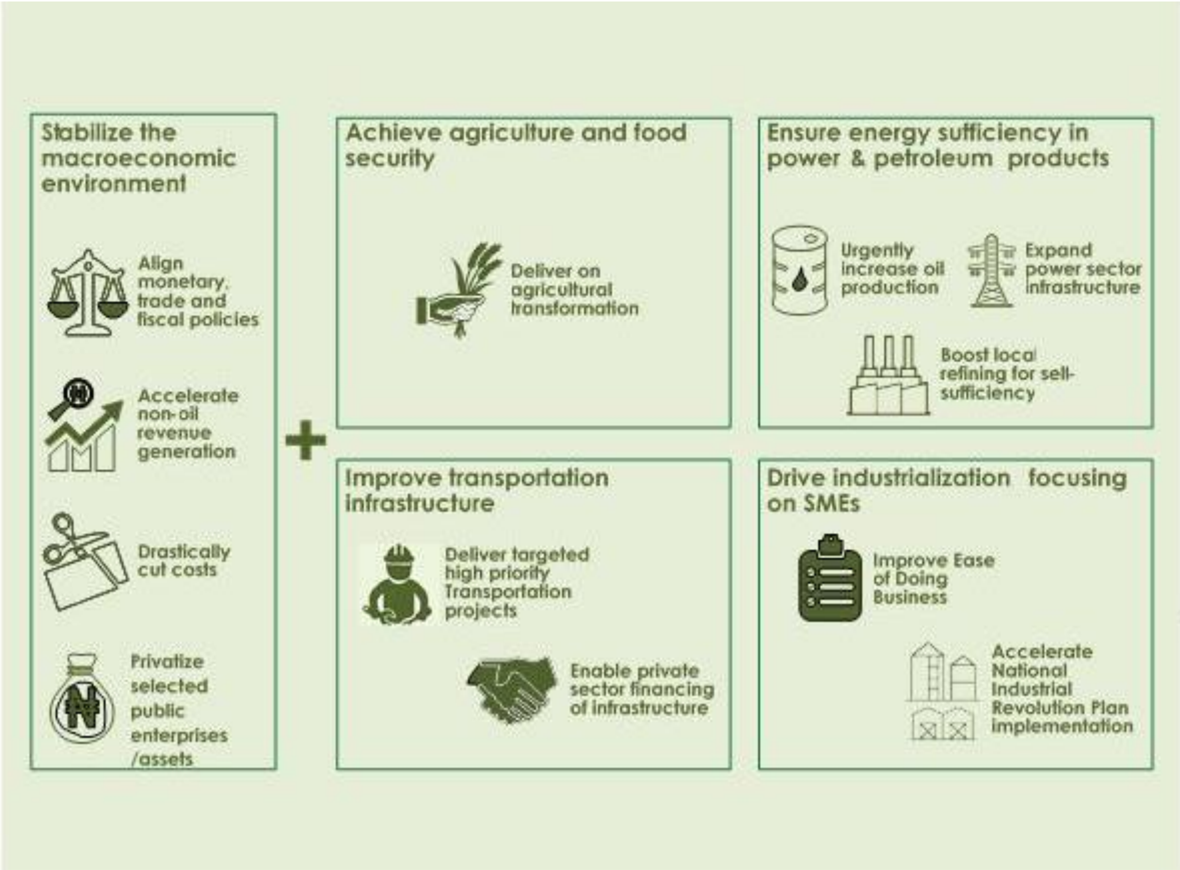
Nigeria has the largest population among African countries. With the recent rebasing of the GDP, the country now also has the largest economy in the African continent, surpassing South Africa.[1] The Nigerian economy has been growing at an annual rate 3.58% over the past five years. The social infrastructure, however, lags far behind economic development. Electricity, in particular, is in extremely short supply, posing a serious impediment to economic development. Even in Lagos, the former capital and largest industrial/commercial center of the country, with a population of over 21 million, the grid power supply is rotated hourly, impelling people to rely heavily on their own generators for protection against power outages. As Nigeria aims to implement its ambitious "Economic Recovery and Growth Plan 2017-2020: ERGP," the country urgently needs to secure a sufficient and stable supply of electricity as a platform for economic development.

2-1 Economic Recovery and Growth Plan 2017-2020: ERGP

The ERGP was formulated in 2014 with the aim of improving the resilience of the economy and making the economy less vulnerable to external shocks by reducing its dependence on the oil sector and improving the implementation of government policies. As illustrated in Figure 2-1, the key execution priorities to achieve the objectives of the ERGP are:

- Stabilizing the macroeconomic environment
- Achieving agriculture and food security
- Ensuring energy sufficiency (power and petroleum products)
- Improving the transportation infrastructure
- Driving industrialization with a focus on Small- and Medium-Scale Enterprises

[1] Nigeria rebased its GDP from 1990 to 2010, resulting in an 89% increase in the estimated size of the economy. With this rebasing, the country now boasts the largest economy in Africa with an estimated nominal GDP of USD 510 billion, surpassing South Africa's USD 352 billion. (African Development Bank, "Nigeria Economic Outlook," downloaded on July 27, 2014 http://www.afdb.org/en/countries/west-africa/nigeria/nigeria-economic-outlook/)



Source: Ministry of Budget and National Planning, "Economic Recovery and Growth Plan 2017-2020," February 2017

Figure 2-1 The ERGP'S TOP Execution Priorities

The target set towards achieving the objectives of the ERGP is to "optimize the delivery of at least 10 GW of operational power capacity by 2020 to boost economic activity across all sectors and improve the quality of life of the citizenry." The Nigerian government has positioned the power sector (electric power and transportation) as one of the first priorities in the ERGP.

The strategies are as follows:

- With regard to the power value chain, efforts will be concentrated on overcoming the current challenges related to governance, funding, legal, regulatory, and pricing issues across the three main power segments of generation, transmission, and distribution, and ensuring stricter contract and regulatory compliance.
- The ERGP aims to optimize the delivery of at least 10 GW of operational capacity by 2020 and to improve the energy mix by promoting greater use of renewable energy.
- The plan also aims to increase power generation by optimizing operational capacity, encouraging small-scale projects, and building more capacity over the long term.
- The government will also invest in transmission infrastructure.

The ERGP reported has that "Nigeria has 12.5 GW of installed capacity, but that less than one-third is operational (average 3.9 GW in 2015; 3.2 GW as of November 2016)." The effective use of the capacity of existing power supply facilities is expected to improve the reliability and quality of the electric power supply.

2-2 General Overview of the Nigerian Economy

Since the turn of the century, the Nigerian economy has recorded strong growth not only as a consequence of the steadier oil price, but also through diversification of its economy from a mono-culture oil-based structure. Nigeria's oil dependence (Oil Rents in Table 2-1) has decreased sharply in recent years without abatements in the steady and ongoing growth of the economy. The urban population also continues to increase rapidly, reflecting the people's aspiration toward modernized life.

Table 2-1 and Table 2-2 give an overview the growth of the Nigerian economy in recent years. Along with the oil sector, the telecommunications, construction and services sectors are the main drivers of the economy. AfDB foresees in its African Economic Outlook 2018 that Nigeria will continue on a path of sustained growth driven by improved performance of the key non-oil sectors –agriculture, information and communication technology, and trade and services– through to the end of 2018.

Social indicators are beginning to improve as efforts to achieve the Sustainable Development Goals (SDGs) and ERGP are being intensified through the implementation of social-sector reforms, though the northeast region still faces conflict-related challenges. Adding value to the exports of primary products, the cornerstone of the Agricultural Transformation Agenda, could help Nigeria climb up the value chain towards industrialization and provide opportunities to bring the large informal sector progressively into the formal economy, thereby making growth more inclusive and offering a high potential for job creation, increased income, and poverty reduction.[1]

Favorable improvements have been seen in the non-oil sector, with real GDP growth of 0.9%, 2.1%, and 2.0% in 2017, 2018, and 2019, respectively. Agriculture, trade, and services are the main drivers of non-oil sector growth.

AfDB foresees that "this growth outlook reflects continued improvement in oil production and higher activity in the agriculture sector, retail, trade, and manufacturing, following the easing of foreign exchange supply constraints and recovery in banks' private sector credit." Growth will hinge on continued recovery of the global economy, favorable agricultural harvests and, to a great extent, a possible boost in energy supply arising from the power-sector reform, as well as on expected positive outcomes from the Agricultural Transformation Agenda. Comprehensive economic and structural reforms are also expected to improve economic growth.

The risks to Nigeria's economic growth are the sluggish recovery of the global economy, security challenges in the northeastern part of the country, continued agitation for resource control in the Niger Delta, and possible distraction from the ongoing reforms as a result of the general elections.

Table 2-1 Economic Indicators of Nigeria

		Economic Indicators						Annual Growth Rate				
		1980	1990	2000	2005	2010	2015	80-90 %	90-00 %	00-05 %	05-10 %	10-15 %
Population												
Total	million	73.5	95.6	122.4	138.9	158.6	181.2	2.7	2.5	2.6	2.7	2.7
Urban population	million	16.1	28.3	42.6	54.3	68.9	86.6	5.8	4.2	5.0	4.9	4.7
(Ratio: %)	%	22.0	29.7	34.8	39.1	43.5	48.7					
GDP												
Current US$	billion	64.2	30.8	46.4	112.2	369.0	481.1	-7.1	4.2	19.3	26.9	5.4
2005 US$	billion	143.8	130.9	157.5	260.5	369.0	464.3	-0.9	1.9	10.6	7.2	4.7
PPP 2011	billion	N/A	289.8	348.5	576.5	816.7	1027.4		1.9	10.6	7.2	4.7
GDP per capita												
Current US$	$/person	874	323	379	808	2327	2655	-9.5	1.6	16.3	23.6	2.7
2005 US$	$/person	1957	1374	1287	1875	2327	2563	-3.5	-0.7	7.8	4.4	2.0
(ratio of Value Added)		(1981)										
Agriculture	%	28.5	30.0	25.3	32.4	23.5	20.6					
Manufacturing	%	9.9	29.9	17.5	12.1	6.5	9.4					
Other Industries	%	30.1	61.3	47.5	37.9	24.9	20.2					
Services	%	31.5	78.3	66.8	72.3	50.0	58.1					
Oil Rents	%	28.1	45.1	34.0	30.2	12.1	3.0					

Source: World Bank, "World Development Indicators," July 2018, https://data.worldbank.org/country/nigeria

Table 2-2 Economic Outlook for Nigeria

National Bureau of Statistics (February 2016)	2015	2016(e)	2017(f)	2018(f)	2019(f)
Real GDP growth	2.97	3.78	5.03	5.61	5.61
Inflation Rates	9.55	10.16	9.49	8.67	8.54
African Development Bank (2018)		**2016**	**2017(e)**	**2018(p)**	**2019(p)**
Real GDP growth		-1.6	0.9	2.1	2.0
Real GDP per capita growth		-4.2	-1.8	-0.5	-0.5
CPI inflation		15.7	16.5	13.9	12.9
Budget balance % GDP		-3.9	-5.1	-4.4	-4.3
Current account balance % GDP		0.7	2.0	1.4	1.7

Source: National Bureau of Statistics, "Economic Outlook for Nigeria, 2011-2019," February 2016, http://nigeria.opendataforafrica.org/gdcmcbg/economic-outlook-for-nigeria-2011-2019
African Development Bank, "African Economic Outlook 2018," May 2018, http://www.africaneconomicoutlook.org/en/

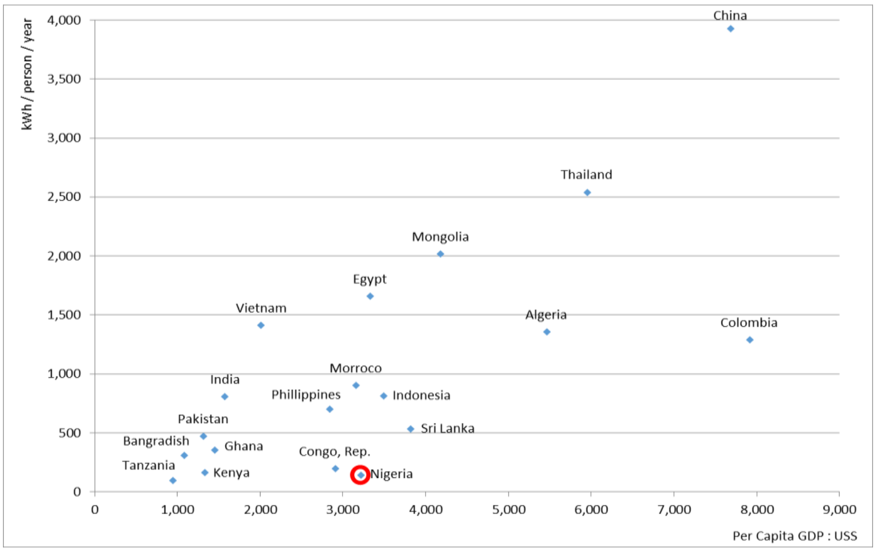
2-3 Energy and Electricity Trend

2-3-1 Overview of Energy and Electricity Demand

Nigeria is the 12th largest producer of petroleum in the world (2.44 million barrels/day in 2015, BP statistics) and the fourth largest exporter of LNG (21.5 million toe exported in the 2015, BP statistics). Nigeria's production of petroleum and natural gas accounts for 3.0%[2] of the country's rebased GDP (2015, World Bank). According to the World Bank, Nigeria's per capita GDP in 2017 was US$3,222, ahead of the Philippines (US$2,843) and Morocco (US$3,155) and approaching Egypt (US$3,328) and Indonesia (US$3,492). Nigeria's capita power consumption in 2017, meanwhile, was only 144 kWh/year, far behind the Philippines (901 kWh/year) and Morocco (699 kWh/year). The country has an electrification rate of roughly 59.3% (2016, World Bank), meaning that nearly half of the population of Africa's most populous country (186 million in 2016, World Bank) lives without

[2] Oil rent (% of GDP) is 23.7% by 2009 before the rebased GDP, 16.4% by 2010 after the rebased GDP, and 3.0% by 2015.

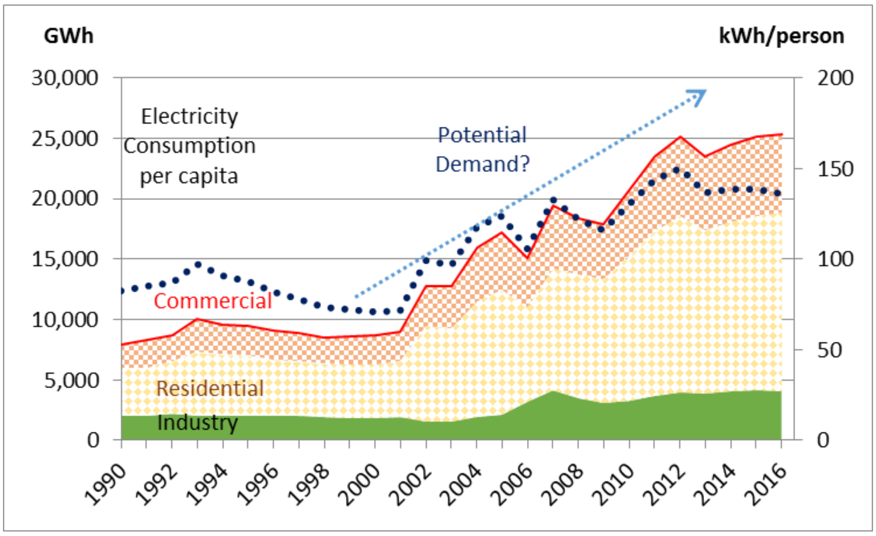
electricity. The Sub-Saharan region is the most underdeveloped region in the world in terms of electrification, and Nigeria is a typical example.



Source: World Bank

Figure 2-2 International Comparison of Electricity Consumption

Power consumption in Nigeria has been strongly affected by supply constraints for many years. In the result of armed conflicts and pipeline vandalism, slow investment and inferior maintenance of the power plants and transmission/delivery system have depressed the power supply for several decades. As a consequence, power consumption supplied from the national grid is very low (see Figure 2-3) compared with other developing countries at similar income levels. Consumption has started to pick up in the last decade, however, with improvements in the security and power supply situation following the granting of amnesty in 2009 and the agreement by militias to turn in their weapons to government forces.

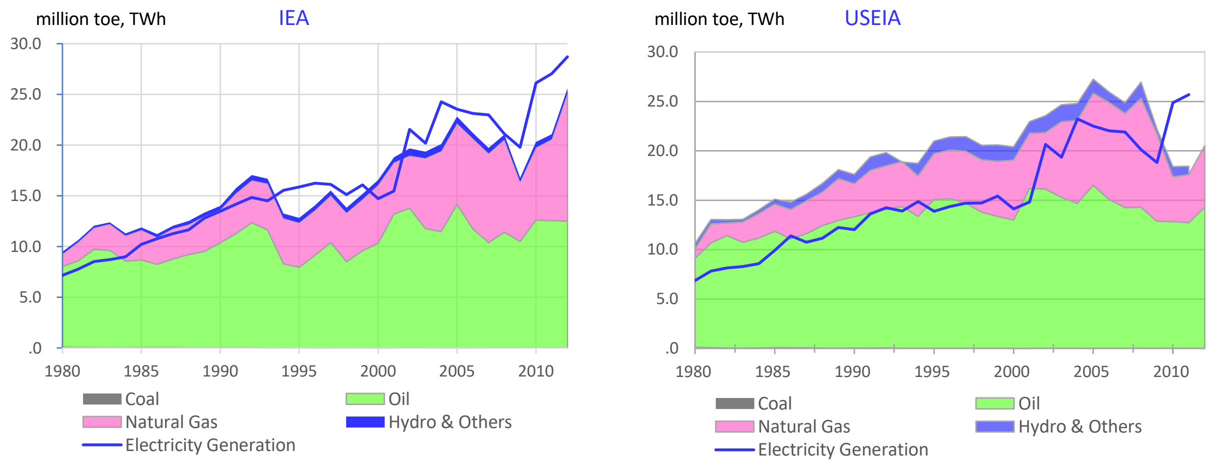


Source: IEA

Figure 2-3 Electricity Consumption of Nigeria

In terms of daily life in Nigeria, the abovementioned official statistics on the power supply from the national grid fail to sufficiently illustrate the reality of the electricity demand in Nigeria. The poor reliability of the power supply compels people to prepare generators at home or in factories and offices. Their daily activities have heavily depended on these generators for decades. The short supply capacity forces power distribution companies to implement frequent power supply rotations even in Lagos, the largest industrial/business center of Nigeria.[3] Big industrial plants and service facilities such as large hotels and hospitals forgo connection to the grid altogether, totally relying on their own big generators instead.[4] Small generators (0.5-10kW) for home use are run by petrol (gasoline) and big generators are driven by diesel gas oil or LPG. Thus, as shown in Figure 2-3, the actual electricity demand over the years must have been higher than those recorded.

This wide use of self-generation in Nigeria is not reported in the statistics available at the IEA[5] or USEIA. Those statistics are considerably different and contradictory. The IEA, for example, reports much higher natural gas consumption and higher power generation than USEIA. USEIA has listed a significant reduction in natural gas supply since 2010, maybe because of the regional armed conflicts and vandalism, but power supply that depends heavily on natural gas is being restored in the same statistics.



Source: IEA, USEIA (not fully available yet for 2012)

Figure 2-4 Primary Energy Consumption and Power Generation by IEA and USEIA

In addition, both statistics report that petroleum supply has almost leveled off in the past decade. Traffic jams in the Lagos Region, however, are getting worse every year. Though no statistics on road transport are available to demonstrate the trend, significantly rising numbers of passenger cars and trucks[6] [7] have pushed up gasoline and diesel consumption. Despite these observations, petroleum

---

3 Even on Victoria Island, the heart of Lagos, the power shuts off within 30 seconds of a short blow of a siren and self-generators everywhere start to roar. This occurs many times a day, sometimes more than hourly.

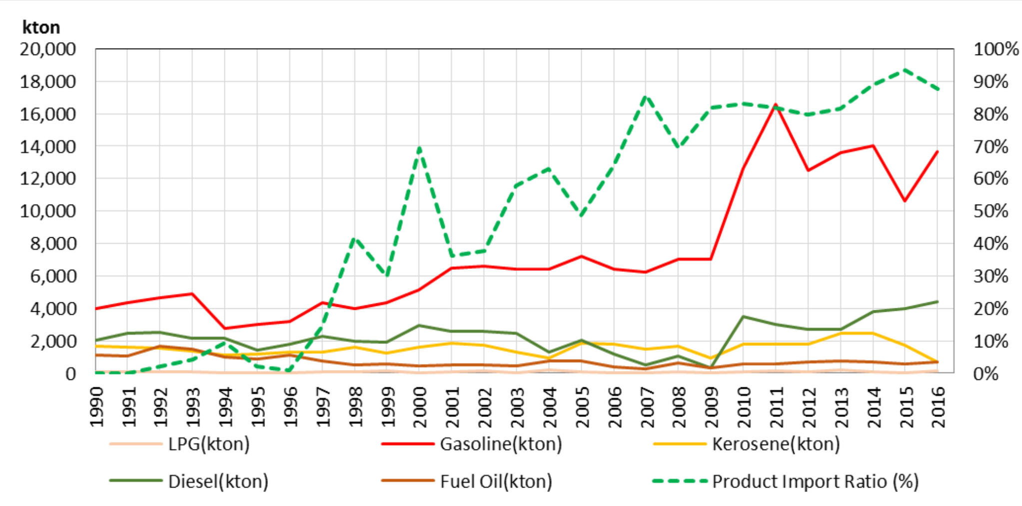
4 Nestle, for example, operates 10MW x 4 generators, and the Sheraton Hotel operates 3MW x 4 generators driven by diesel fuel.

5 IEA's African Energy Outlook discusses the heavy use of back-up generators in Nigeria, though IEA has yet to adjust its statistics to reflect the observation. (IEA World Energy Outlook Special Report 2014)

6 According to Foreign Trade Report, imports of vehicles, aircraft and vessels make up 15-20% of the imports into the country (2008:15.0%, 2009: 19.9%, 2010:21.1%, 2011: 21.1%, 2012: 19.8%, 2013: 10.2%), meaning that motor vehicles have steadily increased. The Minister of Industry, Trade and Investment, Mr. Olusegun Aganga, stated in 2013 that the potential vehicle market in Nigeria was about one million vehicles a year. Nigeria Trade Hub News. http://www.nigeriatradehub.gov.ng/News/tabid/98/entryid/83/fg-raises-tariff-on-imported-cars.aspx

7 According to a household survey conducted in 2015 (NBS, "General Household Survey Panel 2015/2016"), car ownership was 11.9% as a

consumption in the IEA statistics shows stagnant trends for every product. Despite high economic growth of around annual 6% in the decade leading up to 2016, gasoline consumption increased by only 9% in the same period, while diesel gas oil increased by 27% and kerosene surprisingly decreased by 8%, for an overall increase in total petroleum product consumption of only 10%. Total petroleum product consumption sharply fell in the years 2003, 2006, 2007, and 2009. This is contradictory to other statistics, such as the 53% increase in container port traffic (TEU: 20 foot equivalent units) between 2008 and 2012[8], a move suggestive of a significant increase in diesel consumption by trailer-trucks. While a significant portion of petroleum products is supplied via import (87.8% in 2016), we suspect, from these observations, that a substantial amount of petroleum product consumption goes unreported, or even that missing or illegally smuggled petroleum products account for a large portion of those consumed.



Source: IEA

Figure 2-5 Petroleum Product Consumption in Nigeria

According to the household survey of 2015/2016 by NBS, 60.1% of households bought kerosene for cooking and lighting, 32.7% bought electricity for the same purposes and 27.8% bought petrol (gasoline). Their monthly mean expenditures were N5,878 for kerosene, N7,080 for electricity and N11,710 for petrol (see Table 2-3).

If we assume retail prices for kerosene and petrol at N50 and N97 per liter as set out by the government[9], a standard household purchased 118 liters of kerosene and 121 liters of petrol a month. There were about 33 million households in Nigeria (186 million /5.6 person) in 2016. Multiplying this with the occurrence ratio and the average monthly purchase amount, kerosene and gasoline consumption may have stood at 28 million kl and gasoline 13 million kl, respectively. The IEA statistics for 2015, meanwhile, report a middle distillate (kerosene plus diesel) consumption of 5.7 million tons (6.4 million kl) and gasoline consumption of 10 million tons (12 million kl). The

national average and 16.9% in the South West Region. This represents a more than fivefold increase from the 3.1% level reported in UN statistics for 2007.

8 World Bank: World Development Indicators, http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS

9 Gasoline and kerosene are heavily subsidized in Nigeria. The government subsidizes 32% of the delivered cost for gasoline and 66% for kerosene, as their retail prices are regulated by Petroleum Products Pricing Regulatory Agency (PPPRA). http://pppra.gov.ng/

discrepancy is very big. At any rate, the stagnant trends of petroleum product consumption shown in Figure 2-5 look rather unnatural, as the Nigerian economy recorded high economic growth during the past decade. Watching the daily life of Nigerians, the household survey figures look more reasonable.[10]

Table 2-3 Household Expenditure for Fuel

	North Central	North East	North West	South East	South South	South West	Urban	Rural	Nigeria
(Household Reporting Expenditure)	%	%	%	%	%	%	%	%	%
Kerosene	42.4	16.0	23.6	92.5	83.3	84.4	77.1	48.2	60.1
Palm Kernel Oil	11.0	3.1	6.0	1.9	6.1	1.2	3.6	5.3	4.6
Gas (for lighting/cooking)	1.8	0.2	0.1	4.0	9.3	10.7	10.2	1.4	5.1
Other liquid cooking fuel	0.3	0.0	0.1	0.2	0.3	0.1	0.3	0.1	0.2
Electricity, including electricity vouchers	27.2	9.2	14.0	45.5	34.9	51.9	53.6	18.0	32.7
Candle	1.3	1.0	1.9	4.0	7.8	1.9	4.2	2.1	3.0
Firewood	16.1	32.1	48.5	5.5	12.9	7.8	21.7	19.3	20.3
Charcoal	9.3	5.2	1.9	0.3	0.6	2.7	5.5	1.3	3.0
Petrol	30.8	24.3	19.8	24.0	31.2	34.2	33.7	23.7	27.8
Diesel	1.2	1.1	0.6	0.8	1.1	1.3	0.8	1.2	1.0
(Mean Expenditure)	Naira /month	Naira /month	Naira /month	Naira /month	Naira /month	Naira /month	Naira /month	Naira /month	Naira /month
Kerosene	3,874	1,158	1,511	8,334	8,851	9,178	9,249	3,510	5,878
Palm Kernel Oil	1,917	160	408	64	499	174	439	539	498
Gas (for lighting/cooking)	539	22	17	1,671	4,712	3,013	3,448	697	1,832
Other liquid cooking fuel	36	0	3	7	62	21	42	8	22
Electricity, including electricity vouchers	6,023	2,458	2,615	8,889	9,246	10,787	12,692	3,140	7,080
Candle	22	38	86	85	114	72	116	43	73
Firewood	2,158	5,812	6,426	549	1,581	713	3,057	2,492	2,725
Charcoal	966	820	200	18	59	292	608	157	343
Petrol	13,519	8,428	6,977	8,860	16,706	14,355	16,735	8,181	11,710
Diesel	593	598	116	250	427	1,825	1,072	488	729

Source: NBS, "General Household Survey Panel 2015/2016"

The same survey reports that 44.8% of households use electricity as a source of lighting, while more households rely on kerosene for the same purpose. Electrification is most advanced in the South West region, but 36.3% of households still relied upon other sources in 2015.

Table 2-4 Source of Lighting

Region	Collected Firewood	Purchased Firewood	Grass	Kerosene	Electricity	Gas	Battery/ Dry Cell	Candles	Other
	%	%	%	%	%	%	%	%	%
North Central	4.9	1.1	0.1	9.1	35.9	0.0	41.4	1.5	0.2
North East	5.4	2.0	0.2	8.5	19.5	0.0	61.4	0.3	0.0
North West	10.1	2.8	0.3	8.6	25.4	0.2	49.4	0.4	0.9
South East	2.1	0.8	0.0	36.3	54.1	0.0	2.7	0.4	0.3
South South	2.2	0.3	0.0	21.3	54.4	0.3	7.1	0.7	4.2
South West	0.9	1.0	0.0	16.0	63.7	0.3	12.4	0.5	0.5
Urban	1.2	1.2	0.1	9.7	72.9	0.3	9.1	0.5	0.2
Rural	6.2	1.4	0.1	21.2	25.6	0.1	38.5	0.7	1.6
Nigeria	4.1	1.3	0.1	16.6	44.8	0.2	26.6	0.6	1.1

Source: NBS, "General Household Survey Panel 2015/2016"

Among the people who used electricity, 95.9% obtained power supply from the PHCN national grid (see Table 2-5) even though most of them experienced severe daily blackouts. While the people who

[10] An officer of an electric company in Lagos, for example, reports consumption of about 350 liters of gasoline a month: 100 liters for a home generator and 250 liters for driving.

rely solely on self-generation are limited in numbers, most people own generators to prepare for power cuts. Though many people have stopped complaining of the trend, the running hours of generators has been getting longer.

Table 2-5 Electricity Sources and the Frequency of Blackouts

Region	Source of Electricity		Frequency of Blackout				
	PHCN	Rural Electrification	Never	Everyday	Several Times a Week	Several Times a Month	Several Times a Year
	%	%	%	%	%	%	%
North Central	98.1	1.9	1.6	64.6	24.2	6.6	3.0
North East	98.7	1.3	4.5	56.3	18.6	5.8	14.8
North West	91.6	8.4	5.7	43.4	35.9	11.3	3.8
South East	96.1	3.9	0.3	38.9	35.6	15.4	9.8
South South	91.5	8.5	1.8	42.8	29.9	19.7	5.7
South West	99.7	0.3	6.2	56.9	28.3	5.4	3.1
Urban	98.7	1.3	4.6	55.4	28.9	8.1	3.0
Rural	92.0	8.0	2.2	41.4	31.8	15.6	9.0
Nigeria	95.9	4.1	3.6	49.6	30.1	11.2	5.5

Source: NBS, "General Household Survey Panel 2015/2016"

In this context, though power generation in Nigeria increased 75% in the last decade (2001 to 2011), as shown in Figure 2-4, actual power generation, including self-generated power, may have increased much more. Nigeria is an oil country: everything is run by oil. The publicly available energy consumption statistics are heavily skewed and must be reassessed before we forecast the future. We will try a reassessment in the next section.

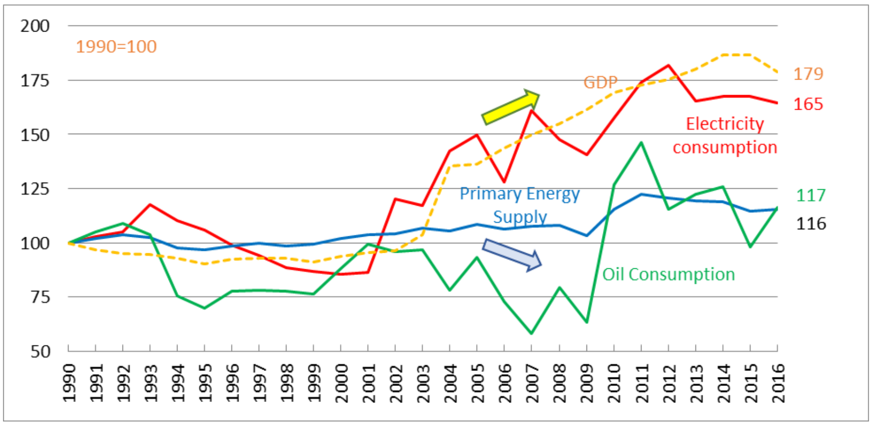
2-3-2 Reassessment of Energy and Electricity Consumption

In forecasting electricity demand in Nigeria, the greatest problem is defining the whole electricity demand, something that has not materialized in the current environment of power supply shortages. In 2009, the Power Holding Company of Nigeria (PHCN) and Tractabel Engineering conducted a thorough study on the suppressed electricity demand, including a detailed survey on the load demand at the feeder level.[11] This survey, however, neglected to consider that self-generation at home and office is quite common in this country. In this study we will reassess electricity demand with a focus on this aspect.

Affected by strong population growth, energy statistics for developing countries sometimes appear illusive. The erroneous feature of the Nigerian energy statistics discussed above becomes more apparent when we compare the history of energy consumption and GDP on a per capita basis. As shown in Figure 2-6, the per capita GDP increased 1.79-fold between 1990 and 2016 in Nigeria, while the per capita energy consumption increased by far less. Per capita electricity consumption increased 1.65-fold over the same period, while the per capita oil consumption decreased 1.17-fold, resulting in only a 1.16-fold increase in the per capita total primary energy supply, according to the IEA

[11] The Power holding Company of Nigeria, Tractable Engineering, Omega Systems, "National Load Demand Study – National Energy Development Project," April, 2009.

statistics.[12] This seems quite contradictory to the reality: the numbers of motor vehicles and power generators have apparently increased together with penetration of modern home and business appliances, according to a recent household survey.[13] With these puzzling statistics, an econometric analysis on these data cannot be expected to furnish any meaningful results.[14]



Source: IEA

Figure 2-6 Per Capita Energy Consumption and GDP

Statistics on natural gas and electricity may be close to the reality, as both are supplied only by pipelines and transmission lines and are measured only by a limited number of big suppliers. Various supply constraints, however, have prevented the suppliers from fully responding to the demand. The energy supply deficit may thus have been made up for with another energy source. The only such option with a flexible supply ability is oil. Oil must have been supplied at much higher levels than are reflected in the statistics.

Energy consumption generally grows in line with income growth. This is especially so when an economy is growing fast. As shown in Table 2-6 developing countries have recorded high energy demand elasticity over GDP (on per capita basis) during the past two decades up to 2012. Primary energy supply, excluding traditional biomass and waste, recorded elasticity over real-term GDP exceeding 1.0 (on a per capita basis) in many developing countries. Petroleum product consumption was slightly lower.

---

[12] IEA Energy Balances of Non-OECD Countries 2014

[13] Motor car ownership of 10.3% in 2010 reported by the Household Survey suggests that the total number of motor vehicles in Nigeria stands at about 3 million units. (National Bureau of Statistics, ”General Household Panel Survey Wave 2012/13”). If the annual sales amount is one million units, as stated by the Minister for Industry and Trade, motor vehicles are increasing at an annual growth rate of 33%.

[14] We can consider a typical demand model of $Ln\ Y_t = aLnY_{t-1}+b\ Ln\ GDP_t - c\ Ln\ Price_t+d$, where (1-a) is an adjustment period, b is a short-term income elasticity, and c is a short-term price effect. The outcome of a regression analysis for 1993-2011 is as follows:

Per capita oil consumption, where X1 is per capita income and X2 is the oil price (t-value):

$$Ln\ Y_t= 1.3582(1.06)+.80245(5.28)*Ln\ Y_{t-1}+ .079604(-.359)*Ln\ X_{1t}-.0051807(-.0534)*Ln\ NX_{2t} \quad R=0.673$$

Per capita electricity consumption:

$$Ln\ Y_t=-1.7646(-2.07)+.62966(4.42)*Ln\ Y_{t-1}+.41354(2.24)*Ln\ X_{1t}-.037048(-.554)*Ln\ X_{2t} \quad R=0.933$$

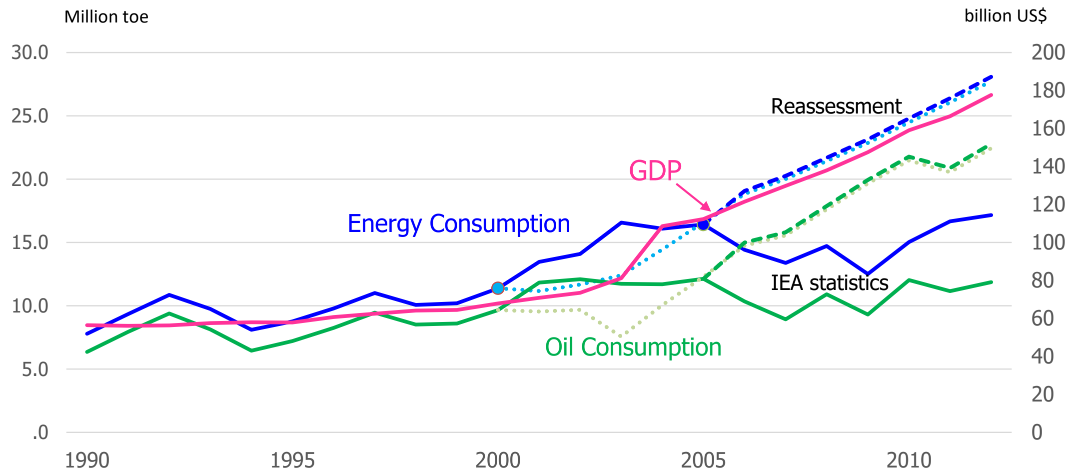
For oil, however, the above equation gives a very low income elasticity of merely 8% and shows a decreasing trend in future projections. This unacceptable in view of the fast increases in vehicle ownership in Nigeria.

Table 2-6 GDP Elasticity of Primary Energy and Oil Product Consumption on a Per Capita Basis 1990 - 2012

	Nigeria	Vietnam	Indonesia	Thailand	Malaysia	China	India	Egypt	World	Non-OECD	Asia, excluding China
Primary Energy	0.06	1.65	1.02	1.55	1.16	0.6	0.82	0.94	0.3	0.52	0.88
Oil Products	-0.64	1.47	0.71	1.11	0.59	0.59	0.69	0.15	-0.05	0.27	0.64

Source: IEA, Primary energy supply without traditional biomass and waste

In view of these examples, we may modestly assume an energy elasticity over GDP for Nigeria in the range from 0.8 to 1.2 over the past decade. The economy, meanwhile, grew at a fairly high annual rate of 8.3% between 2000 and 2012 on a real term PPP basis. If we apply this hypothesis from 2005 when the questionable movement of energy consumption starts, then, as shown in Figure 2-7, the primary energy consumption in Nigeria in 2012 may have been 28.1 million tonnes oil equivalent (toe) rather than 17.2 million toe, the level reported in the IEA statistics. As discussed above, the balance may have been supplied by oil products. Oil consumption in 2012 may thus have been 22.8 million toe instead of 17.9 million toe. If the base year is replaced to 2000, the reassessed amount of energy consumption stays almost the same from 2005 onward, with primary energy consumption and oil consumption for 2012 estimated to reach 27.7 million toe and 22.4 million toe, respectively.



Note: The reassessment is made assuming the elasticity of energy consumption over GDP on per capita basis at 1.0 and the balance is supplied by oil products. Three year moving average is used to mitigate yearly fluctuation.

Source: JICA Study Team

Figure 2-7 Reassessment of Energy Consumption

Another notable fact in Nigeria is the high popularity of self-generation. Small households, factories and shops use small, gasoline-driven generators; bigger hotels, buildings, and factories use high-power generators driven by diesel gas oil or natural gas. A significant portion of oil products are thus being consumed for self-power generation.

2-3-3 Methodologies for Power Demand Forecasts

The past power consumption trends and current situation should be analyzed to forecast the future power demand of Nigeria, and the structural factors of the forecasts should be identified. If we assume that the power demand is reflected by changes in social and economic activities, the structures of the power demand model should be designed to enable analysis of those changes.

Sector-wise power energy demands are forecasted by the model. Next, the peak demand and power generation are calculated, and the power demands are then forecasted for each distribution company (DisCo). A power demand flow chart is presented in Figure 2-8.

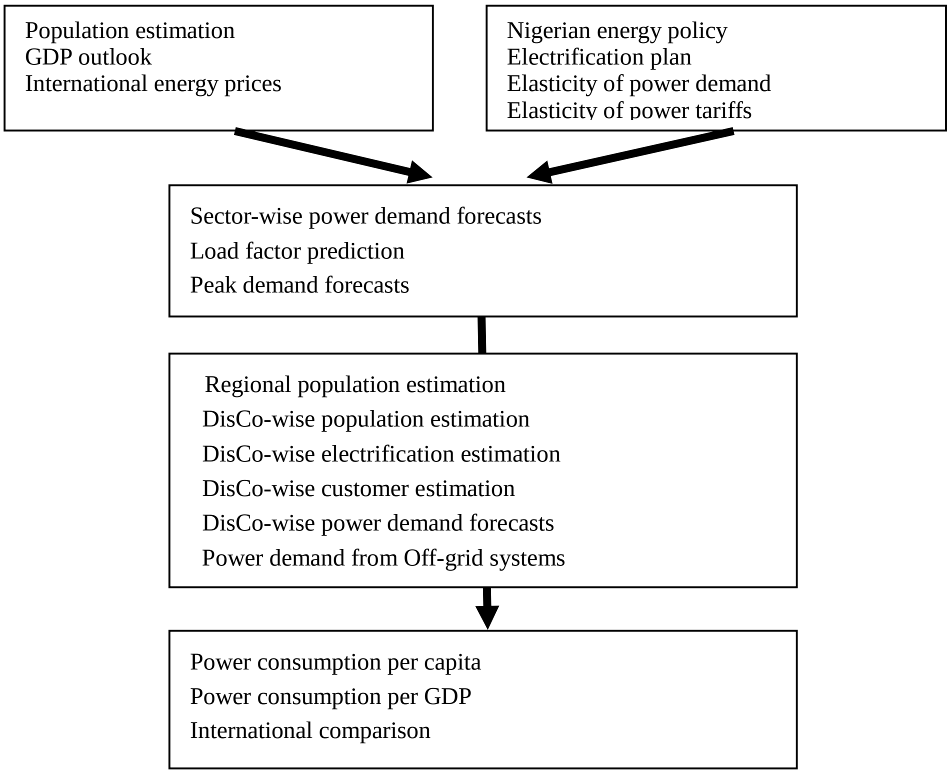


Figure 2-8 Power Demand Forecast Flow

The power demand model is built up in line with the previous flow. The model procedures are as follows:

- The future socioeconomic activities are decided after evaluating the existing socioeconomic strategies, power development plans, and policies.
- The power demand and supply balance is made in line with the definition of balance applied by the International Energy Agency (IEA). Regarding sectoral power demand, additional sectoral power demands of Nigeria are added to the IEA sector definitions such as Agriculture, Industry, Commercial, and Residential.
- Regarding the technology for model building, econometric methods are used. "Simple.E," a Microsoft Excel add-in, is used as the application software for model building.

2-3-4 Structural Factors of the Power Demand Forecasts

(1) Current State of Power Demand

Nigeria faces a chronic power shortage. According to Statistic Year Books of the Federal Ministry of Power, Works and Housing (FMPWH), the main reasons for the shortage are low operation loads of hydropower plants and poor maintenance of power stations of every kind. When calculating the growth rates of domestic power demands at send-out (power energy base) using TCN (Transmission Company of Nigeria) data in the below table, the average growth rates were 4.4% from 2005 to 2014 (nine year period) and 10.2% from 2010 to 2014 (four year period). The power demand elasticity to GDP in developing countries generally falls in the range of 1.2 - 1.5. Given the Nigerian average GDP growth rate of 6.9% from 2005 to 2014, the Nigerian power demand is expected to range from 8 to 10% per year under the current economic conditions.

The actual power consumption data on developing countries sometimes fails to show the size of the power demand. Rather, the real power demand is shown by "Actual power demand + α" or put in other words, the actual power demand is insufficient to fill the power demand on all days (24 hours) because of shortfalls in the power capacity and fuel energies. The distribution companies implement chronic planned outages (shedding) in the result of the power shortage. The comparatively big factories and commercial facilities therefore have their own power generators.

The power demand forecasts in this project are implemented with "computed data," that is, power demand data without constraints. At first, the past computed data are calculated and future power demand is forecast under the computed data. In the formulas used for the "without-constraint data" are called "Computed data" and the actual data (with-constraint data) are called "recorded data." The difference between the computed data and recorded data can be considered "Shedding." And the shedding should be reduced to zero in the future. The current recorded data, computed data, and shedding data are shown in Table 2-7.

Table 2-7 Actual Power Demand in Nigeria

Unit: GWh

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Recorded total	24,077	23,300	23,187	21,309	20,870	25,020	25,020	29,573	29,628	30,126	31,515
Computed total	24,577	23,800	23,387	24,509	26,370	30,420	30,720	36,373	43,428	45,926	47,315
Shedding total	500	500	200	3,200	5,500	5,400	5,700	6,800	13,800	15,800	15,800

Note: "Recorded data" are the actual data of TCN
Computed data is taken from "National Load Demand Supply in 2009"by TCN and Tractabel Engineering (consultant)
Shedding is defined as "computed data – recorded data."

Source: "Annual Technical Report 2015" and "Analysis of National Load Demand Supply in 2009"

(2) Current Peak Demand

Table 2-8 and Table 2-9 show the results of an analysis of the peak times and peak seasons in the "Analysis of Nigeria's National Electricity Demand Forecast," a study published by staff members and professors from Nigerian Universities in 2014.

Table 2-8 Daily Load Demand

Time	Demand	Reasons
00-05	Low	Low power demand in the residential and commercial sectors
05-08	High	High power demand in the residential sector
08-18	Low	Low power demand because many people are working outside of their houses.
18-24	High	High power demand in the residential sector

Source: "Analysis of Nigeria's National Electricity Demand Forecast"

Table 2-9 Annual load demand

Months	Load	Reasons
Jan- April	High load	High-temperature, low-humidity months
Jun-Sep	Low load	Low power demand months

Source: "Analysis of Nigeria National Electricity Demand Forecast"

The annual peak demands (MW) from 2005 to 2015 in the computed data and recorded data are shown in Table 2-10. The peak demand in the computed data was 7,060MW in 2015. In contrast, the actual power supply at the peak time (recorded data) was 4,880MW. In the recorded peak demand, off-grid power demand in the regional area is excluded.

Table 2-10 Peak Demand of Computed Data and Recorded Data (Actual and Estimated Values)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Recorded peak	3,774	3,682	3,600	3,597	3,710	3,804	4,089	4,518	4,458	4,390	4,880
Computed peak	3,849	3,757	3,630	4,090	4,564	4,647	4,975	5,559	6,532	6,765	7,060
Shedding total	75	75	30	493	854	843	886	1,041	2,074	2,375	2,180
Load factor (%)	73%	72%	74%	68%	64%	75%	70%	75%	76%	78%	74%

Source: "Annual Technical Report 2015" and "Analysis of National Load Demand Supply in 2009"

(3) Off-grid Demand

Table 2-11 shows the capacities of renewable energies such as solar power and small hydro according to the "National Renewable Energy and Energy Efficiency Policy 2015" published by FMPWH. While we cannot assume that the total capacities shown in Table 2-11 are used for Off-grid power sources, we can imagine that most of them are used for regional Off-grids and independent power sources in individual houses.

The operation loads of renewable energy equipment are generally lower than those for fossil fuel power plants. The operation loads of solar power and small hydro are around 20% and 50%, respectively. Herein, when setting the average load of the above renewable energy equipment at 30%, the estimated power generation totals 267GWh in 2014. As the computed demand in the same year was 45,000 GWh (TCN + Auto producers + Off grid), the Off-grid power demand share to the total computed power demand was only 0.6% in 2014. This can be considered a very small share in the current situation.

Table 2-11 Off-grid Capacity and Power Energy Demand

Items	Unit	2010	2011	2012	2013	2014
Energy demand (Off grid)	GWh	131	158	184	197	267
Power demand (Off grid)	MW	15	18	21	23	30
Capacity (Off grid)	MW	50	60	70	75	102
Installed capacity	MW	50	60	70	75	102
Computed demand (On + Off grid)	GWh	29,783	34,416	38,626	42,096	44,919
Share of Off grid	%	0.4%	0.5%	0.5%	0.5%	0.6%

Source: National Renewable Energy and Energy Efficiency Policy 2015 by FMPWH

(4) Power Export

According to the "MYTO II MODEL" edited by NERC and TCN, the share of Nigerian power exports in the computed data (TCN + Auto producers + Off grid + Export) after 2013 and 2014 was around 5%, as shown in Table 2-12. The exports are sent to neighboring countries in accordance with political considerations of the Nigerian government.

Table 2-12 Power Exports

Items	Unit	2010	2011	2012	2013	2014
Power export	GWh	967	967	1,538	2,094	2,217
Average power export	MW	110	110	180	240	250
Power export at peak time	MW	157	157	257	343	375
Computed demand (On+Off grid＋export)	GWh	30,750	35,383	40,164	44,190	47,136
Share of Export	%	3%	3%	4%	5%	5%

Source: NERC and TCN

(5) Transmission Loss Rate (T- loss)

Table 2-13 shows the total power demand and T-loss of computed data and recorded data. Looking at the T-loss rate trend, the values become smaller after 2007. This is because the distribution loss is neglected.

Table 2-13 T- loss and T- loss Rate

	T- loss (A)		Total demand (B)		T- loss rate ((A)/(B)	
	Recorded data	Computed data	Recorded data	Computed data	Recorded data	Computed data
	GWh	GWh	GWh	GWh	%	%
2005	4,914	5,017	22,873	23,355	21.5	21.5
2006	6,194	6,328	22,123	22,601	28.0	28.0
2007	1,699	1,714	22,027	22,220	7.7	7.7
2008	1,123	1,297	20,244	23,397	5.5	5.5
2009	1,232	1,571	19,849	25,310	6.2	6.2
2010	2,145	2,632	23,769	29,163	9.0	9.0
2011	1,854	2,259	26,307	32,046	7.0	7.0
2012	1,873	2,329	28,094	35,008	6.7	6.7
2013	1,802	2,793	28,147	41,958	6.4	6.7
2014	1,814	2,956	28,620	44,431	6.3	6.7
2015	3,187	-	30,911	-	10.3	-

Source: “Annual Technical Report 2015” and “Analysis of National Load Demand Supply in 2009”

(6) Load Factor

The load factor is calculated by the following expression using the actual peak demand (MW) and net power demand (GWh) as variables. Regarding the future load factor, the targeted load factor of 70% shown in the MYTO II Model is used for the power demand forecasts.

Load Factor = Net power demand (GWh)*1000 / (24hours*365days) / Peak demand (MW)*100

Table 2-14 Load Factor Forecasts

Year (2001-2010)		Year (2011-2020)		Year (2021-2030)		Year (2031-2040)	
Year	%	Year	%	Year	%	Year	%
2001	68.6	2011	69.8	2021	70.0	2031	70.0
2002	76.3	2012	74.7	2022	70.0	2032	70.0
2003	74.2	2013	75.9	2023	70.0	2033	70.0
2004	80.4	2014	78.3	2024	70.0	2034	70.0
2005	72.8	2015	73.7	2025	70.0	2035	70.0
2006	72.2	2016	72.5	2026	70.0	2036	70.0
2007	73.5	2017	72.0	2027	70.0	2037	70.0
2008	67.6	2018	71.5	2028	70.0	2038	70.0
2009	64.2	2019	71.0	2029	70.0	2039	70.0
2010	75.1	2020	70.0	2030	70.0	2040	70.0

Source: "Annual Technical Report 2015," "Analysis of National Load demand Forecasts in 2009," and "MYTOIIModel sheet"

2-3-5 Preconditions of Social and Economic Predictions

(1) Population Growth Rate

According to the censuses implemented by NBS in 1991 and 2006, the population grew at a rate of 3.07% during the term covered (2.9% in 2006). As the figures show, the population growth rate will gradually decrease in the future. The rate in 2030 is forecasted to decline to 2.2% in "World Population Prospects: The 2017 Revision" in the UN Population Study.

Table 2-15 Future Population Forecasts by the UN Population Study

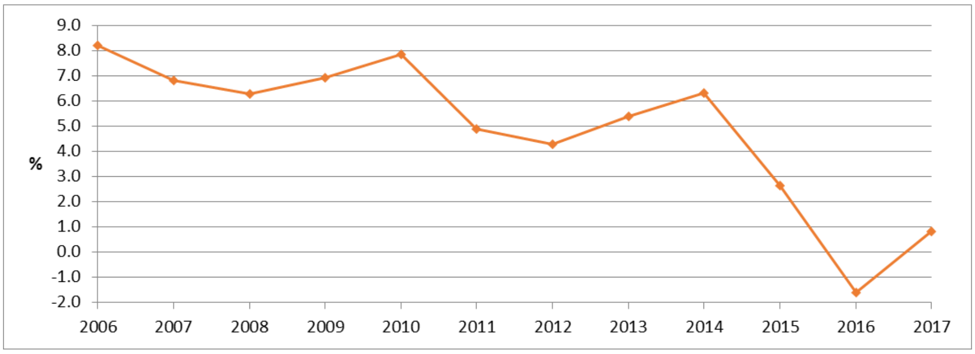
	Country	Urban	Rural share	Urban share	Rural share	Country growth rate	Urban growth rate	Rural growth rate
	1000psn	1000psn	1000psn	%	%	%	%	%
2010	158,578	68,950	89,628	43.5	56.5	2.6	4.8	1.1
2015	181,182	86,673	94,509	47.8	52.2	2.7	4.6	1.1
2020	206,153	107,113	99,040	52.0	48.0	2.6	4.2	0.9
2025	233,348	130,312	103,036	55.8	44.2	2.5	3.9	0.9
2030	264,068	156,300	107,768	59.2	40.8	2.2	3.6	0.8

Source: United Nations, "World Population Prospects: The 2017 Revision," June 2017

According to the data of middle income countries and developing countries, the population growth rate will decline in countries with rising per capita income. The National Bureau of Statistics reported a population growth rate of 2.7% in Nigeria from its 2006 census, a figure that supports the assumption of a 2.8% growth rate in 2015. There is also a possibility that the future population growth rate will decrease to 2.0% over the long term. The low population growth rate of 1.8% in Nigeria's 1991 census is explainable. The government recently advises the population that it is better for a woman to have 4 children (not a mandate, just advice). As a consequence, the future population growth rate is expected to decrease over the long term. Table 2-15 shows the population forecasts made by the JICA Study Team by referring to the growth rates forecasted by the UN population Study.

(2) GDP Growth Rate

As Figure 2-9 shows, the average GDP growth rate was 7.2% per year from 2006 to 2010 and 4.7% per year from 2011 to 2014. Though the rate decreased to -1.6% in 2016, it turned positive in 2017.



Source: JICA Study Team

Figure 2-9 GDP Growth Rate Trends from 2006 to 2017

Table 2-16 shows the several projected GDP growth rates from the "Economic Recovery and Growth Plan," "GDP outlook from 2015 to 2020" published by the Ministry of Budget and National Planning (FMBNP), The "Nigeria Economic Outlook 2015" published by AfDB, and the "Regional Economic Outlook April 2015" published by the International Monetary Fund (IMF).

Table 2-16 GDP Outlook from Nigeria and International Organizations

Documents	Organizations	GDP growth rates	Period
Economic Recovery and Growth Plan 2017-2020	Nigeria Gov.	4.62% per year	2017 - 2020
GDP Outlook from 2015 to 2020	FMBNP	5% - 6% per year	2015 - 2020
Nigeria Economic Outlook 2015	AfDB	7%/per year including oil sector	2015 - 2020
Regional Economic Outlook April 2015	IMF	6 % /per year excluding oil sector	2015 - 2020

Source: Same organizations shown in the table

By referring to the current GDP growth rate and the outlooks of the above organizations, the GDP growth rates used in the power demand forecasting model are set as shown in Table 2-17.

- In the Base case, the GDP growth rates per year are 5.0% from 2015 to 2020, 6.0% from 2020 to 2025, and 6.5% from 2025 to 2030. The GDP growth rates in this case include the oil and gas sector. Two kinds of GDP are published in Nigeria, one excluding the oil and gas sector and another including it. GDP statistics including the oil and gas sector are used in the model.
- The annual growth rates per year in the High case are higher than those in the Base case, at 6.8% from 2015 to 2020 and 8.0% from 2020 to 2030.
- In the Low case, the current GDP growth rate is predicted to continue in the future. Under this condition, manufacturing and commercial sectors cannot expect significantly higher growth rates in the years ahead. Table 2-17 shows the future real GDP growth rate of each case. The

elasticity between the sectoral GDP growth rates and country-wide GDP growth rate are shown in Table 2-18.

Table 2-17 Real GDP Growth Rate of Each Case

	2015-2020	2020-2025	2025-2030
High case	6.8%	8.0%	8.0%
Base case	5.0 %	6.0 %	6.5 %
Low case	4.7%	5.0%	5.0%

Source: JICA Study Team

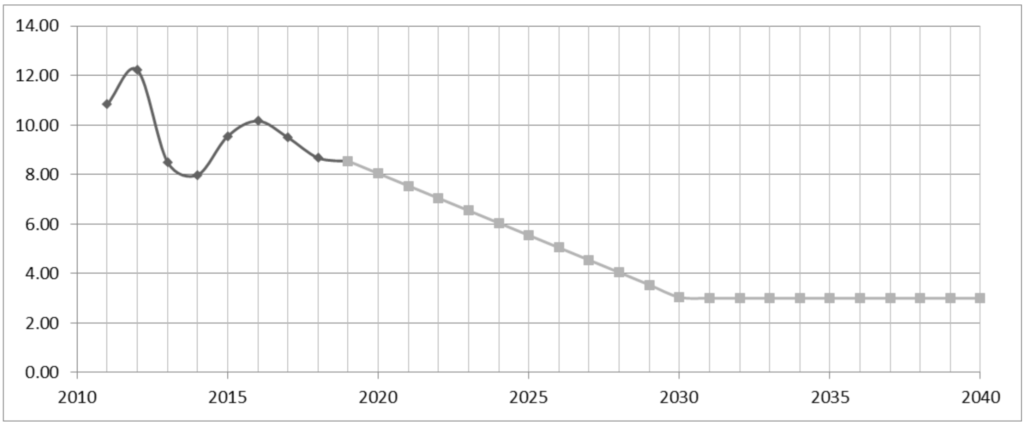
Table 2-18 Elasticity between Sectoral GDPs and Country GDPs

Sector	2020		2030	
	Elasticity	GDP G.R.	Elasticity	GDP G.R.
Agriculture	0.60	3.6%	0.60	3.9%
Industry	1.10	6.6%	1.10	7.2%
Manufacturing	1.20	7.2%	1.20	7.8%
Oil and gas	0.90	5.4%	0.70	4.6%
Commercial & Services	1.20	7.2%	1.15	7.5%
GDP growth rate	1.00	6.0%	1.00	6.5%

Note: Country GDP growth rates in the table are calculated at 6.0 % in 2020 and 6.5% in 2030
Source: JICA Study Team

(3) Inflation Rate

Under a stable inflation rate (2% to 3%), the country's economy is generally expected to actively grow due to rising domestic savings. Under high inflation conditions, however, high GDP growth would be difficult to achieve. The inflation trend after the year 2011 is shown in Figure 2-10. Nigeria had inflation of over 10% per year from 2010 to 2015, but the inflation rates have been stable since 2016 (Table 2-19). Going forward, inflation rates in Nigeria are expected to stand at around 6.5% per year from 2021 to 2025, and around 3% per year after 2030. The power demand forecasting model forecasts the power demands under real economic indicators. The energy prices and power tariffs in Nigeria in 2015 are assumed to be the real prices. And long-term nominal prices are defined by the "Real price *(multiply) Inflation rate."



Source: Actual data from NBS statistics、Forecasted values are estimated by JICA Study Team

Figure 2-10 Inflation Rate Trends

Table 2-19 Average Inflation Rate

Period	2011-15	2015-20	2020-25	2025-30	2030-35	2035-40
Inflation rate	9.82%	9.00%	6.50%	4.00%	3.00%	3.00%

Source: Actual data from NBS statistics、The forecasted values are estimated by JICA Study Team

(4) Foreign Exchange Rate

The volatility of foreign exchange rates affects the domestic investment and inflation rate. When accounting for the recent volatility of the US dollar and Euro, the Nigerian currency NGN (Nigerian Naira) cannot be seen to be drastically devaluated against those currencies. The following equation is used to calculate the NGN-per-US-dollar rate (the variable Nt in the equation) from 2019 to 2030. The NGN moves in proportion with the difference between US inflation and Nigeria inflation.

Nt = Nt-1 * (1 + (Nigeria inflation rate - US inflation rate))

Table 2-20 shows the estimated results of the NGN-to-US-dollar exchange rate.

Table 2-20 Foreign Exchange Rate Forecasts

Years	Exchange rate (NGN/USD)	Changes (%)	Nigeria Inflation (%)	USA Inflation (%)
2018	357	6.7	8.7	2.0
2019	380	6.5	8.5	2.0
2020	403	6.0	8.0	2.0
2021	426	5.5	7.5	2.0
2022	447	5.0	7.0	2.0
2023	467	4.5	6.5	2.0
2024	486	4.0	6.0	2.0
2025	504	3.5	5.5	2.0
2026	519	3.0	5.0	2.0
2027	532	2.5	4.5	2.0
2028	543	2.0	4.0	2.0
2029	551	1.5	3.5	2.0
2030	557	1.0	3.0	2.0

Source: JICA Study Team

(5) Crude Oil Price

As of February 2016, WTI (West Texas Intermediate) in the New York market stated within a range of $30/bbl. to $35/bbl. Crude oil exporting countries like Saudi Arabia expected that crude oil price should be increased to compensate for the benefits from the US dollar devaluation (equal to the US inflation rate at around 2%). According to oil market information, with the supply of shale oil & gas to the recent energy market, the near-future crude oil price is forecasted to stay at the current level or to decrease by 2020 and thereafter to gradually increase again. Based on the conditions in the international oil market, the WTI price is predicted to stand at the levels shown in Table 2-21.

Table 2-21 West Texas Intermediate (WTI) Crude Oil Price

	WTI		USA inflation			WTI		USA inflation	
	US$/bbl.	%	2015=100	%		US$/bbl.	%	2015=100	%
2015	49	-47.8	100.0	2.0	2023	86	2.3	117.2	2.0
2016	43	-11.0	102.0	2.0	2024	88	2.3	119.5	2.0
2017	51	17.2	104.0	2.0	2025	90	2.2	121.9	2.0
2018	60	20.0	106.1	2.0	2026	92	2.2	124.3	2.0
2019	70	16.7	108.2	2.0	2027	94	2.1	126.8	2.0
2020	80	14.2	110.4	2.0	2028	96	2.1	129.4	2.0
2021	82	2.4	112.6	2.0	2029	98	2.0	131.9	2.0
2022	84	2.4	114.9	2.0	2030	100	2.0	134.6	2.0

Note: The 2015 price is set as the base price. The Brent oil price is nearly the same as the WTI price.
Source: Actual data from BP statistics. Recent data from The Institute of Energy Economics, Japan

(6) Power Tariffs

The standardized power tariff system in the country is defined in "Multi Year Tariff Order (MYTO)" by the Nigerian Electricity Regulatory Commission (NERC). DISCO-wise and sector-wise category power tariff systems are prepared in "Multi Year Tariff Order (MYTO) 2015 - 2018." One of them is a fixed tariff system and the other is a metering system. Regarding the power tariffs after 2015, "MYTO - 2015 Distribution Tariffs (2015 - 2024)" forecasts the power tariffs up to 2024 (see Table 2-22).

Table 2-22 Power Tariff Forecasts (Abuja Distribution Company)

NGN/kWh

	Average	Domestic	Commercial	Industry	LNG	Street lights
2008	8.00	6.00	8.50	8.50	5.70	6.50
2009	9.00	6.60	9.70	10.30	6.90	5.90
2010	11.00	8.90	12.30	12.90	8.60	6.80
2011	13.00	11.00	14.50	15.20	11.20	8.60
2012	15.00	11.70	21.03	22.04	16.24	12.47
2013	16.00	12.62	21.03	22.04	16.24	13.41
2014	17.00	13.25	22.08	23.14	17.05	14.08
2015	18.00	14.70	29.98	31.43	17.10	19.11
2016	17.76	24.30	46.23	46.23	25.43	26.84
2017	27.24	24.30	47.09	47.09	25.90	27.14
2018	27.65	24.03	45.72	45.72	25.15	26.54
2019	26.94	20.40	38.82	38.82	21.35	22.53
2020	22.88	19.69	37.46	37.46	20.60	21.75
2021	22.34	20.08	37.83	37.83	20.81	21.97
2022	22.61	20.49	38.21	38.21	21.02	22.19
2023	22.89	20.90	38.60	38.60	21.23	22.41
2024	23.16	21.31	38.98	38.98	21.44	22.63
2025	23.45	21.74	39.37	39.37	21.65	22.86
2026	23.82	22.17	39.96	39.96	21.98	23.20
2027	24.21	22.62	40.56	40.56	22.31	23.55
2028	24.60	23.07	41.17	41.17	22.64	23.90
2029	24.99	23.53	41.79	41.79	22.98	24.26
2030	25.39	24.00	42.41	42.41	23.33	24.63

Note: The above are not the country average power tariffs but those of the Abuja Distribution Company. The R2, C2, D2, A2, and S1 categories are the Residential tariff, Commercial tariff, Industry tariff, Special tariff, and Streetlight tariff, respectively. The tariffs after 2015 do not include inflation.

Source: The forecasted tariffs from 2015 to 2024 refer to the "MYTO -2015 Distribution Tariffs (2015-2024) Dec 2015." The tariffs after 2025 are estimated by the JICA Study Team

2-3-6 Power Demand Forecast

The summation demand of TCN-and Export becomes the country-wide power demand of Nigeria. The power demand, peak demand, and required capacities for the total domestic power demand and export are shown in Table 2-23.

The power demand by GDP scenario is shown in Table 2-23. The average GDP growth rates are 8.0 % / year in the High case, 6.5% in the Base case, and 5.0% in the Low case. The average peak demand growth rates from 2020 to 2030 are 14.3% / year in the High case, 11.5% / year in the Base case, and 8.7% / year in the Low case.

Table 2-23 Peak Electricity Demand Outlook for Nigeria

	Low Case JICA						Base Case JICA						High Case JICA					
	National						National						National					
	TCN peak demand	Export power demand	Total demand	TCN peak demand	Export power demand	Total demand	TCN peak demand	Export power demand	Total demand	TCN peak demand	Export power demand	Total demand	TCN peak demand	Export power demand	Total demand	TCN peak demand	Export power demand	Total demand
Unit	MW	MW	MW	%	%	%	MW	MW	MW	%	%	%	MW	MW	MW	%	%	%
2020	11,076	387	**11,463**	100%	100%	100%	11,729	387	**12,116**	100%	100%	100%	12,107	387	**12,494**	100%	100%	100%
2021	12,097	-	-	109%	-	-	13,207	-	-	113%	-	-	14,033	-	-	116%	-	-
2022	13,176	-	-	119%	-	-	14,821	-	-	126%	-	-	16,204	-	-	134%	-	-
2023	14,319	-	-	129%	-	-	16,581	-	-	141%	-	-	18,643	-	-	154%	-	-
2024	15,527	-	-	140%	-	-	18,496	-	-	158%	-	-	21,376	-	-	177%	-	-
2025	16,805	1,540	**18,345**	152%	398%	160%	20,574	1,540	**22,114**	175%	398%	183%	24,426	1,540	**25,966**	202%	398%	208%
2026	18,336	-	-	166%	-	-	23,054	-	-	197%	-	-	28,099	-	-	232%	-	-
2027	19,893	-	-	180%	-	-	25,670	-	-	219%	-	-	32,091	-	-	265%	-	-
2028	21,480	-	-	194%	-	-	28,423	-	-	242%	-	-	36,420	-	-	301%	-	-
2029	23,103	-	-	209%	-	-	31,322	-	-	267%	-	-	41,104	-	-	340%	-	-
2030	24,629	1,830	**26,459**	222%	473%	231%	34,174	1,830	**36,004**	291%	473%	297%	45,883	1,830	**47,713**	379%	473%	382%
Annual%			8.7%			8.7%			11.5%			11.5%			14.3%			14.3%

Note: IBEDC supplies the southern part of Ogun State, southern part of Oyo State, and Osun State. The power demand forecast for the study was carried out based on the demand in Ogun State (212MW, in 2020).

Source: JICA Study Team

Table 2-24 Lagos Region Peak Demand

	Lagos Region TCN 2017 [19]		Lagos Region JICA				
	Total demand	Total demand	Ikeja peak demand	EKO peak demand	Ibadan peak demand	Total demand	Total demand
Unit	MW	%	MW	MW	MW	MW	%
2020	**2,813**	100%	1,143	1,208	212	**2,563**	100.0%
2021	-	-	-	-	-	-	-
2022	-	-	-	-	-	-	-
2023	-	-	-	-	-	-	-
2024	-	-	-	-	-	-	-
2025	**3,455**	123%	1,794	2,041	414	**4,249**	165.8%
2026	-	-	-	-	-	-	-
2027	-	-	-	-	-	-	-
2028	-	-	-	-	-	-	-
2029	-	-	-	-	-	-	-
2030	**4,816**	171%	2,259	2,489	553	**5,301**	206.8%
Annual %	5.5%	5.5%	-	-	-	7.5%	7.5%

Source: JICA Study Team

Table 2-24 shows the estimated results of peak demand in the Lagos region.

There are three power distribution companies covering the megalopolis. The Eko Electricity Distribution Company supplies electricity (EKEDC) to the southern part of Lagos State, including Lagos Island, Victoria Island, Lekki and Badagry. The Ikeja Electricity Distribution Company (IKEDC) supplies the northern part of the Lagos State around and north of the Lagos airport. The Ibadan Electricity Distribution Company (IBEDC) supplies the southern part of Ogun State, southern part of Oyo State, and Osun State. The power demand forecast for the study is carried out based on the demand in Ogun State (212MW, in 2020).

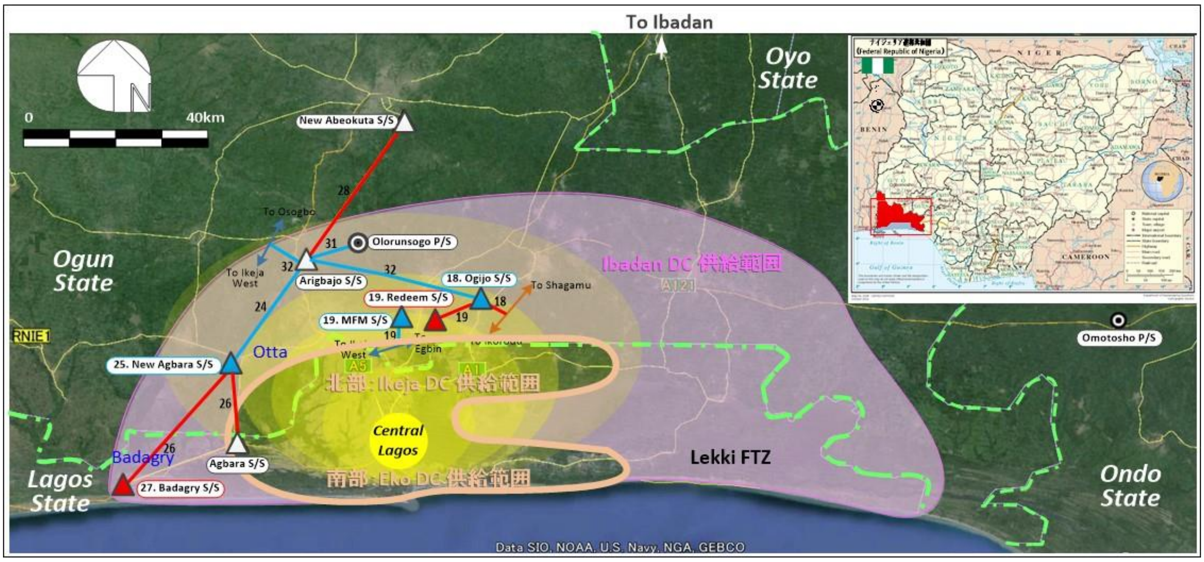
In 2020, the requirement will be 2,563MW in the Lagos Region versus 11,463MW in the whole national grid. In 2025, the requirement will be 4,249MW versus 18,345MW. In 2030, it will be 5,301MW versus 26,459.

The power demand forecast by the study is similar value to that of TCN[15] (Table 2-24).

2-4 Power Demand in Lagos State and Ogun State (Surveyed in 2014 and Reviewed in 2018)

2-4-1 General Demand Trend in Lagos/Ogun Megalopolis

The Lagos Region is an area encompassing Lagos State and the southern part of Ogun State in the southwestern part of Nigeria. The region is the former capital, an active industrial and commercial center, and the richest province of the country, with a population exceeding 21 million. According to the Lagos State Electricity Board, the electricity demand in the Lagos Region presently stands at 1,250MW, about double the average supply capacity of 650MW, resulting in a short supply continuously.[16] The power supply is seriously short even in the central part of Lagos State, and supply rotation is implemented almost daily. The supply shortage compels everyone to keeps generators at their homes and offices. Large users of electricity such as large factories and hotels depend solely on their own generators, without depending on the grid.



Source: JICA Study Team

Figure 2-11 Lagos Region Expanding to the Periphery

15 TCN, "Transmission Expansion Plan, Development of Power System Master Plan for the Transmission Company of Nigeria," December 2017

16 Interview with General Manager of the Board on July 30, 2014.

The central part of Lagos State is already highly developed with commercial and industrial facilities. The megalopolis is now adopting a policy of "Decentralizing the Large City" by expanding to the east (Lekki), west (Badagry), and north (Ibadan). Among the various development plans, the development of the Lekki area in the east, including the Free Trade Zone (FTZ; with Chinese capital participation) and the Export Processing Zone (EPZ; under the Lagos State Government initiative), is progressing ahead of the others. The construction of a new airport and deep water port were an urgently needed step to ensure that the Lagos region can accommodate its ever increasing personnel and commodity movement. The Lekki area was selected as the site for both facilities. Meanwhile, the Badagry development plan in the west is progressing slowly. New electricity demand is coming up in periphery areas where power transmission/delivery system is only poorly developed. Energy supply, in particular electricity, is a serious problem everywhere. This study aims to develop a comprehensive electricity supply system covering these new demand centers to enhance the security of the power supply in the whole Lagos Region.

Incorporated information from EKEDC, IKEDC, and IBEDC covering the megalopolis and demand trend in these areas is explained in the following sections.

2-4-2 Eastern Region

The eastern part of the Lagos Island surrounding the Lekki Lagoon, located 40-70 km east of Lagos, is one of the major areas plotted for future industrial development. The Lagos State Government has embarked on the development of the Lekki district under a long-term plan that will span the next 20 years. Among the key projects, the construction of the new airport (Lekki-Epe International Airport) and sea port (Lekki Deep Sea Port) was already completed by 2017/18. The southern part facing the Atlantic Ocean is allotted for an industrial zone and sea port, the northern part is allotted for an airport, and the eastern part of the peninsula (on the opposite site of Epe) is allotted for residential/commercial and resort/tourism zones (see Figure 2-12). The development of the industrial zone is given priority. The development of the leisure/tourism zone is scheduled for a later stage. Following are details on the aforesaid development plans in the Eastern Region.

(1) New International Airport

Tender for construction of the New Lekki-Epe International Airport over a 3,500 hectare site was called at the end of 2014. The new airport was just completed in December 2017. The power supply to the existing MM Lagos airport is presently regulated at 25MW (the average consumption is 15MW). The power demand at the new airport is expected to be 50MW, as a large amount of air cargo will be handled there.

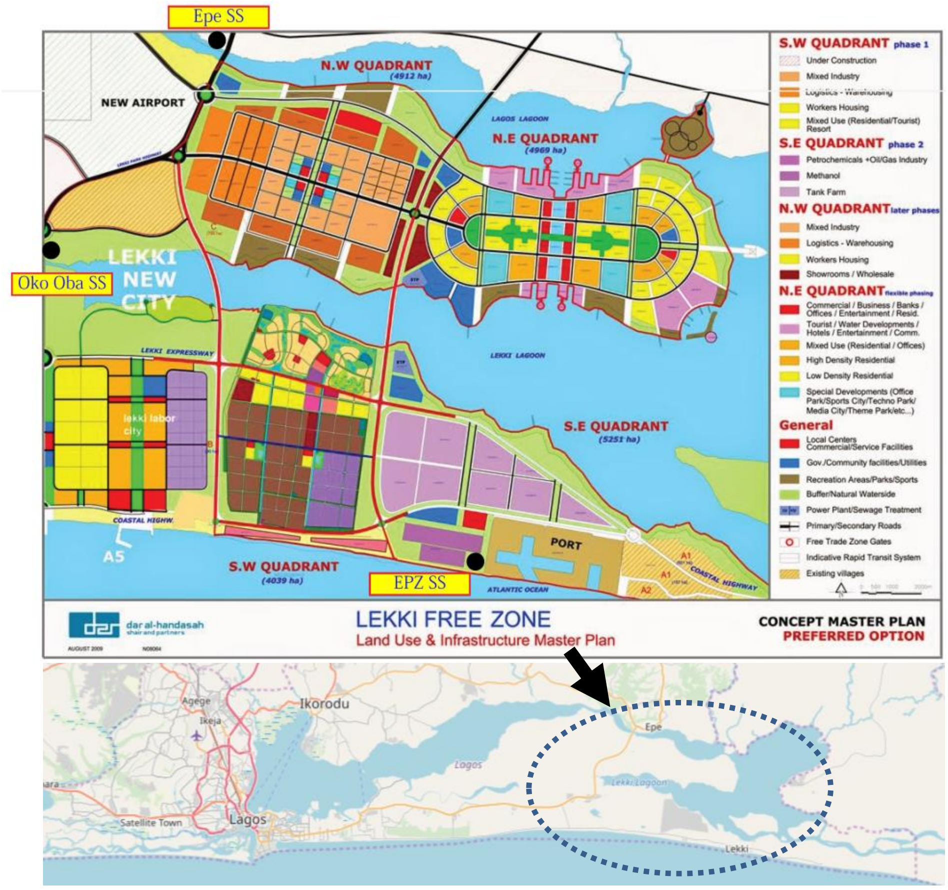
(2) Lagos Deep Sea Port Project

The Lagos Deep Sea Port is being constructed in the easternmost part of the district (east of the Export Processing Zone) as a cut-in type marine port. Construction started in 2013 and the major components were completed at the beginning of 2018. The electricity demand is estimated to stand at 20-30MW at the early stage and is expected to eventually grow to 100MW once all the facilities, including the gantry cranes and warehouses, become operational.

(3) Lekki Refinery Project

The biggest refinery in Africa is planned immediately to the west of Deep Sea Port, but no detailed plans or updates on the progress are available.

- Refinery project plans with an expected scale of 200,000-300,000 bpd (barrels per day) have been proposed by NNPC, local oil companies, local big businesses, Chinese capital, etc. News on the project is reported from time to time, but news of a final confirmation has yet to come. The investment amount is estimated to be huge, reaching upwards of US$8 billion, so a final decision on the project cannot be easily reached.



Source: JICA Study Team

Figure 2-12 Lekki Development Zone

- For reference, Nigeria, the largest oil producer in Africa, is importing 70-80% of its petroleum products requirements (provided that the IEA statistics are correct) due to a shortage of refining capacity at home. Petroleum product imports at present amount to 8 million tons a year, or 160,000 bpd. A 200,000 bpd class refinery (10 million tons x 80% operation) will be enough to satisfy the present import requirement, while a greater capacity will be necessary to accommodate future demand increases. Such a refinery could run on its own boilers and generators, given its dual use of huge amounts of heat and power simultaneously.

(4) Industrial Park

The zone west of the refinery site is allotted for light industries and warehouses/depots as a commodity distribution center. Two railway lines will be constructed from this area toward the north. All of the land in the area has already been sold. The prospects of fuel and power supply are uncertain, however, so most of the scheduled industries have yet to start construction. The number of self-power generators may amount to 7,000, or eventually to as high as 10,000, in the whole of the Lekki zone (most of which will be home generators). The small self-generators for home use are generally 5-20kW units driven by petrol. The larger ones used by factories are estimated to have capacities in ranges of 100-500kW for less electricity intensive factories and 1,000 -5,000kW for more electricity intensive plants. All of the self-generators for factories will be driven by diesel, LPG, or CNG. If electricity supply is sufficient and stable, the self-generators will not be necessary. The industrial zone is scheduled to be completed by 2019.

(5) Power Plant (Independent Power Producer: IPP)

An IPP is constructing power plants to boost the construction of factories in the industrial park. The first unit (12MW class plant), to be completed within six months, will give the IPP a final capacity of 500MW. The size of this plant can accommodate only a part of the power demand expected in the whole industrial zone. LPG and CNG are both accepted as fuel and brought in by tank-lorries (an IPP of the same type using LPG is operating in Lagos Island). The generation cost based on CNG will be N36.5/kWh (about 20 US cents /kWh), and that based on diesel will be 40-50 US cents /kWh. This is just an immediate relief measure, however, that is low in efficiency and high in generating cost.

Another large-scale IPP project is being sought by project promoters. While the total generation capacity of such a project has yet to be revealed, the construction of such a plant would provide great relief for the tight electricity supply in the Lagos Region.

One distribution line of 33kV is running west to east along the coastal road at present, while the electricity demand connected to the line is over 60MW thus the power supply is not sufficient. TCN plans to build an Export Processing Zone (EPZ) S/S at the site. Power will be transmitted via a 132kV line newly constructed from the Oko-oba S/S (new build) along the lagoon shore and southbound to the EPZ S/S site, from which point it will be delivered at 33kV to factories to be built in the new industrial park EPZ. Under the circumstance, the progress of the big new IPP project being sought should be carefully watched as such a plant would substantially change the scope of the power flow in the Lekki area.

2-4-3 Central and Northern Region

The area north of the MM Lagos airport is the industrial center of Lagos. IKEDC is supplying about

520MW in Lagos State and IBEDC is supplying about 70MW in the southern part of Ogun State. Honda Manufacturing Nigeria Ltd. (HMN) has been producing portable generators and other petrol engine appliances in Ogun State since 1979. The regional electricity demand has been growing at a fast annual pace of 18-22% in recent years. As the district is already fully developed, it is expanding further north. However, the delivery system is poor and many customers have been connected to insubstantial 33KV feeder lines amounting to several times the distribution capacity. Distribution companies cannot accommodate new demand but have no choice but to decline requirements to connect in Likosi (Ogijo), Shagamu, and the periphery. In the southern part of Ogun State, the electricity consumption of the non-connected consumers is estimated to be almost the same as those of the connected customers at present, at about 90MW (peak load). This is a serious constraint against industrial and residential development of the district, while self-generation is becoming a common practice of emerging customers. Industrial and residential development, meanwhile, is progressing fast outside of the comprehensive power delivery plan. IKEDC is worried about securing right of way for future expansion of the distribution network.

Another major power consumer in the north is the assembly center of a famous religious group, MFM, the Mountain of Fire and Miracles Ministry. While MFM's church is located nearby the 330kV transmission line connecting the Benin Main and Lagos, no substation is established for local delivery. The religious center is a huge complex that accommodates hundreds of thousands of people, with many large-scale facilities and significant numbers of church staff residing nearby. The center is presently running 5MW x 2 self-generators and plans to install 15MW x 1 to cater to future demand as it makes headway in developing another facility at a nearby new site.

To accommodate the above demand, construction of three substations at Likosi (Ogijo), Redeem, and MFM is considered in this study.

2-4-4 Central/ Western Region

According to EKEDC, the historical peak supply in its area was recorded in March 2004 at 530MW.[17] Disorder in the supply system in the years since has pushed the electricity supply back down to the present level of about 350MW. This supply is estimated to satisfy only about 30-35% of the requirement of the customers connected. Supply rotation has thus become a common routine, with the distribution power for only 5-6 hours a day per customer. The shortage is supplemented by self-generation.

In addition to the supply volume, feeder lines of 33KV are extending longer and longer, exceeding 20 km in some cases, and old lines and transformers dating back 30-40 years are still used without proper maintenance. Modernization of the equipment is another urgent issue. The significant shortage of electricity supply versus the demand results in frequent voltage sags and frequency fluctuations, which creates the added problem of electricity quality. While many industrial factories operate in the area, nobody questions the use of self-generation. Low confidence in the supply dissuades most newcomers

[17] Interview with EKEDC on August 1, 2014.

from considering connection to the grid in spite of the low efficiency and high cost of self-generation. Many factories are using natural gas, where available, from the pipeline running nearby. Supply constraints regrettably prevent EKEDC from distributing sufficient electricity to satisfy the abundant demand.

Many industrial factories are already operating in the district up to and around the Agbara substation in the west of Lagos. In addition, the industrial and residential development is extending further west toward Badagry 60 km to the west of Lagos. Nissan Motor Co., Ltd. runs an assembly factory in that city. This area is deemed a future development zone, and a new railway connecting Badagry and Lagos is under construction. The construction of new substations is scheduled at Ajegunle (New Agbara) and Badagry in this study. A material amount of electricity demand is already there, and an industrial development plan is in place for the construction of a cut-in type deep water port in the Badagry district. The tender for construction was called in 2015. Construction work was commenced by the contractor in 2016 and will be completed by the end of 2018.

The redevelopment of the central part of Lagos is envisioned, though specific plans have yet to come. The development of the railway network, business offices, and commercial facilities may significantly raise the density of human activities and electricity demand in the city center. EKEDC is rather optimistic that such incremental demand can be accommodated via replacement/modernization of the existing distribution facility with upgrades.

2-4-5 Projected Electricity Demand in the Lagos Region

TCN has projected the future electricity demand in the Lagos Region by substation, as summarized in Table 2-25. In spite of the present state of electricity supply, we assume in this study that it will catch up with the implicit peak demand for the national grid by 2020. The macro study, meanwhile, indicates that the Lagos Region peak demand in 2020 will be 2,563MW. From these comparisons, we judge that TCN's projected demand of 2,864MW falls within a reasonable band.

The projected demand of 4,760MW for the year 2025 exceeds the macro projection band of 4,249MW by 12%. This could be deemed to be within a reasonable deviation range, however, as extensive development plans such as the construction of an airport and deep sea port are underway and the regional demand is projected, including bottom-up demand based on information on potential customers. Note also that the sum of the bottom-up approach on individual substations will generally exceed the simultaneous peak demand of all of substations. For the year 2030, the projected demand of 6,133MW falls within the macro projection band of 5,301MW. Thus, we may be able to judge that the projection of the Lagos Region peak electricity demand by TCN is modest and reasonable.

Table 2-25 Projection of Electricity Demand in the Lagos Region by Substation: TCN

Region	Sub-stations	National Demand			Average Annual Growth		
		2020	2025	2030	2020-2025	2025-2030	2017-2025
		MW	MW	MW	%	%	%
Central,	Ijora	91.8	147.2	186.9	9.9	4.9	7.4
South & East	Alagbon	93.9	150.5	150.5	9.9	0.0	4.8
(EKEDC)	Akangba	101.8	163.2	237.7	9.9	7.8	8.8
	Apapa Road	49.9	80.1	80.1	9.9	0.0	4.8
	Amuwo Odofin	61.5	98.6	98.6	9.9	0.0	4.8
	Odogunyan	96.8	149.5	146.5	9.1	0.4	4.2
	Akoka	72.0	115.5	114.3	9.9	0.2	4.7
	Oworon-shoki	54.0	99.0	99.0	12.9	0.0	6.2
	Ajah	123.3	157.7	230.0	5.0	7.8	6.4
	Lekki	66.1	106.0	180.6	9.9	11.2	10.6
	Epe	45.0	50.1	124.7	2.2	20.0	10.7
	Oko-oba	40.7	65.3	140.0	9.9	16.5	13.1
	EPZ	54.7	87.8	87.8	9.9	0.0	4.8
	Ikorodu	95.9	175.9	175.9	12.9	0.0	6.3
	Sub-total	*1,047.4*	*1,646.4*	*2,052.6*	9.4	4.8	7.0
Central & West	Oke-Aro	52.9	97.0	301.8	12.9	25.5	19.0
(IKEDC)	Alimosho	64.4	118.1	118.1	12.9	0.0	6.3
	Ogba	134.4	246.4	238.4	12.9	0.7	5.9
	Alausa	60.4	110.8	110.8	12.9	0.0	6.3
	Ejigbo	153.6	266.2	266.2	11.6	0.0	5.7
	Ilupeju	46.1	84.6	70.4	12.9	3.6	4.3
	Maryland	48.2	88.4	88.5	12.9	0.0	6.3
	Igando	0.0	0.0	0.0	-	-	-
	Ayobo	12.2	22.4	22.4	12.9	0.0	6.3
	Itire	42.9	68.8	64.4	9.9	1.3	4.1
	Isolo	103.1	165.3	164.1	9.9	0.2	4.8
	Agbara	54.3	87.0	87.0	9.9	0.0	4.8
	Badagry	39.9	44.3	44.3	2.1	0.0	1.1
	Ojo	92.4	148.1	148.1	9.9	0.0	4.8
	AFR Foundry	29.5	54.2	54.2	12.9	0.0	6.3
	Egbin	63.0	115.6	115.6	12.9	0.0	6.3
	Ikeja West	38.2	70.0	189.0	12.9	22.0	17.3
	Sub-total	*1,035.5*	*1,792.5*	*1,787.2*	11.4	2.6	6.8
North & West	Ejio (Arigbajo)	70.0	109.0	313.8	9.3	23.6	16.2
(IBEDC)	Ajegunle (New Agbara)	63.4	101.7	101.7	9.9	0.0	4.8
	Otta	55.6	117.8	117.2	16.2	0.1	7.7
	Papalanto	12.9	27.3	27.3	16.2	0.0	7.8
	Old Abeokuta	25.5	54.0	54.0	16.2	0.0	7.8
	New Abeokuta	30.9	68.3	68.3	17.2	0.0	8.2
	Igbora	-	-	-	-	-	-
	Lanlate	11.2	23.7	23.7	16.2	0.0	7.8
	Igangan	11.2	23.7	23.7	16.2	0.0	7.8
North & East	Shagamu	53.7	113.8	80.2	16.2	6.8	4.1
(IBEDC)	Likosi (Ogijo)	42.4	77.8	282.6	12.9	29.4	20.9
	Abule Oba (Redeem)	40.3	74.0	74.0	12.9	0.0	6.3
	Makogi (MFM)	63.6	99.1	253.7	9.3	20.7	14.8
North & West	Olorunsogo	40.3	75.3	75.3	13.3	0.0	6.5
	Sub-total	*521.0*	*965.5*	*1,495.4*	14.0	5.1	9.3
Benin	Sakete	260.0	361.3	6.8	6.8	6.8	8.2
	Sub-total	*260.0*	*361.3*	*502.0*	6.8	6.8	6.8
	Total	***2,863.9***	***4,760.4***	***6,133.2***	**11.4**	**4.2**	**7.6**

Note: While Lanlate and Igangan belong to the Osogbo line (Area 2) adjacent to the Lagos line, both are demand places supplied from the Lagos line (Area 1).

Source: JICA Study Team

Chapter 3　Candidate Components of the Project

Chapter 3 Candidate Components of the Project

3-1 Background to select Project Components

TCN has compiled a transmission network expansion plan aimed at boosting transmission capacity and improving system reliability. In a report entitled "Appraisal of Transmission Projects" (March 2014) (hereafter, the "Appraisal Report"), TCN outlines its transmission projects and details its investment plans with a view to attracting the investment it needs to realize the transmission network plan.

The Appraisal Report compiles investment plans separately for TCN's transmission department (TSP: Transmission Services Provider), system operation department (SO: System Operator), and power market operating department (MO: Market Operator). A phased and yearly detailed investment plan has been compiled for the TSP in charge of power transmission infrastructure, as shown in Table 3-1.

Table 3-1 Investment Plan in the Transmission Department (TSP)

Package	Project Name	Construction Cost (US$ Million)	Target Transmission Capacity	Target Year of Completion
-	(1) Rehabilitation of existing equipment	$947	—	2015
1	(2) Projects under construction (Package 1)	$989	7-8 GW	2015
2	(3) 10GW Transmission capacity (Package 2)	$2,235	10GW	2017
3	(4) 13GW Transmission capacity (Package 3)	$1,570	13GW	2018
4	(5) 16GW Transmission capacity (Package 4)	$1,000	16GW	2019
5	(6) 20GW Transmission capacity (Package 5)	$1,000	20GW	2020
	Total	**$7,742**		

Source: Extracted table from "Appraisal Report", Transmission Company of Nigeria (March 2014)

Among the investment projects indicated in Table 3-1, TCN considers the implementation of (1) Rehabilitation of existing equipment, (2) Projects under construction (Package 1), and (3) 10GW Transmission capacity (Package 2) to be urgently necessary. While the candidate project components should be identified out of TCN's plans for the expansion of transmission networks, the targeted completion (1) Rehabilitation of existing equipment in 2015 limits the time available for those projects, while contracts have been signed and work is already underway for (2) Projects under construction (Package 1). The survey here will therefore target (3) 10GW Transmission capacity (Package 2), specifically the project for the southwest area (Lagos State and Ogun State), in consideration of three factors: the large scale of project benefits, the rather stable security situation in the area, and the prevention of voltage collapse due to shortfalls in system voltage under future demand conditions.

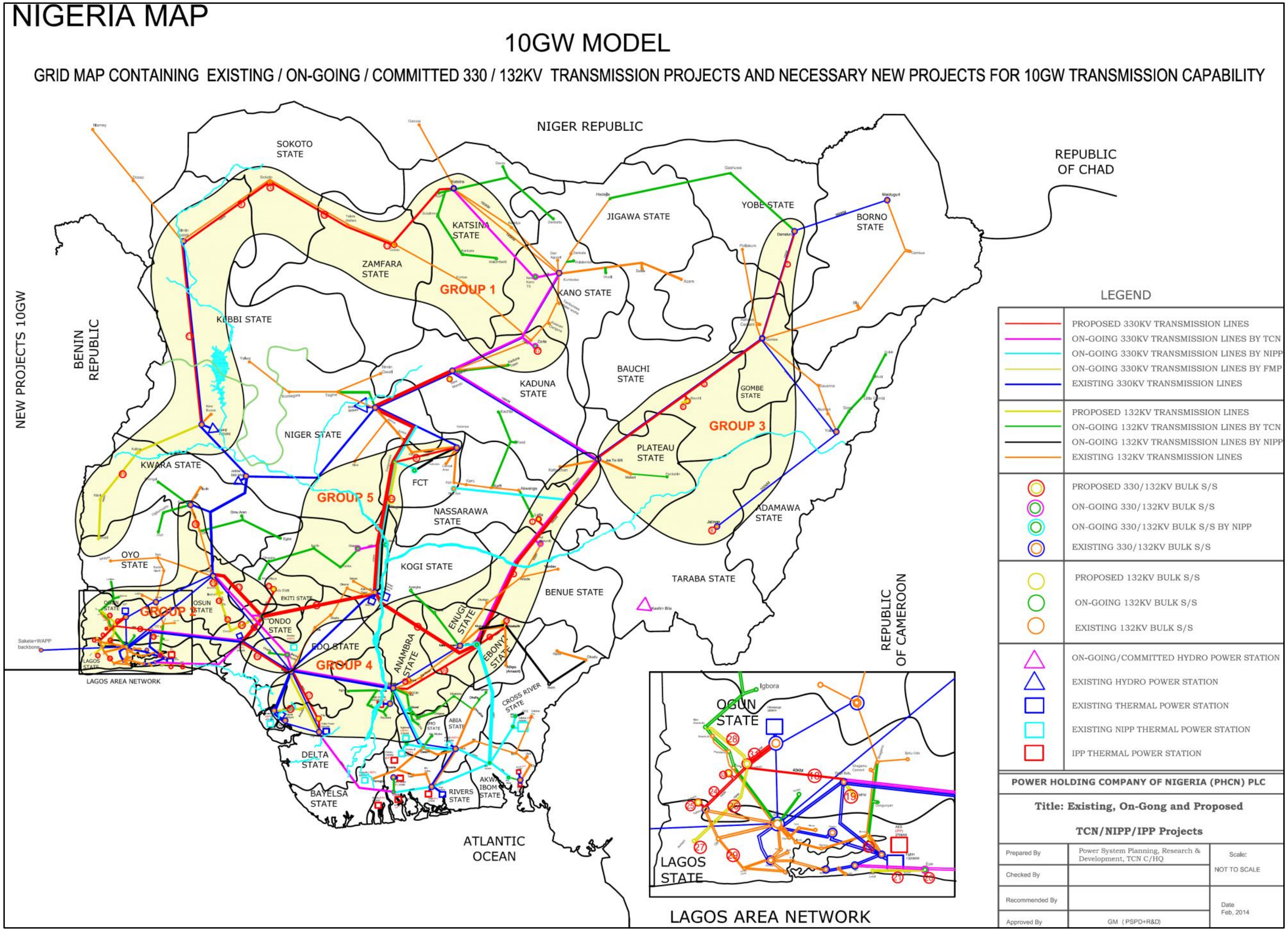
The projects under (3) 10GW Transmission capacity (Package 2) are classified into five groups by area, as shown in Table 3-2.

Table 3-2 Area-wide Classification of Projects for 10GW Transmission Capacity (Package 2)

Group	Area	Number of transmission and distribution projects	Voltage maintenance projects	Construction cost (US$ Million)
1	Kainji - Birnin Kebbi - Gusau	11	13	$438
2	Lagos	25	21	$548
3	Jos – Gombe - Damaturu	4	8	$246
4	Awka – Ugwuaji - Jos	16	13	$617
5	Benin - Katampe	5	16	$385
	Total	61	71	**$2,235**

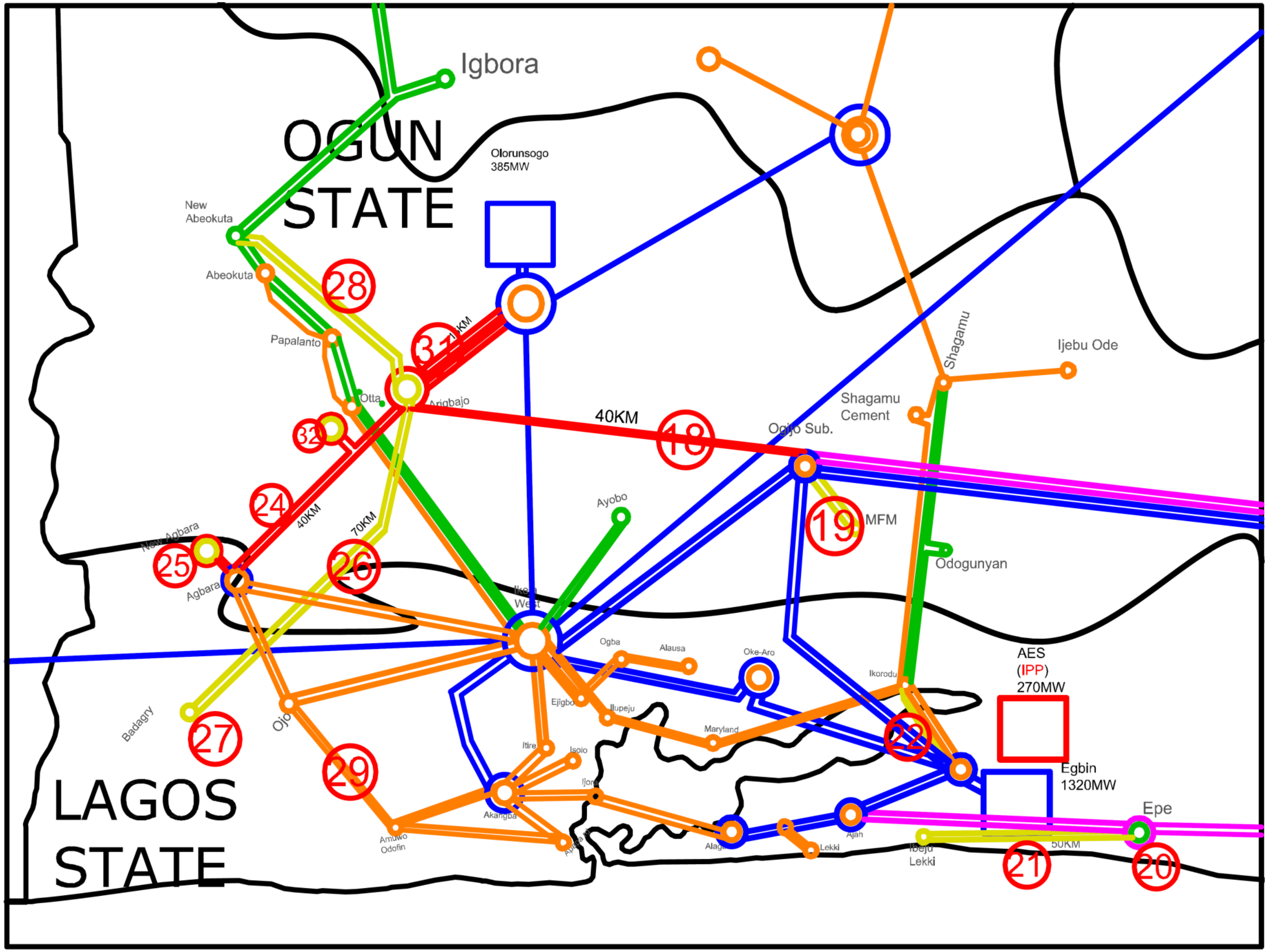
Source: Extracted table from "Appraisal Report", Transmission Company of Nigeria (March 2014)

Figure 3-1 and Figure 3-2 are a map of 10GW transmission system projects and an expanded diagram of transmission systems in the Lagos area (Group 2), respectively. Table 3-3 is a list of Lagos area (Group 2) projects in the 10GW Transmission Capacity (package 2) category. The figures circled in Figure 3-1 and Figure 3-2 correspond to S/N in Table 3-3.



Source: Extracted figure from “Appraisal Report”, Transmission Company of Nigeria (March 2014)

Figure 3-1 Map for 10GW Transmission Capacity (Package 2)



Source: Extracted figure from "Appraisal Report", Transmission Company of Nigeria (March 2014)

Note: The legend is the same as in Figure 3-1

Figure 3-2 Expanded Diagram in the Lagos Area (Group 2) for 10GW Transmission Capacity (Package 2)

Table 3-3 List of Projects in the Lagos Area (Group 2) for 10GW Transmission Capacity (Package 2)

Type	S/N	Project description	Cost (US$)
	14	Akure-Ondo 132kV DC Transmission line + line bay extensions (92km)	12,031,250
	15	Osogbo-Ilesha 132kV Quad condutor Transmission line (40km)	15,400,000
	16	Ilesha Tee - Ife 132kV DC Transmission line (20km)	4,812,500
	17	Ife - Ondo 132kV DC Transmission line (60km)	14,437,500
	18	2 x 330/132kV 150MVA + 2 x 132/33kV 60MVA Transformer at Ogijo, Lagos and turn-in-out of Benin-Egbin-Ikeja West 330kV DC Transmission line at Ogijo	37,745,000
	19	132kV DC Transmission line (20kM) from Ojigo - MFM and 2 x 132/33kV 60MVA at MFM	
	19-1	132kV DC Transmission line (20kM) from Ojigo - MFM	4,812,500
	19-2	2 x 132/33kV 60MVA S/S at MFM	9,700,000
	20	2 x 330/132kV 150MVA + 2 x 132/33kV 60MVA substation at Epe and Associated 6 x 33kV feeder	32,700,000
	21	132kV DC Transmission line to Ibeju (50km) + 2 x 132/33kV 60MVA substation at Ibeju Lekki and 2 x 132kV line bay extension at Epe.	
	21-1	132kV DC Transmission line to Ibeju (50km)	12,031,250
Transmission lines and Substations	21-2	2 x 132/33kV 60MVA substation at Ibeju Lekki and 2 x 132kV line bay extension at Epe	9,700,000
	22	2 x 330/132kV 150MVA substation at Ado Ekiti + 2 x 132/33kV 60MVA Transformer	32,700,000
	23	Akure - Ado Ekiti 330kV DC transmission line (80km)	29,000,000
	24	Arigbajo - Agbara 330kV DC transmission line (40km)	14,500,000
	25	2 x 150MVA, 330/132kV substation at New Agbara, with 2 x 330kV and 4 x 132kV line bay	28,475,000
	26	New Agbara - Agbara -Badagry 132kV DC Transmission line (70km).	16,843,750
	27	2 x 60MVA, 132/33kV substation at Badagry and 2 x 132kV line bay extension at Agbara	9,700,000
	28	Arigbajo - New Abeokuta 132kV DC Transmission line	11,057,767
	29	Convert Akangba -Amuwo -Ojo 132kV DC Transmission line to ACCC conductor	3,606,250
	30	Convert existing Oshogbo - Offa (50km) SC (Hyena)- Offa-Ganmo (50km) DC Transmission line using existing ROW with ACCC conductor	12,031,250
	31	Olorunsogo - Arigbajo 330 KV Quad conductor Transmission line (15km)	8,700,000
	32	Ikeja West/Osogbo 330KV DC Transmission line turn in-out (15km) at Arigbajo + Ogijo - Arigbajo DC Transmission line (40km)	19,937,500
	42	Omotosho -Akure 330kV DC Transmission line Quad Conductor (80km) + line bay extension	46,400,000
	43	Akure - Oshogbo 330kV DC Transmission line Quad Conductor (96km)+ line bay extension	55,680,000
	Subtotal		**442,001,517**
	2	Osogbo, SVC, 330kV, +60MVAr, -75MVar	5,602,500
	5	Ikeja West, Fixed Shunt Capacitor, 132kV, 50MVar	2,075,000
	6	Papalanto, Fixed Shunt Capacitor, 132kV, 50MVar	2,075,000
	7	Akoka, Fixed Shunt Capacitor , 132kV, 50MVar	2,075,000
	8	Alausa, Fixed Shunt Capacitor, 132kV, 75MVar	3,112,500
	9	Meryland, Fixed Shunt Capacitor, 132kV, 60MVar	2,490,000
	10	Ogba, Fixed Shunt Capacitor, 132kV, 50MVar	2,075,000
Capacitors and Reactors	11	Otta, Fixed Shunt Capacitor, 132kV, 50MVar;	2,075,000
	12	Oworosoki, Fixed Shunt Capacitor, 132kV, 50Mvar	2,075,000
	13	Old Abeokuta, Fixed Shunt Capacitor, 132kV, 50MVar	2,075,000
	14	Oke Aro, Fixed Shunt Capacitor, 132kV, 75MVar	3,112,500
	15	Maryland, Fixed Shunt Capacitor, 33kV, 40MVar	1,660,000
	16	Ikorodu, Fixed Shunt Capacitor, 33kV, 20MVar	830,000
	17	Ilupeju, Fixed Shunt Capacitor, 11kV, 50MVar	2,075,000
	18	Itire, Fixed Shunt Capacitor, 11kV, 20MVar	830,000
	23	Old Abeokuta, Fixed Shunt Capacitor, 33kV, 10MVar	415,000
	25	Omuaran, Fixed Shunt Capacitor, 33kV, 30MVar,	1,245,000
	55	IFE 1, Fixed Shunt Capacitor, 132kV, 20MVar	830,000
	58	Osogbo 1, Fixed Shunt Capacitor, 132kV, 10MVar	415,000
	小計		**37,142,500**
Spare Transformers		3 x 330/132kV 150MVA, 4 x 330/132kV 300MVA, 10 x 132/33kV 60MVA	**62,974,200**
Spare Reactors		Osogbo 75MVar, Omotosho 75MVar	**6,225,000**
Total			**548,343,217**

Note: DC (Double Circuit), SC (Single Circuit), ACCC (Aluminium Conductor Composite Core)
Source: Extracted table from “Appraisal Report”, Transmission Company of Nigeria (March 2014)

3-2 Selection of Candidate Components

As indicated in "3-1 Background to select Project Components", basic components to study for the project were identified out from Table 3-3 Group 2 (Lagos) for 10GW Transmission Capacity (Package 2) "Appraisal Report".

Throughout the field surveys from 2014 up to the end of 2018, power flow analysis, and discussions with TCN have been made to identify most suitable components as shown in Table 3-4.

Table 3-4 Candidate Components for Japan's Yen Loan

S/N		Category	Request as of February, 2014	Candidate components as of June, 2015	Reason	Candidate components as of July 2018	Reason	Scoping as of December 2018
18		Substation	Likosi (Ogijo) substation(2x150MVA 330/132KV + 2 x 60MVA 132/33kV)	● Likosi (Ogijo) substation; 2 x 300MVA 330/132KV + 2 x 100MVA 132/33kV S/N18	[Change] Upgrade of transformer capacity to accommodate increased demand in the future (Nov. 2014)	-	-	In the Scope
				● Incoming and outgoing transmission line from Ikorodu - Shagamu line to Likosi (Ogijo) substation; approx. 2.3 km length, 132kV (Added) S/N18-1	[Additional] Requested by TCN to support expansion plans in the future (Nov. 2014)	-	-	In the Scope
19	19-1	Transmission line	132kV double-circuit transmission line from Likosi (Ogijo) substation to Makogi (MFM) substation	-	[Deleted] 132kV double-circuit transmission line from Likosi (Ogijo) substation to MAKOGI (MFM) substation (Nov. 2014)	-	-	Out of Scope
				● Incoming and outgoing transmission lines from existing Benin - Egbin - Ikeja West line to Makogi (MFM) substation; approx. 4.2 km length, 330kV (Added) S/N19-1	[Additional] Requested by TCN to support expansion plans in the future (Nov. 2014)	[Change] Transmission line changed to a double-circuit x2 tower instead of a 4-circuit type	Likosi (Likosi (Ogijo)) – The Makogi (MFM) transmission line is connected to an important bulk system of a 330kV transmission line. It was determined, through discussion with TCN, that a 4-circuit transmission line should not be adopted, from the viewpoint of reliability.	In the Scope
	19-2	Substation	Makogi (MFM) substation (132/33KV, 2X60MVA)	● Makogi (MFM) substation; 2 x 150MVA 330/132KV + 2 x 60MVA 132/33kV S/N19	[Additional] Upgrade of voltage class to 330/132/33kV and transformer capacity to accommodate increased demand in the future (Nov. 2014)	-	-	In the Scope
				-	[Change] The substation site has been moved to a new site outside of MAKOGI (MFM)'s properties. A part of the land for a new university has been acquired (Jan. 2015)	-	-	
				● Abule Oba (Redeem) substation; 132/33kV, 2 x 60MVA S/N19	[Additional] Requested by TCN to support expansion plans in the future (Jul. 2014)			In the Scope
				● Likosi (Ogijo) - Abule Oba (Redeem) transmission line; approx. 10.3 km length, double circuit, 132kV	[Additional] Requested by TCN to support expansion plans in the future (Jul. 2014)	-	-	In the Scope

S/N		Category	Request as of February, 2014	Candidate components as of June, 2015	Reason	Candidate components as of July 2018	Reason	Scoping as of December 2018
				(Added) S/N19-3				
20		Substation	Epe substation (2x150MVA, 330/132kV + 2x60MVA, 132/33kV)	-	[Deleted] Out of scope in consideration of the need to quickly commence this project, the priority on demand, and effect on the transmission system (Oct. 2014)	-	-	Out of Scope
21	21-1	Transmission line	132kV double-circuit transmission lines from Epe substation to Ibeju Lekki substation	-	[Deleted] Out of scope in consideration of the need to quickly commence this project, the priority on demand, and effect on the transmission system (Oct. 2014)	-	-	Out of Scope
	21-2	Substation	Ibeju Lekki substation (2x60MVA, 132/33kV)	-	[Deleted] Out of scope in consideration of the need to quickly commence this project, the priority on demand, and effect on the transmission system (Oct. 2014)	-	-	Out of Scope
24		Transmission line	330kV double-circuit transmission line from Ejio (Arigbajo) substation to Ajegunle (New Agbara) substation	● Ejio (Arigbajo) substation - Ajegunle (New Agbara) substation transmission line; approx. 30.6 km length, double circuit, 330kV S/N24	The length of the transmission line is determined from the results of the outline study.	-	-	In the Scope
25		Substation	Ajegunle (New Agbara) substation (2x150MVA, 330/132kV)	● Ajegunle (New Agbara) substation; 2 x 150MVA 330/132kV + 2 x 60MVA 132/33kV S/N25	-	-	-	In the Scope
26	26-1	Transmission line	132kV double-circuit transmission line connecting Agbara substation – Ajegunle (New Agbara) substation - Badagry	● Agbara substation - Ajegunle (New Agbara) substation transmission line; approx. 20.8 km, double circuit, 132kV S/N26-1	The length of the transmission line is determined from the results of the outline study.	-	-	In the Scope
	26-2	Transmission line		● Ajegunle (New Agbara) substation - Badagry transmission line; approx.	[Change] The substation is changed from the existing Agbara	-	-	In the Scope

S/N	Category	Request as of February, 2014	Candidate components as of June, 2015	Reason	Candidate components as of July 2018	Reason	Scoping as of December 2018
			34.2 km, double circuit, 132kV S/N26-2	substation to the Ajegunle (New Agbara) substation (Oct. 2014)			
27	Substation	Badagry substation (2X60MVA, 132/33kV)	● Badagry substation; 2 x 60MVA, 132/33kV S/N27	[Change] The Substation site was moved (Jan. 2014)	-	-	In the Scope
28	Transmission line	132kV double-circuit transmission line from Ejio (Arigbajo) substation to New Abeokuta substation	● Ejio (Arigbajo) substation - New Abeokuta substation transmission line; approx. 37.8 km, double circuit, 132kV S/N28	The length of the transmission line is determined from the results of the outline study.	-	-	In the Scope
29	Transmission line	Reconductoring of 132kV double-circuit transmission line between Akangba substation-Amuwo Odofin substation-Ojo substation	-	[Deleted] Out of scope in consideration of the need to quickly commence this project, the priority on demand, and effect on the transmission system (Oct. 2014)	-	-	Out of Scope
31	Transmission line	330kV double-circuit transmission line from Olorunsogo power station to Ejio (Arigbajo) substation	● Olorunsogo power station - Ejio (Arigbajo) substation transmission line; approx. 12.9 km, double circuit, 330kV S/N31	The length of the transmission line is determined from the results of the outline study.	-	-	In the Scope
32	Transmission line	330kV double-circuit transmission line from Ejio (Arigbajo) substation to Likosi (Ogijo) substation	● Ejio (Arigbajo) substation to Likosi (Ogijo) substation transmission line; approx. 43.7 km, double circuit, 330kV S/N32-1	The length of the transmission line is determined from the results of the outline study.	-	-	In the Scope
		330kV double-circuit turn-in/turn-out at Ikeja West-Osogbo line to Ejio (Arigbajo) substation	● Incoming and outgoing transmission line from Ikeja West - Osogbo line to Ejio (Arigbajo) substation; approx. 5.9 km, double circuit, 330kV S/N32-2,3	The length of the transmission line is determined from the results of the outline study.	-	-	Out of Scope
	Transmission line	-	● Incoming line from Olorunsogo - Ejio (Arigbajo) substation S/N32 ● Incoming line from Ayede -	[Additional] Requested by TCN to support expansion plans in the future (Nov. 2014)	-	-	In the Scope

S/N		Category	Request as of February, 2014	Candidate components as of June, 2015	Reason	Candidate components as of July 2018	Reason	Scoping as of December 2018
				Ejio (Arigbajo) substation S/N32				
		Substation	-	● Outgoing bay for transmission line S/N 28 in New Abeokuta substation S/N32	[Additional] Requested by TCN to support expansion plans in the future (Nov. 2014)	-	-	In the Scope
				● Outgoing bay for transmission line S/N 26-1 in Agbara substation S/N32	[Additional] Requested by TCN to support expansion plans in the future (Nov. 2014)	-	-	In the Scope

Remarks: **Blue**, Addition; **Green**, Amendment; **Red**, Deletion from the original components
Source: JICA preparatory survey team and TCN

3-3 Major Benefit by Project Components

The major project benefits[1] expected from those selected components are described below.

(1) Construction of Likosi (Ogijo) Substation and Turn-in/turn-out From the Shagamu-Ikorodu 132kV Transmission Line

Large-scale electricity consumers such as a cement factory, steel product manufacturer, and university are established in Shagamu. The power supply to those consumers is insufficient, however, due to the limited transmission capacity of the existing 132kV lines. The construction of a 330/132/33kV Likosi (Ogijo) substation and turn-in/turn-out connection from the substation to the Shagamu-Ikorodu 132kV transmission line will mitigate overloading in the Shagamu substation by distributing the load.

(2) Construction of the Makogi (MFM) Substation and Abule Oba (Redeem) Substation

While the Makogi (MFM) and Abule Oba (Redeem) areas have schools, hospitals, and even religious facilities large enough to accommodate tens of thousands of people, the unreliable power supply still forces residents to rely on private power generators. More stable power supply is anticipated once the projects facilities are online. The construction of Makogi (MFM) substation and Abule Oba (Redeem) substation will improve the power supply and alleviate the concentration of power flow into the Ikeja West substation.

(3) Construction of Ajegunle (New Agbara) Substation and 132kV Transmission Line from the Ajegunle (New Agbara) Substation to the Agbara Substation

Agbara is an industrial area occupied by large numbers of factories in industries such as food, steel, plastics, and beverages. While the large-scale electricity consumption by these factories generates huge demand, most of the factories depend on captive power generation due to unstable power supply conditions. A stabilized power supply to Agbara is expected to vitalize the industrial activities in the area. The installation of Ajegunle (New Agbara) substation and the construction of 132kV transmission line from the Ajegunle (New Agbara) substation to the Agbara substation will improve the power supply and alleviate the concentration of power flow into the Ikeja West substation.

(4) Construction of the Badagry Substation

Badagry, a new intended load area, is a industrial city with a developing residential population and plans for the development of a commuting railway and ports and harbors. The power supply, however, is far from sufficient at present. The unstable power supply situation fetters economic growth and the prompt establishment of stable power is awaited. Badagry substation

[1] Some Japanese companies are also expected to advance with the development of automobile assembling manufactures in Otta and in Lagos along with Badagry Expressway.

will be effective in improving the power supply and alleviating the concentration of power flow into the Ikeja West substation.

(5) Construction of a 330kV Transmission Line Between Olorunsogo-Ejio (Arigbajo)-Likosi (Ogijo)

Olorunsogo is a considerably large-scale power station consisting of Phase-1 (335MW, simple cycle gas turbine) and Phase-2 (750MW, combined cycle) components with a total generation capacity of 1,085MW. This huge generation capacity is incompletely utilized, however, as the existing 330kV double transmission line is overloaded when an N-1 contingency occurs. The construction of an additional double-circuit 330kV transmission line connecting Olorunsogo power station, Ejio (Arigbajo) substation, and Likosi (Ogijo) substation will complete a 330kV loop system that will provide an alternative route when the 330kV transmission system fails.

(6) Construction of Ejio (Arigbajo) to make a conversion from a Radial System Concentrating on Ikeja West to a 330kV Loop System

Ejio is the end of the buildup area where population and power demand would be increased in the future. In addition, Ejio area is the best location to construct 330kV grid substation because existing 330kV lines pass through the area to connect south-north national grid.

Most of the 330kV transmission lines in the Lagos area currently enter into Ikeja West substation. The power entering the substation is stepped down to 132kV and transmitted to substations in and around the area. The reliability of the radial system is significantly compromised by the lack of diversion routes in case of line fault. The formulation of a 330kV loop system by the project will help improve the power supply reliability by securing contingency routes. When the Ejio (Arigbajo) substation becomes the base substation for the west area and north area, the loop system with the Ejio substation will be effective in alleviating the concentration of power flow into the Ikeja West substation. This arrangement is expected to be highly effective in meeting the increased power demand in the future. It has been concluded that the dense grid formed by the loop system in this project will protect the transmission system from voltage collapses under high-power-demand conditions in the future.

Chapter 4 Outline design and method of constructing the candidate components

Chapter 4 Outline design and method of constructing the candidate components

4-1 Outline of the Project Schedule

4-1-1 Project Objective

The project is intended is to expand the power supply capacity in Lagos and Ogun state, improve the reliability of the power supply and minimize power losses, thereby helping promote socioeconomic development in the area.

4-1-2 Outline of the Candidate Components

This project involves the installation and expansion of 330/132kV transmission lines to install and transmission substations in southwest Nigeria. An outline of the candidate components is shown in Table 4-1.

Table 4-1 Outline of the Candidate components

Component		ID	Name of Substation/Transmission line	Location/ Length	Voltage Class	Description
Substation	New	-	Likosi (Ogijo) S/S	Ogun State	330/132/33kV	New substation including incoming bay for existing transmission line
		-	Makogi (MFM) S/S	Ogun State	330/132/33kV	New substation including incoming bay for existing transmission line
		-	Ejio (Arigbajo) S/S	Ogun State	330/132/33kV	New substation including incoming bay for existing transmission line
		-	Ajegunle (New Agbara) S/S	Ogun State	330/132/33kV	New substation including incoming bay for existing transmission line
		-	Abule Oba (Redeem) S/S	Ogun State	132/33kV	New substation
		-	Badagry S/S	Lagos State	132/33kV	New substation
	Existing	-	Agbara S/S	Lagos State	132/33kV	Expansion of incoming bay
		-	Olorunsogo P/S	Ogun State	330/132/33kV	Expansion of outgoing bay
	Under construction	-	New Abeokuta S/S	Ogun State	132/33kV	Expansion of incoming bay New Abeokuta S/S is almost completed, except for the control system, the handover of which is expected soon.
Transmission	New (Double-circuit)	LI- (IK-SH)	Likosi (Ogijo) S/S-turn in/out Ikorodu S/S-Shagamu S/S line	4.82km in Double-circuit	132kV	Double-circuit (4-Circuit Tower , length: 2.41 km)
		LI-AO	Likosi (Ogijo) S/S-Abule Oba (Redeem) S/S line	7.78km	132kV	Double-circuit
		AJ-AG	Ajegunle (New Agbara) S/S-Agbara S/S line	21.7km	132kV	Double-circuit
		AJ-BA	Ajegunle (New Agbara) S/S-Badagry S/S line	36.2km in Double-circuit	132kV	Double-circuit (4-Circuit Tower, length: 6.0 km)
		EJ-NA	Ejio (Arigbajo) S/S-New Abeokuta S/S line	35.5km	132kV	Double-circuit

Component		ID	Name of Substation/Transmission line	Location/ Length	Voltage Class	Description
		EJ-LI	Ejio (Arigbajo) S/S-Likosi (Ogijo) S/S line with turn-in at Likosi (Ogijo) S/S as below - Omotosho P/S line (4 circuits) - Egbin P/S via Paras Energy P/S line (2 circuits) - MAKOGI (MFM) S/S line (2 circuits)	48.8km	330kV	Double-circuit
		MA- (IK-LI)	MAKOGI (MFM) S/S-turn in/out Likosi (Ogijo) S/S-Ikeja West S/S line	10.81km in Double-circuit	330kV	Double-circuit (Parallel Double Circuit Tower, length: 5.4 km)
		EJ-AJ	Ejio (Arigbajo) S/S-Ajegunle (New Agbara) S/S line with turn in/out Ikeja West S/S-Sakete S/S line	29.6km	330kV	Double-circuit
		EJ-OL	Ejio (Arigbajo) S/S-Olorunsogo P/S line with turn in existing Ejio (Arigbajo) S/S-Olorunsogo P/S line and turning in/out Ikeja West S/S-Ayede S/S line	13.9km	330kV	Double-circuit

Note: S/S: Substation, P/S: Power Station
Source: JICA preparatory survey team

4-2 Outline Design Conditions

4-2-1 Natural Conditions

Lagos and Ogun states are located in southwest Nigeria, with the Lagos and Victoria islands on the southern side of the Lagos lagoon and the Lagos port situated on the south coast. The area is classified as tropical. The elevation of Lagos state ranges from almost 0 m to about 50 m above sea level, while Ogun state ranges from 10 m to about 200 m.

(1) Location

The topographical character of Badagry S/S in Lagos state is coastal in character, while the remaining four sites in Ogun state are inland. The Ogun state is hilly country and the Ogun River flows on the west side of Makogi (MFM) S/S and Abule Oba (Redeem) S/S. The latitude and longitude of these sites are as shown in Table 4-2:

Table 4-2 Project Site and Topographic Area

No.	PROJECT SITE	STATE	Coordinates UTM Zone: 31N	Area (ha)
1	Likosi (Ogijo) Substation	Ogun state	558609.058mE 748529.402mN (Nigeria Minna)	25.1162
2	Makogi (MFM) Substation		542205.352mE 745927.357mN (Nigeria Minna)	20.09
3	Abule Oba (Redeem) Substation		552566.553mE 744146.485mN (Nigeria Minna)	9.62
4	Ajegunle (New Agbara) Substation		507792.00mE 735774.00mN (WGS84)	34.067
5	Ejio Substation		523212.279mE 756556.164mN (WGS84)	108.384

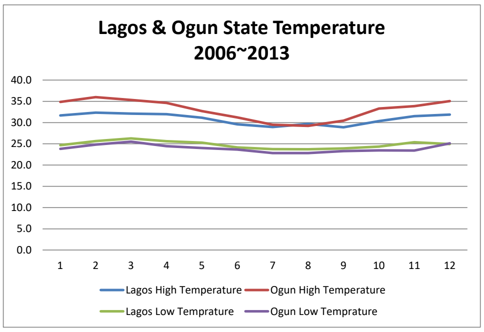
No.	PROJECT SITE	STATE	Coordinates UTM Zone: 31N	Area (ha)
6	Badagry Substation	Lagos state	483928.5850mE 710633.9150mN (WGS84)	19.605
			Total	217.8622

Source: JICA Study Team

(2) Weather Conditions (Temperature, Rainfall, Humidity, Wind speed, Thunder and Earthquakes)

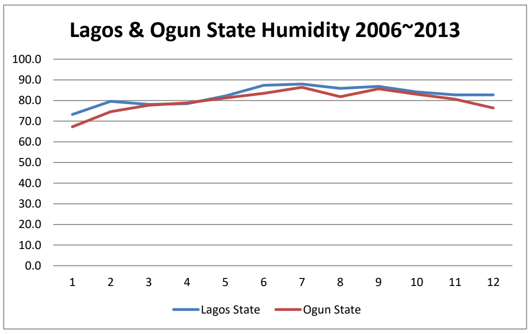
1) Temperature, Rainfall, Humidity

Figures 4-1 to 4-4 show the temperature, relative humidity and precipitation in Lagos and Ogun states in terms of the monthly average values from 2006 to 2013. Lagos and Ogun states are located by the coast and have a hot and humid climate, with high average temperatures and humidity. Temperatures peak in the period between December and April, with daytime highs often exceeding 35 degrees Celsius. June to September, meanwhile, is relatively cool, with a minimum temperature of around 25 degrees Celsius. There are two rainy seasons, the lighter of which occurring from September to October and the heavy rainy season from May to July.



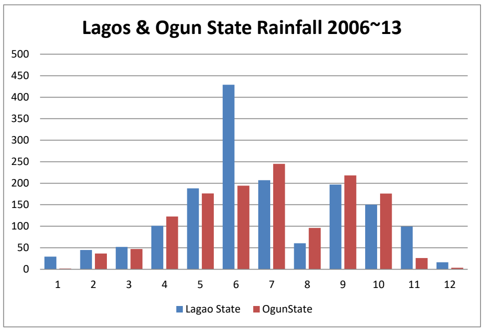
Source: Nigeria Meteorological Agency

Figure 4-1 Monthly Temperature



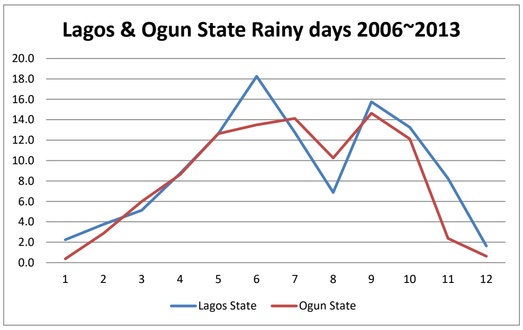
Source: Nigeria Meteorological Agency

Figure 4-2 Monthly Humidity



Source: Nigeria Meteorological Agency

Figure 4-3 Monthly Rainfall (2006-2013)



Source: Nigeria Meteorological Agency

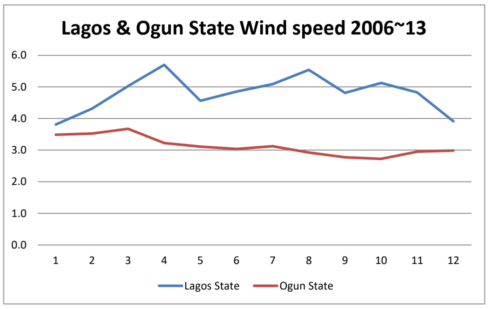
Figure 4-4 Monthly Rainy Days (2006-2013)

2) Wind Speed

The wind speed in Lagos and Ogun states, as recorded by the Nigeria Meteorological Agency, is shown in Figure 4-5. The Figure shows the average monthly value from 2006 to 2013, with an annual average wind speed of 4.5 m/s in Lagos state and 3.1 m/s in Ogun state. According to the Nigeria Meteorological Agency, winds strong enough to impact on power equipment etc. are rare in Lagos and Ogun states and cyclones etc. do not occur in those areas.

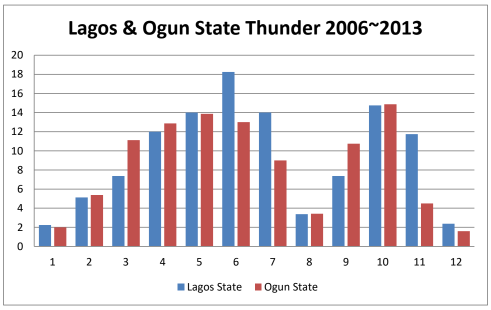
3) Thunder (Lightning)

The number of thunder days, as measured by the Nigeria Meteorological Agency, is shown in Figure 4-6 for Lagos and Ogun states respectively, in terms of the monthly average values from 2006 to 2013. Thunder days proliferate during the two rainy seasons and from March to November, thunder occurs at a frequency ranging from once every three days to every other day, except during the month of August. From December to February as well as in August, thunder is far less common. In 2013 the total number of thunder days in Lagos state was 144, which exceeds the average of 110 days.



Source: Nigeria Meteorological Agency

Figure 4-5 Wind Speed



Source: Nigeria Meteorological Agency

Figure 4-6 Thunder

4) Earthquakes

The Nigeria Meteorological Agency has not recorded any big earthquakes in Lagos or Ogun States. However, Table 4-3 shows a list of historical/instrumental earthquakes felt in Nigeria, with magnitudes of 4.0-6.5 observed several times.

Table 4-3 List of Historical/Instrumental Earthquakes Felt in Nigeria

S/N	Year-Month-Day	Origin Time	Felt Areas	Intensity/ Magnitude	Probable Epicenter	Coordinates	
1	1933	-	Warri	-	-	$05^{o}\ 45^{1}\ 23^{11}$E	$05^{o}\ 31^{1}\ 42^{11}$ N
2	1939-06-22	19:19:26	Lagos, Ibadan, Ile-Ife	6.5 (Ml)	Akwapin fault in Ghana	$03^{o}\ 23^{1}00^{11}$E	$06^{o}\ 30^{1}\ 11^{11}$N
3	1948-07-28	-	Ibadan	-	Close to Ibadan	-	-
4	1961-07-2	15:42	Ohafia	-	Close Ohafia area	$07^{o}\ 47^{1}\ 21^{11}$E	$05^{o}\ 37^{1}\ 15^{11}$N
5	1963-12-21	18:30	Ijebu-Ode	V	Close to Ijebu-Ode	-	-
6	1981-04 -23	12:00	Kundunu	III	At Kundunu village	-	-
7	1982-10-16	-	Jalingo, Gembu	III	Close to Cameroun Volcanic Line	-	-
8	1984-07-28	12:10	Ijebu-Ode, Ibadan, Shagamu, Abeokuta	VI	Close to Ijebu-Ode	-	-
9	1984-07-12		Ijebu Remo	IV	Close to Ijebu - Ode	$03^{o}22^{1}\ 00^{11}$E	$07^{o}\ 11^{1}\ 45^{11}$N
10	1984-08-02	10:20	Ijebu-Ode, Ibadan, Shagamu, Abeokuta	V	Close to Ijebu-Ode	-	-
11	1984-12-08	-	Yola	III	Close to Cameroun Volcanic Line	-	-
12	1985-06-18	21:00	Kombani Yaya	IV	Kombani Yaya	-	-
13	1986- 07-15	10 :45	Obi	III	Close to Obi town	$08\ ^{o}46^{1}$E	$08^{o}\ 22^{1}$N
14	1987-01-27	-	Gembu	V	Close to Cameroun Volcanic Line	$11^{o}\ 15^{1}$E	$06^{o}\ 42^{1}$N
15	1987 – 03-19	-	Akko	IV	Close to Akko	$10^{o}\ 57^{1}$E	$10^{o}\ 17^{1}$N
16	1987-05-24	-	Kurba	III	Close to Kurba village	$10^{o}\ 12^{1}$E	$11^{o}\ 29^{1}$N
17	1988-05-14	12:17	Lagos	V	Close to Lagos	-	-
18	1990-06-27	-	Ibadan	3.7(ML)	Close to Ijebu-Ode	$03^{o}\ 58^{1}$E	$07\ ^{o}22^{1}$N
19	1990-04-5	-	Jerre	V	Close to Jerre Village	-	-
20	1994-11-07	05:07:51	Ojebu-Ode	4.2(ML)	Dan Gulbi	-	-
21	1997	-	Okitipupa	IV	Close to Okitipupa Ridge	-	-
22	2000-08-15		Jushi-Kwari	III	Close to Jushi Kwari village	$07^{o}\ 42^{1}$E	$14^{o}\ 03^{1}$N
23	2000-03 -13	-	Benin	IV	Benin City (55Km from Benin)	-	-
24	2000-03-07	15:53:54	Ibadan, Akure, Abeokuta, Ijebu-Ode, Oyo	4.7(ML)	Close to Okitipupa	-	-
25	2000-05-07	11:00	Akure	IV	Close to Okitipupa Ridge	-	-
26	2001-05-19	-	Lagos	IV	Close to Lagos city	-	-
27	2002-08-08	-	Lagos	IV	Lagos city	-	-
28	2005-03	-	Yola	III	Close to Cameroun Volcanic Line	-	-
29	2006-03-25	11:20	Lupma	III	Close to Ifewara-Zungeru Fault	-	-
30	2009-09-11	-	Abomey-Calavi	II	Close to Benin	-	-
31	2011-11-05	-	Abeokuta	4.4	Close to Abeokuta	-	-

Source: Review of Historical and Recent Seismic Activity in Nigeria (February 2015)

(3) Environmental Conditions

Environmental conditions based on meteorological data are shown in Table 4-4.

Table 4-4 Weather Observation Data

State		Lagos	Ogun
Elevation above sea level		0~50m	10~200m
Ambient temperature	Max.	39°C	37.3°C
	Min.	22.4°C	21.2°C
	Ave.	27.8°C	28.5°C
Highest humidity		90%	89%
Max wind velocity		30.9m/s (*)	
Highest monthly rainfall		750mm	415mm
Remark	* Ground height of measurement: 1.9m		

Source: Nigeria Meteorological Agency and Local consultant; Best and Crompton Engineering Africa Ltd.

(4) Soil Conditions

- Likosi (Ogijo) S/S

A shallow foundation (spread footing) is considered adequate for the proposed on-site development because N values is more than 10 at a depth of 3 m or less according to the result as below.

Table 4-5 N-value of soil in Likosi (Ogijo) S/S

Borehole No.	Depth (m)	N Values
1	0.00 - 3.00	5 - 13
	3.00 - 8.00	15 - 22
	8.00 - 14.00	24 - 32
	14.00 - 20.00	31 - 36
2	0.00 - 4.00	4 - 14
	4.00 - 9.00	17 - 21
	9.00 - 15.00	26 - 31
3	0.00 - 3.00	4 - 12
	3.00 - 8.00	15 - 20
	8.00 - 15.00	22 - 30

Source: JICA Study Team

Table 4-6 Bearing capacity of soil in Likosi (Ogijo) S/S

Depth (m)	Allowable bearing capacity (kN/m^2)
0.00 - 0.50	60
0.50 - 1.00	115
1.00 - 1.50	215
1.50 - 2.00	320

Source: JICA Study Team

- Makogi (MFM) S/S

A shallow foundation (spread footing) is considered adequate for the proposed on-site development because N values is more than 10 at a depth of 3 m or less according to the result as below. The site is flodded by water level 1m between dry and wet seasons, hence the conclusion that soil filling is considered for the foundation design.

Table 4-7 N-value of soil in Makogi (MFM) S/S

Borehole No.	Depth (m)	N Values
1	0.00 - 3.00	6 - 15
	3.00 - 7.50	18 - 26
	7.50 - 15.00	28 - 32
2	0.00 - 2.25	5 - 13
	2.25 - 8.25	15 - 30
	8.25 - 15.00	30 - 33
3	0.00 - 3.75	5 - 14
	3.75 - 12.00	12 - 27
	12.00 - 20.00	30 - 33

Source: JICA Study Team

Table 4-8 Bearing capacity of soil in Makogi (MFM) S/S

Depth (m)	Allowable bearing capacity (kN/m^2)
0.00 - 0.50	60
0.50 - 1.00	104
1.00 - 1.50	235
1.50 - 2.00	257

Source: JICA Study Team

- Abule Oba (Redeem) S/S

The foundation of the structures should be a shallow foundation because N values is more than 10 at a depth of 3 m or less according to the following result:

Table 4-9 N-value and Bearing capacity of soil in Abule Oba (Redeem) S/S

Borehole No.	Depth (m)	N Values	Allowable bearing capacity (KN/m^2)
1	0.6	13	52
	2.1	100	400
2	0.6	4	16
	2.1	14	56
	3.6	20	80
	5.1	100	400
	6.6	100	400
3	0.6	4	16
	2.1	9	36
	3.6	15	60
	5.1	59	236
	6.6	100	400

- Ajegunle (New Agbara) S/S

A shallow foundation (spread footing) is considered adequate for the proposed on-site development because N values is more than 10 at a depth of 3 m or less according to the following result:

Table 4-10 N-value of soil in Ajegunle (New Agbara) S/S

Borehole No.	Depth (m)	N Values
1	0.00 - 2.00	14
	2.00 - 9.00	16 - 21
	9.00 - 15.00	24 - 31
2	0.00 - 1.50	18
	1.50 - 11.00	17 - 24
	11.00 - 20.00	21 - 30
3	0.00 - 3.00	15 - 19
	3.00 - 8.00	18 - 25
	8.00 - 15.00	23 - 30

Source: JICA Study Team

Table 4-11 Bearing capacity of soil in Ajegunle (New Agbara) S/S

Depth (m)	Allowable bearing capacity (kN/m^2)
0.00 - 0.50	156
0.50 - 1.00	214
1.00 - 1.50	402

Source: JICA Study Team

- Badagry S/S

According to the following result, a shallow foundation could be considered for any ancillary facilities with foundation pressure not exceeding the allowable bearing capacity stated below. Shallow is restricted to the use of stiffened raft slabs because it helps minimize differential settlement. For the proposed structures, with foundation pressure exceeding the allowable bearing pressure stated below, pile foundations should be considered and each tower in the area should be examined by soil investigation. The water level of lagoon around the site changes over 1.5 m between dry and wet seasons and ground elevation is a few meters, hence the conclusion that soil filling is required for earthworks to avoid on-site flooding.

Figure 4-7 Site condition around Badagry S/S

Table 4-12 N-value of soil in Badagry S/S

Borehole No.	Depth (m)	N Values
1	0.00 - 4.50	2 - 6
	4.50 - 10.50	12 - 26
	10.50 - 15.00	30 - 34
2	0.00 - 5.25	2 - 5
	5.25 - 9.00	14 - 23
	9.00 - 15.00	26 - 31
3	0.00 - 5.25	2 - 5
	5.25 - 11.25	12 - 24
	11.25 - 20.00	28 - 32

Source: JICA Study Team

Table 4-13 Bearing capacity of soil in Badagry S/S

Depth (m)	Allowable bearing capacity (kN/m^2)
0.00 - 0.50	17
0.50 - 1.00	17
1.00 - 1.50	29
1.50 - 2.00	29

Source: JICA Study Team

- Ejio (Arigbajo) S/S

A shallow foundation (spread footing) is considered adequate for the proposed on-site development because N values is more than 10 at a depth of 3 m or less according to the following result:

Table 4-14 N-value and Bearing capacity of soil in Ejio (Arigbajo) S/S

Borehole No.	Depth (m)	N Values	Allowable bearing capacity (kN/m^2)
1	0.6	13	52
	2.1	100	400
2	0.6	4	16
	2.1	14	56
	3.6	20	80
	5.1	100	400
	6.6	100	400
3	0.6	4	16
	2.1	9	36
	3.6	15	60
	5.1	59	236
	6.6	100	400

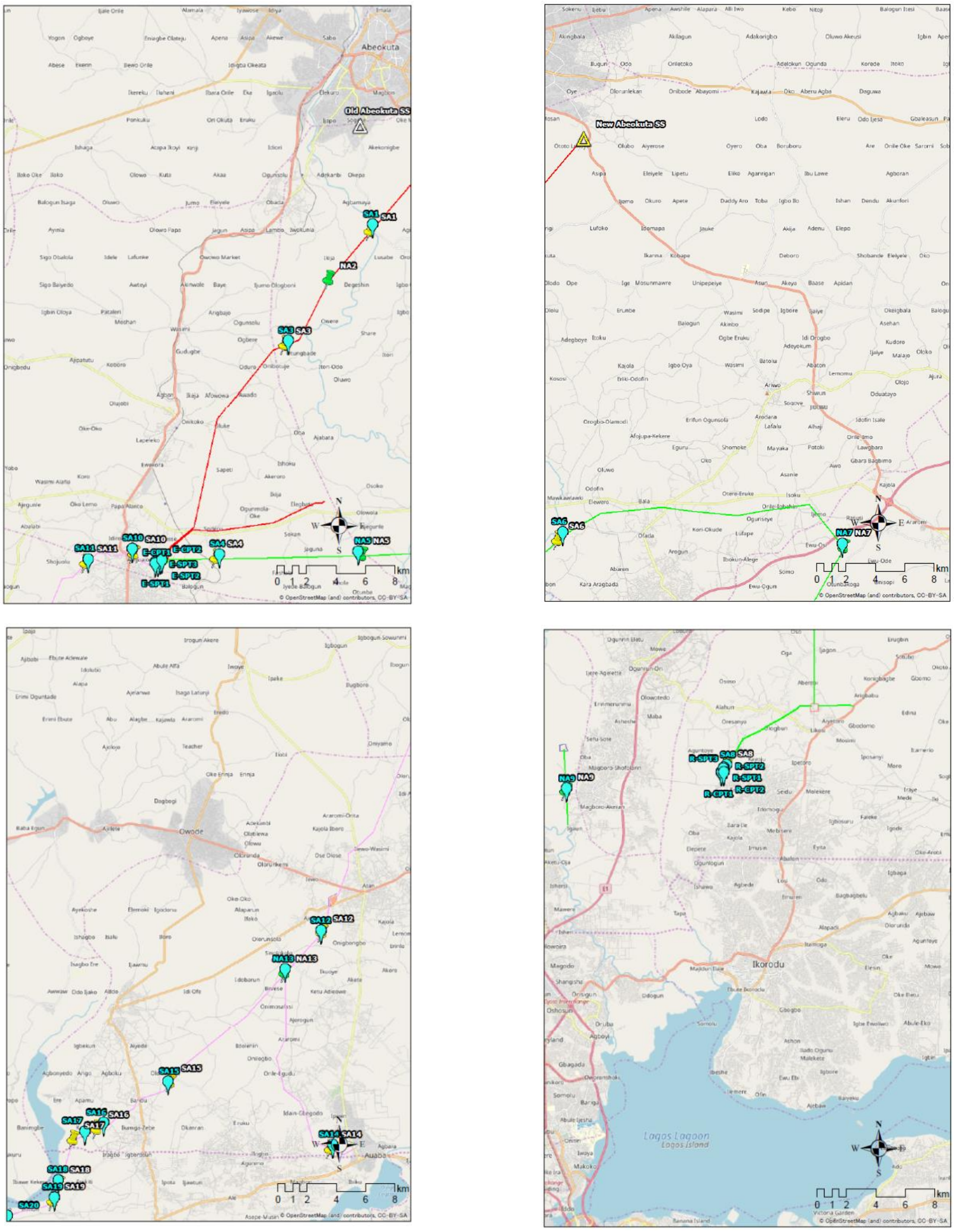
Source: JICA Study Team

- Transmission line

In this survey, about 28 locations along the transmission routes where wetlands and lagoons are expected to cause soft soil were selected for the soil survey, in which ground strength was confirmed in preparation for the basic tower foundation design. If the ground is found to be sufficiently strong at depths deeper than 3m, inverted t-shaped foundations will be used, but otherwise mat or pile foundations will be used. To judge whether the ground is sufficiently strong, the soil survey N-value must be at least 20 at depths of between three and five meters and must maintain an equivalent or stronger value at lower depths down to 10m. The selection conditions for each type of foundation are shown below:

- N-value <10: pile foundations
- N-value 10 - 20: mat or pile foundation
- N-value >20: inverted T-shape foundation

The contents of the soil survey are as follows:



Source: JICA Study Team

Figure 4-8 Soil investigation points for Transmission tower foundation

- 330 kV Transmission line

A shallow foundation (spread footing) is considered adequate for the proposed on-site development according to the following result: The soil investigation points are shown in the Figure below.

Table 4-15 N-value and Bearing capacity of soil in 330 kV Transmission line

Boring No.	Depth (m)	N-Value	Ultimate bearing capacity (kN/m^2)	Allowable bearing capacity (kN/m^2)
SA4	0.6	10	100	40
	2.1	21	210	84
	3.6	34	340	136
	5.1	90	900	360
	6.6	100	1000	400
NA5	0.6	19	190	76
	2.1	53	530	212
	3.6	52	520	208
	5.1	90	900	360
	6.6	100	1000	400
SA6	0.6	69	690	276
	2.1	25	250	100
	3.6	31	310	124
	5.1	100	1000	400
	6.6	100	1000	400
	8.1	100	1000	400
NA7	0.6	19	190	76
	2.1	100	1000	400
	3.6	100	1000	400
NA9	0.6	26	260	104
	2.1	29	290	116
	3.6	93	930	372
	5.1	100	1000	400
	6.6	100	1000	400
SA10	0.6	9	90	36
	2.1	48	480	192
	3.6	62	620	248
	5.1	67	670	268
	6.6	87	870	348
	8.1	100	1000	400
	9.6	100	1000	400
SA11	0.6	3	30	12
	2.1	20	200	80
	3.6	100	1000	400
	5.1	100	1000	400
	6.6	100	1000	400

Source: JICA Study Team

- 132 kV Transmission line

A shallow foundation (spread footing) is considered adequate for the proposed on-site development except for Boring Nos. SA12, SA14, SA16, SA17, SA19 and SA20 according to the result below. The abovementioned Boring Nos. are located in Badagry area, swampy soil or near a lagoon as shown in the photos below, the Allowable bearing capacity at depths shallower than 5m is weak, but subsoil at depth deeper than 5m is high bearing capacity and the ground water level is high with spring water. In conclusion, pile foundations should be applied in the area and a soil investigation implemented in each tower during construction.

Figure 4-9 Soil condition near the lagoon

Figure 4-10 Soil condition in the swamp

Table 4-16 N-value and Bearing capacity of soil in the 132 kV Transmission line

Boring No.	Depth (m)	N-Value	Ultimate bearing capacity (kN/m^2)	Allowable bearing capacity (kN/m^2)
SA1	0.6	4	40	16
	2.1	21	210	84
	3.6	26	260	104
	5.1	32	320	128
	6.6	37	370	148
	8.1	60	600	240
	9.6	100	1000	400
SA2	0.6	3	30	12
	2.1	56	560	224
	3.6	82	820	328
	5.1	100	1000	400
	6.6	100	1000	400
	8.1	100	1000	400
SA3	0.6	10	100	40
	2.1	60	600	240
	3.6	84	840	336
	5.1	100	1000	400
SA8	0.6	2	20	8
	2.1	10	100	40
	3.6	19	190	76
	5.1	32	320	128
	6.6	40	400	160
	8.1	50	500	200
	9.6	100	1000	400
SA12	0.6	4	40	16
	2.1	2	20	8
	3.6	2	20	8
	5.1	42	420	168
	6.6	46	460	184
	8.1	100	1000	400
	9.6	100	1000	400
NA13	0.6	4	40	16
	2.1	30	300	120

Boring No.	Depth (m)	N-Value	Ultimate bearing capacity (kN/m^2)	Allowable bearing capacity (kN/m^2)
	3.6	100	1000	400
SA14	0.6	4	40	16
	2.1	4	40	16
	3.6	17	170	68
	5.1	97	970	388
	6.6	100	1000	400
	8.1	100	1000	400
SA15	0.6	2	20	8
	2.1	37	370	148
	3.6	80	800	320
	5.1	45	450	180
	6.6	40	400	160
	8.1	80	800	320
	9.6	100	1000	400
SA16	0.6	2	20	8
	2.1	12	120	48
	3.6	34	340	136
	5.1	100	1000	400
	6.6	100	1000	400
SA17	0.6	2	20	8
	2.1	6	60	24
	3.6	11	110	44
	5.1	49	490	196
	6.6	100	1000	400
	8.1	100	1000	400
SA18	0.6	2	20	8
	2.1	20	200	80
	3.6	35	350	140
	5.1	50	500	200
	6.6	44	440	176
	8.1	100	1000	400
SA19	0.6	2	20	8
	2.1	17	170	68
	3.6	11	110	44
	5.1	100	1000	400
SA20	0.6	3	30	12
	2.1	4	40	16
	3.6	17	170	68
	5.1	41	410	164
	6.6	65	650	260
	8.1	100	1000	400

Source: JICA Study Team

4-2-2 Nigeria's Power System

The design of the transmission line is based on the table below.

Table 4-17 Nigeria's Power System

Item	Criteria	
Nominal voltage	330kV	132 kV
Highest voltage	362kV	145kV
Lightning impulse withstand voltage	1,175kV	650kV
Power-frequency withstand voltage	510kV	275kV
Frequency (Allowance)	50 Hz (48.5～51.75Hz)	
Earth system	Solid grounding system	
Minimum surface leakage distance	16-31mm/kV	
Right of way for transmission line	50m	30m

Item	Criteria	
Minimum clearance (between conductor and support)	145cm	70cm
Design maximum wind velocity	32m/s	
Transmission line field intensity	< 10kV/m (At 2m above ground level directly under the transmission line) < 2kV/m (At the edge of the transmission line occupancy range)	

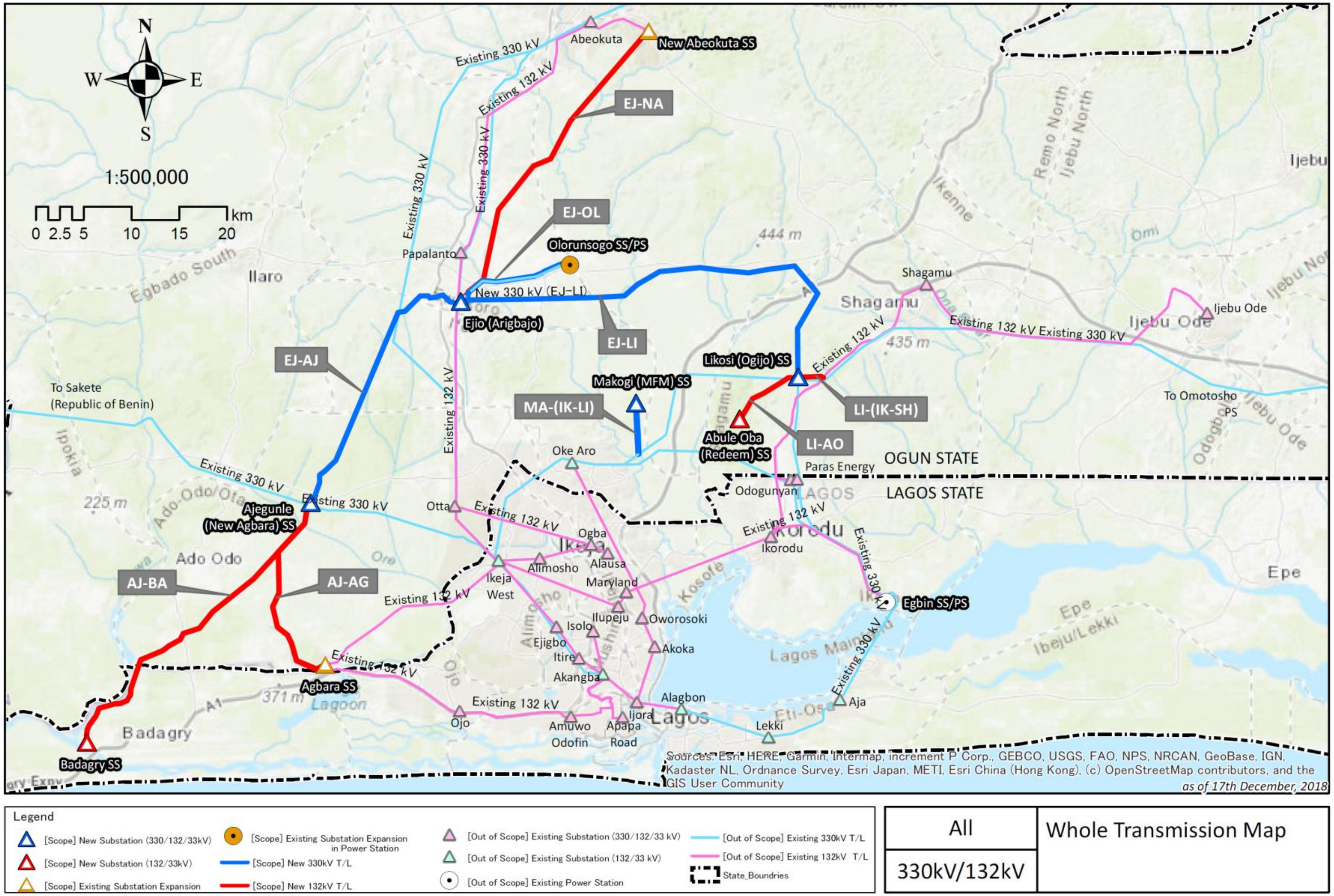
Source: TCN and NERC: Nigeria Electricity Regulatory commission

4-3 Outline Design of the Transmission Line

4-3-1 Transmission Line Plan

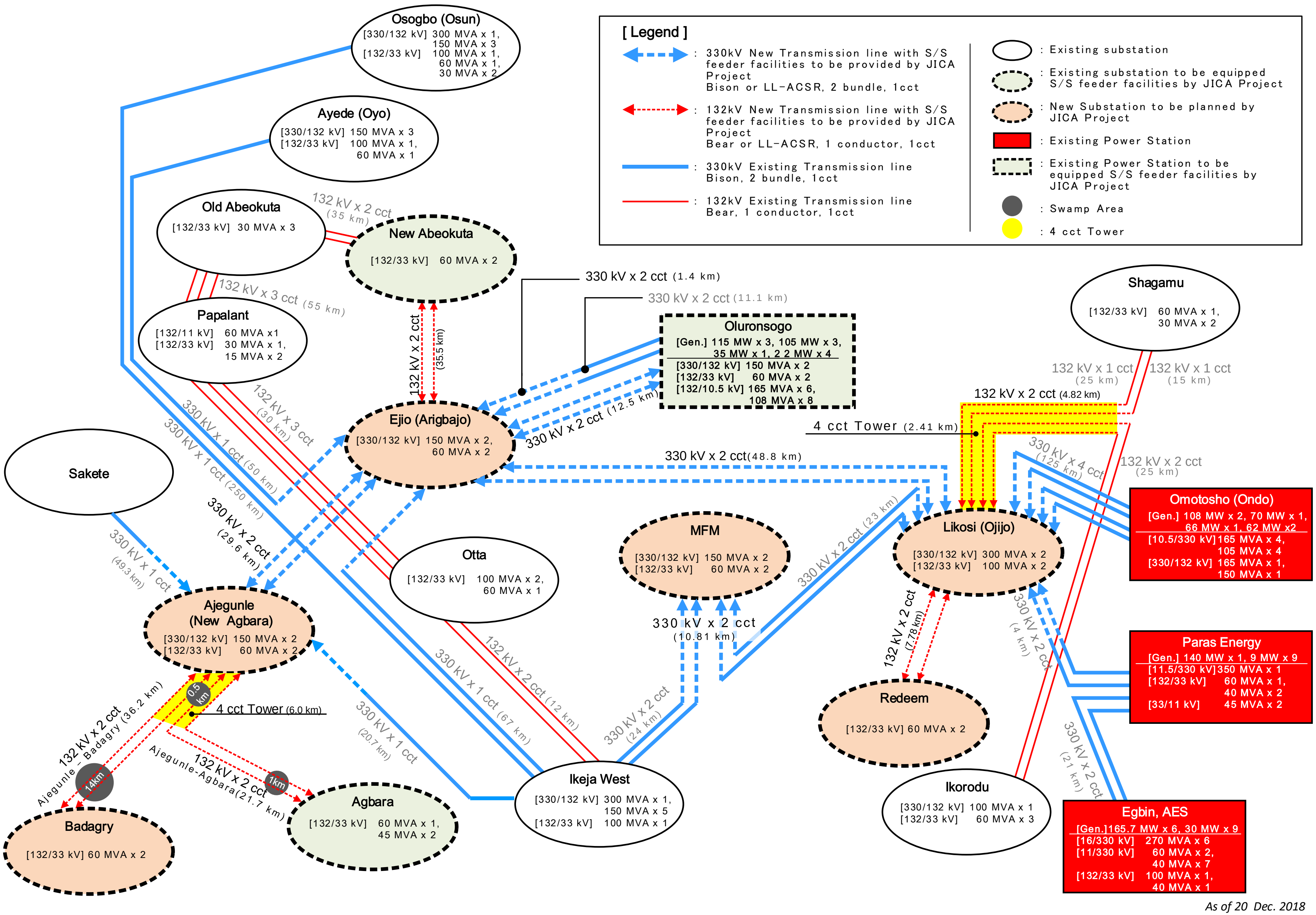
(1) Scheme of the Transmission Plan

Lagos state and the southern part of Ogun state were selected as candidate target regions for the project based on discussions with TCN. Site location plans for the substations and transmission lines are shown in Figure 4-11 and a transmission line system diagram is shown in Figure 4-12.



Source: JICA Study Team

Figure 4-11 Site Location



Source: JICA Study Team

Figure 4-12 Transmission System

(2) Transmission Route

The total length of the candidate transmission line is about 209.1 km, about 106 km of which is a 132kV transmission line and 103.1 km of which a 330kV transmission line. This project involves installing a new transmission line and modifying an existing transmission line. Each transmission route is detailed below and the transmission routes are designed using satellite images (Google earth, etc.) and local site surveys.

This project also includes incoming and outgoing feeders to newly constructed substations, which are connected to both existing and planned transmission lines.

1) New Transmission Line

The installation of a new transmission line is planned based on the requirement letter from TCN.

a) Transmission line: Likosi (Ogijo) S/S-turn in/out Ikorodu S/S-Shagamu S/S line [LI- (IK-SH)] A π-branch was installed in the existing double-circuit 132kV transmission lines connecting the Ikorodu and Shagamu S/S, so that about 4.82 km of the new 132kV-line could be installed as a lead-in to the Likosi (Ogijo) S/S (constructed as part of this project). This transmission line is connected to Likosi (Ogijo) S/S of the candidate component and comprises a 132kV double-circuit line for Ikorodu S/S and a 132kV double-circuit line for Shagamu S/S, hence a total of four circuits are used, including 132kV four-circuit towers.

The altitude of the connection point with the existing 132kV-line between Ikorodu and Shagamu S/S is approx. 75 m while the altitude of the connection point to Likosi (Ogijo) S/S is approx. 100 m, meaning the LI- (IK-SH) transmission line spans virtually flat topography.

If this four-circuit transmission line comprised two double-circuit transmission lines running parallel on two sets of double-circuit transmission towers, the land area needed for the transmission lines would be doubled. In addition, land would need to be acquired from Thames Valley University, which lies along the line route, but acquisition proved difficult. Based on discussions with TCN, it was decided that four-circuit transmission towers would be used, to cut the land area needed in half and obviate the need for the land acquisition. The protection sysytem for the four-circuit tower is generally differential relay, After discussing it with TCN, the protection system including all substations connected to Likosi (Ogijo) S/S are not rehabilitated into differential relay for cost reduction. In addition, because power from the four-circuit transmission lines can be switched to a bypass grid in the event of a breakdown, this section of the grid is not crucial, eliminating the need for high reliability. Accordingly, permission was granted to reduce the reliability of the four-circuit transmission lines and four-circuit transmission towers were used. A comparison of two pairs of double-circuit transmission towers vs. four-circuit transmission towers is shown in Table 4-18.

The LI- (IK-SH) transmission line is located alongside the existing 330kV transmission line between Ikeja West S/S and Omotosho Power Station (P/S). The existing 330kV transmission line is a double-circuit line, but there are plans to modify it into a four-circuit transmission line by adding a double-circuit transmission line between Omotosho P/S and Likosi (Ogijo) S/S. Accordingly, clearance will need to be reviewed for LI- (IK-SH) with respect to the planned four-circuit transmission line.

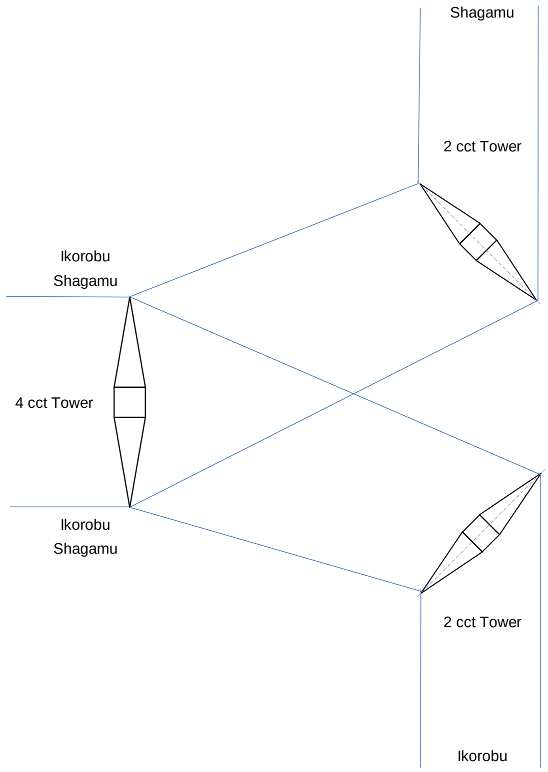
The existing double-circuit 132kV transmission lines, connecting Ikorodu S/S Odogunyan S/S and Shagamu S/S is a single-circuit transverse array as of July 2018, TCN plans to upgrade the line to a double-circuit (vertical layout). The Project of upgrading is expected to be completed on July 2012 at first, however it is under construction as of January 2019. Although the delay is due to internal issues between the EPC partners, the issue has been resolved. All materials already are delivered at site, tower erection is almost completed. It is expected that the time of completion is October 2019.

A draft modification of LI- (IK-SH) is shown in Figure 4-13. Route information and a route map are shown in Table 4-19 and Figure 4-14.

Table 4-18 Comparison of 2 x 2-Circuit Transmission Towers with 4-Circuit Transmission Tower

Item	2 x 2-Circuit Transmission Towers	4-Circuit Transmission Tower
Reliability	○ ● If one of the double-circuit towers topples over or breaks, the other double-circuit tower will still be able to transmit power.	△ ● If the four-circuit tower topples over or breaks, power transmission becomes impossible. ● Lightning strikes are more likely due to the taller tower.
Protection	○	× Unless all substations connected to the four-circuit facilities are appropriate, construction costs will increase as follows: ● Protection panel upgrade (differential relay, etc.) ● Transmission system upgrade (OPGW, etc.)
Maintenance	○ ● When double-circuit transmission tower is under maintenance, only single-circuit under maintenance is de-energized, the other three circuits can be in operation.	△ ● When a single-circuit of upper side is under maintenance, the single-circuit of lower side is de-energized. ● When a single-circuit is under maintenance while the other three circuit is in operation, it requires significant technical skill and stringent safety measures.
Constructed in Nigeria	○	△ ● A contractor with experience of constructing four-circuit towers is required, due to the special needs and protection requirements involved. ● Because few contractors are interested in undertaking such projects in Nigeria, it will be difficult to construct four-circuit towers and upgrade the substations.
Land Required	× ● Twice as much land required (increases the cost of relocating residents)	○

Item	2 x 2-Circuit Transmission Towers	4-Circuit Transmission Tower
	● Problems with relocating residents.	
Total Cost	△	× (Rated △ if protection is not upgraded).
Assessment	△	× (Rated △ if protection is not upgraded, but inferior reliability).

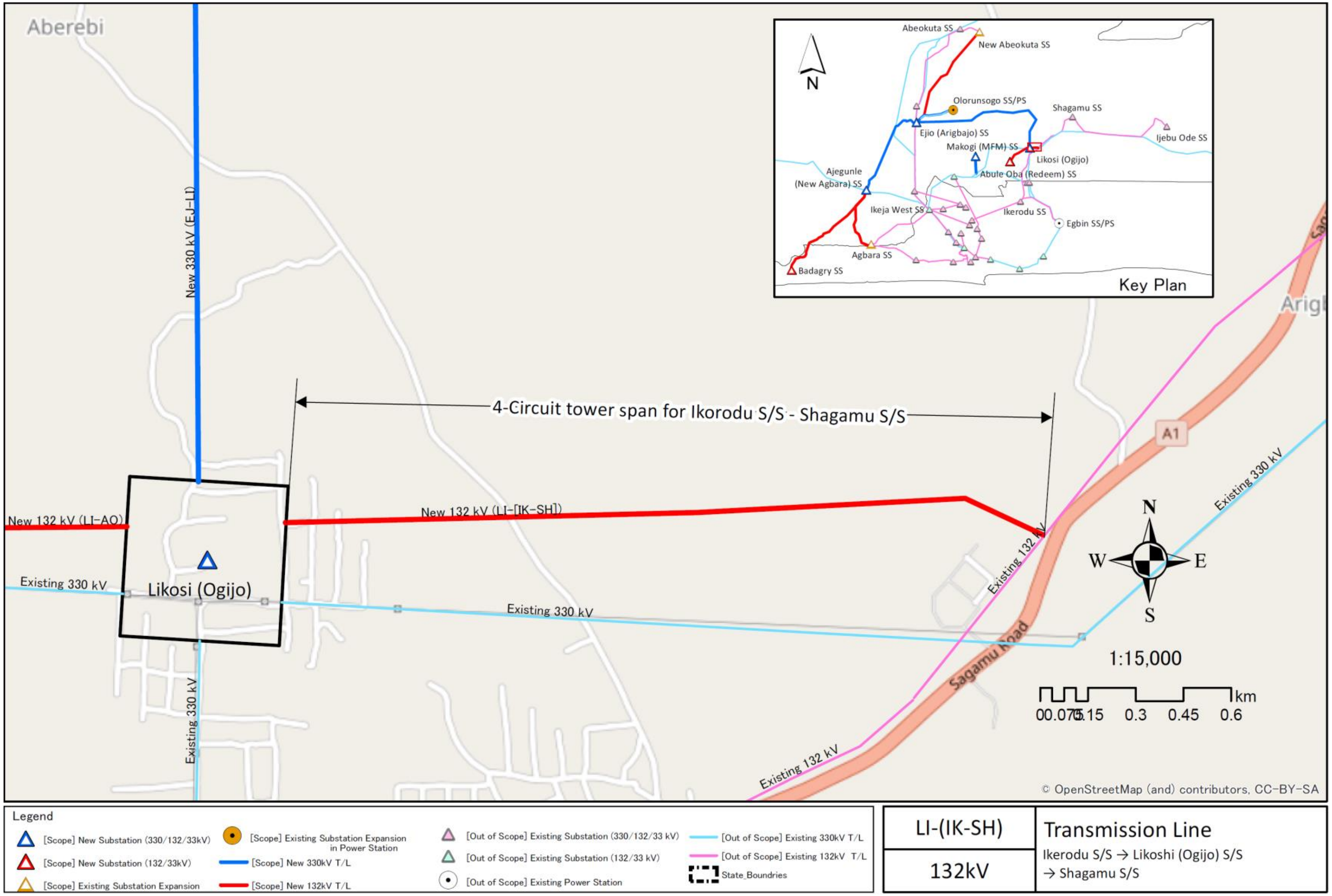


Source: JICA Study Team

Figure 4-13 Modification Plan for the Double-circuit Project of Ikorodu-Shagamu 132kV Transmission Line

Table 4-19 LI- (IK-SH) Route Information

S/N 18-1	From:	Existing transmission line (Ikorodu-Shagamu)
	To:	Likosi (Ogijo) S/S
Length	Approx. 4.82 km in double-circuit	
Voltage	132kV	
Layout	Four-circuit (four-circuit transmission towers), vertical. ➢ Ikorodu → Likosi (Ogijo) S/S, double-circuit ➢ Shagamu → Likosi (Ogijo) S/S, double-circuit	

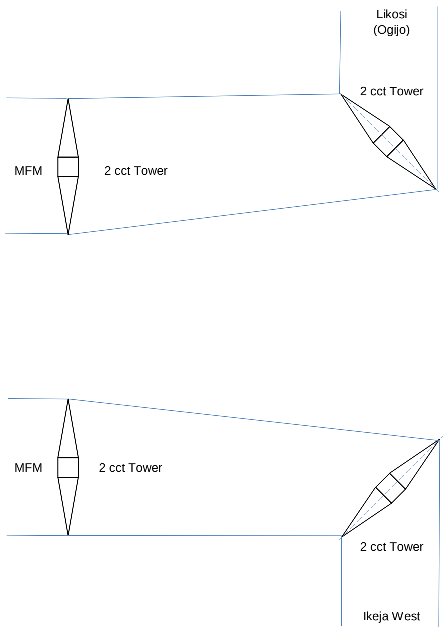


Source: JICA Study Team

Figure 4-14 S/N 18-1 Route Map

b) Transmission line: MAKOGI (MFM) S/S-turn in/out Likosi (Ogijo) S/S-Ikeja West S/S line [MA- (IK-LI)]

The 330kV double-circuit transmission line from Likosi S/S and Ikeja West is cut and then connected to the MA- (IK-LI) 330kV transmission line (Figure 4-15). Accordingly, two sets of double-circuit towers will be used and the total length of the double-circuit transmission lines will be about 10.81 km. This transmission line is connected to Makogi (MFM) S/S of the candidate component. The altitude of the cut point is 11 m and the altitude of Makogi (MFM) S/S is 13 m, so the route spans virtually flat topography. Because the area around the Makogi (MFM) S/S is flooded in the rainy season, the tower foundation must be elevated. A shallow foundation (spread footing) is considered adequate for the proposed on-site development according to the soil investigation result. The route information (Table 4-20) and a route map (Figure 4-16) are as follows:



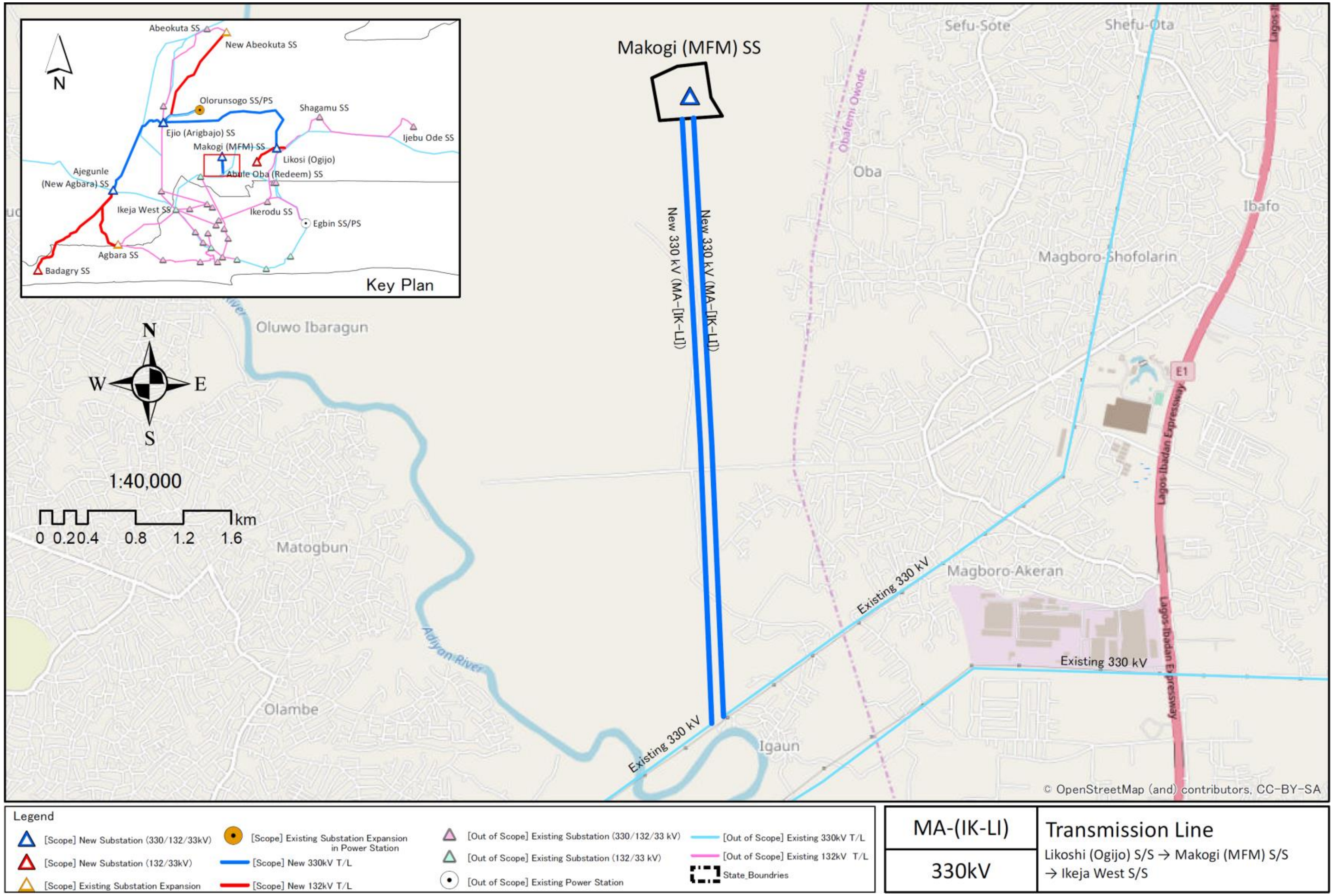
JICA Study Team

Figure 4-15 Current Condition and Modification Plan

Table 4-20 MA- (IK-LI) Proposed Route Information

MA- (IK-LI)	From: Existing transmission line (Likosi (Ogijo) S/S-Ikeja West S/S)
	To: Makogi (MFM) S/S
Length	Approx. 10.81 km in double-circuit
Voltage	330kV
Layout	Four-circuit (double-circuit tower × 2), vertical. ➢ Ikeja West S/S → Makogi (MFM) S/S, double-circuit ➢ Likosi (Ogijo) S/S → Makogi (MFM) S/S, double-circuit

JICA Study Team



Source: JICA Study Team

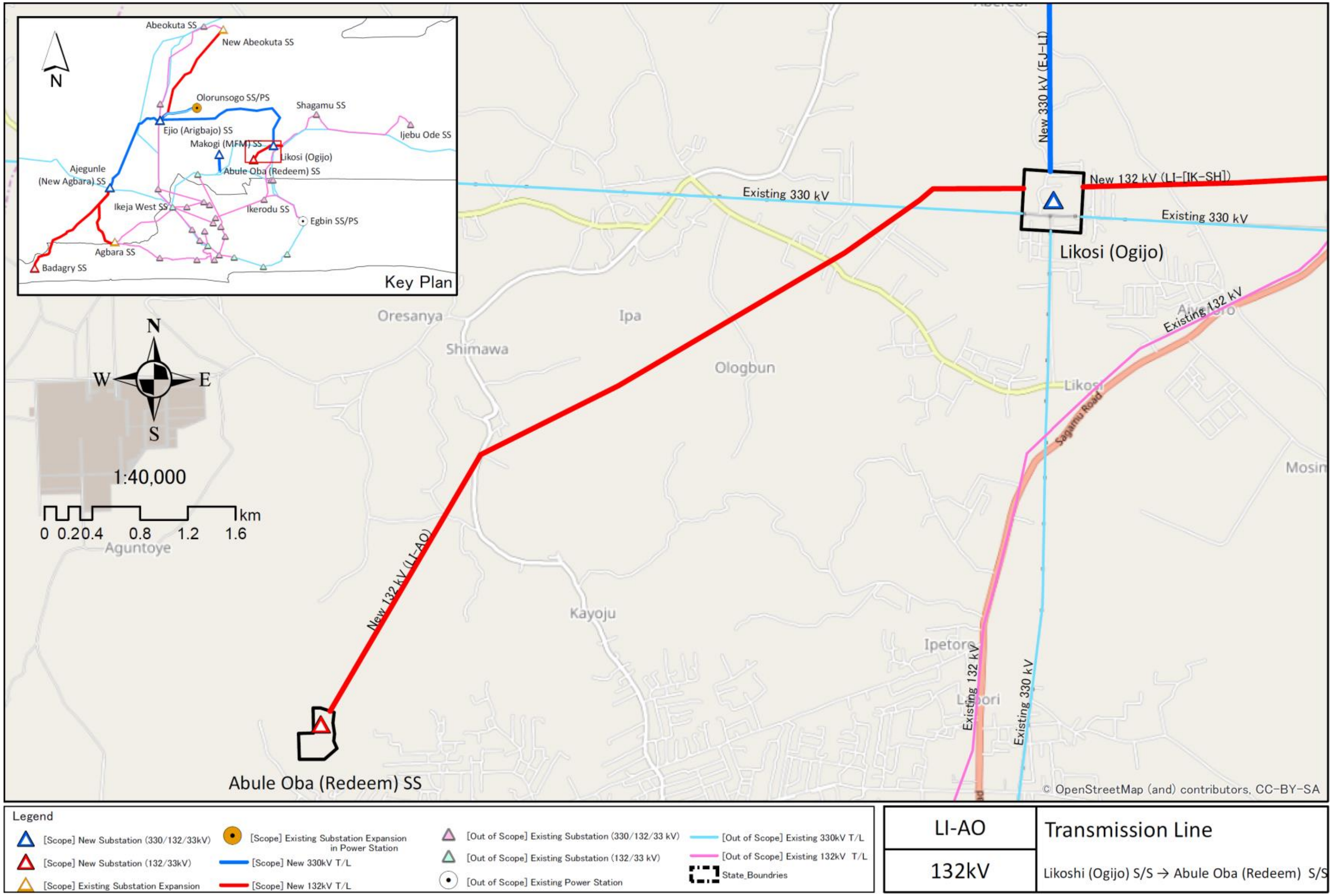
Figure 4-16 MA- (IK-LI) Proposed Route Map

c) Transmission line: Likosi (Ogijo) S/S-Abule Oba (Redeem) S/S line (LI-AO)

This transmission line is a 132kV double-circuit line connecting Likosi (Ogijo) S/S and Abule Oba (Redeem) S/S, with a length of approx. 7.78 km. The altitude of Likosi (Ogijo) S/S is 100 m while that of Abule Oba (Redeem) S/S is 14 m. There are no dense residential areas along the transmission route, but it does traverse a large forest, hence the need for a construction road. A shallow foundation (spread footing) is considered adequate for the proposed on-site development according to the result of the soil investigation. The route information and map are shown in Table 4-21 and Figure 4-17.

Table 4-21 LI-AO Route Information

LI-AO	From: Likosi (Ogijo) S/S
	To: Abule Oba (Redeem) S/S
Length	Approx. 7.78 km
Voltage	132kV
Layout	Double-circuit, vertical



Source: JICA Study Team

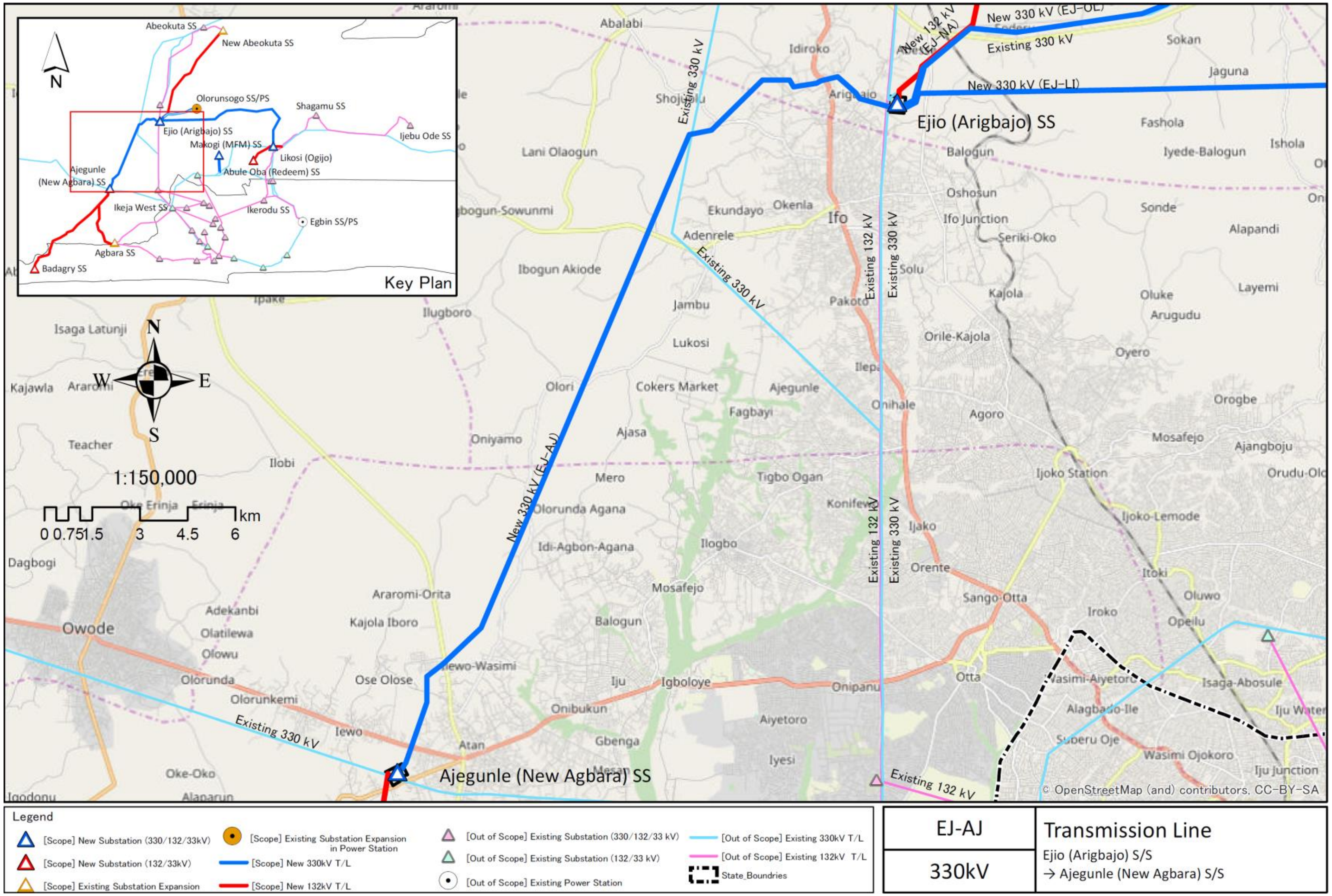
Figure 4-17 LI-AO Route Map

d) Transmission line: Ejio (Arigbajo) S/S-Ajegunle (New Agbara) S/S line with turn in/out Ikeja West S/S-Sakete S/S line (EJ-AJ)

This transmission line is a 330kV double-circuit line connecting Ejio (Arigbajo) S/S and Ajegunle (New Agbara) S/S, with a length of approx. 29.6 km. The transmission line intersects the existing single-circuit transmission line (330kV) between Ikeja West and Osogbo S/S. The route of the EJ-AJ transmission line includes a thickly residential area in the region 2 km west of the Ejio (Arigbajo) S/S, which also includes major road arteries. The altitude of Ejio (Arigbajo) S/S is approx. 80 m while the altitude at a distance of 5 km westward is approx. 110 m, so the EJ-AJ transmission line initially travels upslope from Ejio (Arigbajo) S/S to the west. The altitude of the Ajegunle (New Agbara) S/S, however, is 32 m, so the EJ-AJ transmission line gradually changes to a downslope route toward Ajegunle (New Agbara) S/S. There are hardly any houses on this part of the route but a road for construction is required as the route traverses a forested area. The existing 330 kV single-circuit transmission line from Ikeja West S/S to Sakete S/S traverses Ajegunle (New Agbara) S/S, connecting at Ajegunle (New Agbara) S/S via an open connection. A shallow foundation (spread footing) is considered adequate for the proposed on-site development according to the soil investigation result. The route information and map are shown in Table 4-22 and Figure 4-18.

Table 4-22 EJ-AJ Route Information

EJ-AJ	From: Ejio (Arigbajo) S/S
	To: Ajegunle (New Agbara) S/S
Length	Approx. 29.6 km
Voltage	330kV
Layout	Double-circuit, vertical Including the turn in and out of the Ikeja West S/S-Sakete S/S line at Ajegunle (New Agbara) S/S



Source: JICA Study Team

Figure 4-18 EJ-AJ Route Map

e) Transmission line: Ajegunle (New Agbara) S/S-Agbara S/S line (AJ-AG)

This transmission line is a 132kV double-circuit line between Ajegunle (New Agbara) S/S and the existing Agbara S/S, with a length of approx. 21.7 km, while Ajegunle (New Agbara)-Badagry (AJ-BA) also shares the right of way by four-circuit towers, the sharing section is 6-km from Ajegunle S/S. Based on discussions with TCN, it was determined that since AJ-AG and AJ-BA are not crucial transmission line and power can be re-routed from them in the event of a breakdown, high reliability is unnecessary. Accordingly, reliability was downgraded on this sharing section as a compromise and four-circuit towers were selected to cut the land acquisition costs. The altitude of Ajegunle (New Agbara) S/S is approx. 36 m, although the AJ-AG transmission line gradually travels upslope up to a distance of 50 m from Ajegunle (New Agbara) S/S, approx. 16.5 km of the route to the existing Agbara S/S (Altitude: 15 m) is downward-sloping. The 5 km area around the Agbara S/S is heavily residential. According to the soil investigation result, the area around Agbara S/S is swampy soil, the soil at depths deeper than 5m is a bearing ground, but subsoil at depth shallower than 5m is soft because the area is a body of water, it is concluded that a pile foundation should be applied in the area and a soil investigation implemented in each tower during construction. The route information and map are shown in Table 4-23 and Figure 4-19.

Table 4-23 AJ-AG Route Information

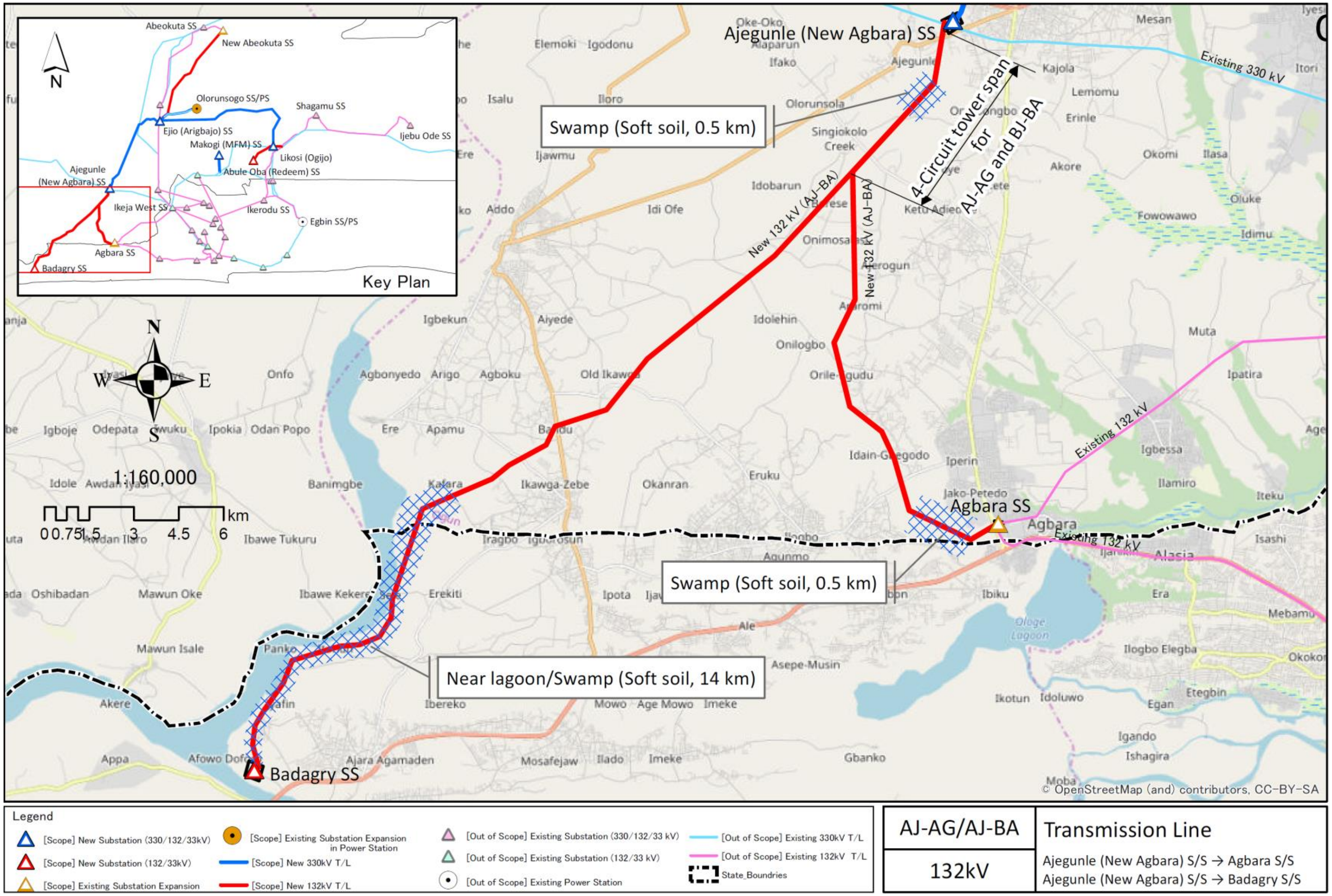
AJ-AG	From: Ajegunle (New Agbara) S/S
	To: Agbara S/S (Existing)
Length	Approx. 21.7 km
Voltage	132kV
Layout	Double-circuit (four-circuit towers in the section parallel to AJ-BA), vertical.

f) Transmission line: Ajegunle (New Agbara) S/S-Badagry S/S line (AJ-BA)

This transmission line is a 132kV double-circuit line between Ajegunle (New Agbara) S/S and Badagry S/S, with a length of approx. 36.2 km. As stated in former sections, four-circuit towers will be used on the 6 km section running parallel to AJ-AG. The elevation in the four-circuit tower section is approximately 50 m, after which a gentle slope leads down to the Badagry S/S at an elevation of about 5 m. Lagoons and swamp area are confirmed along the transmission line route. According to the soil investigation, the soil at depths deeper than 5m is a bearing ground, but subsoil at depth shallower than 5m is soft and the ground water level high with spring water. It is concluded that a pile foundation should be applied in the area and a soil investigation implemented in each tower during construction. Special construction methods must be used for the tower foundations and there is no access road around the transmission line, which increases the construction cost. In addition, there are many large trees and agricultural fields. Part of the lines will also traverse residential areas. The route information and map are shown in Table 4-24 and Figure 4-19.

Table 4-24 AJ-BA Proposed Route Information

AJ-BA	From:	Ajegunle (New Agbara) S/S
	To:	Badagry S/S
Length	Approx. 36.2 km	
Voltage	132kV	
Layout	Double-circuit (four-circuit towers in the section parallel to AJ-AG), vertical.	



Source: JICA Study Team

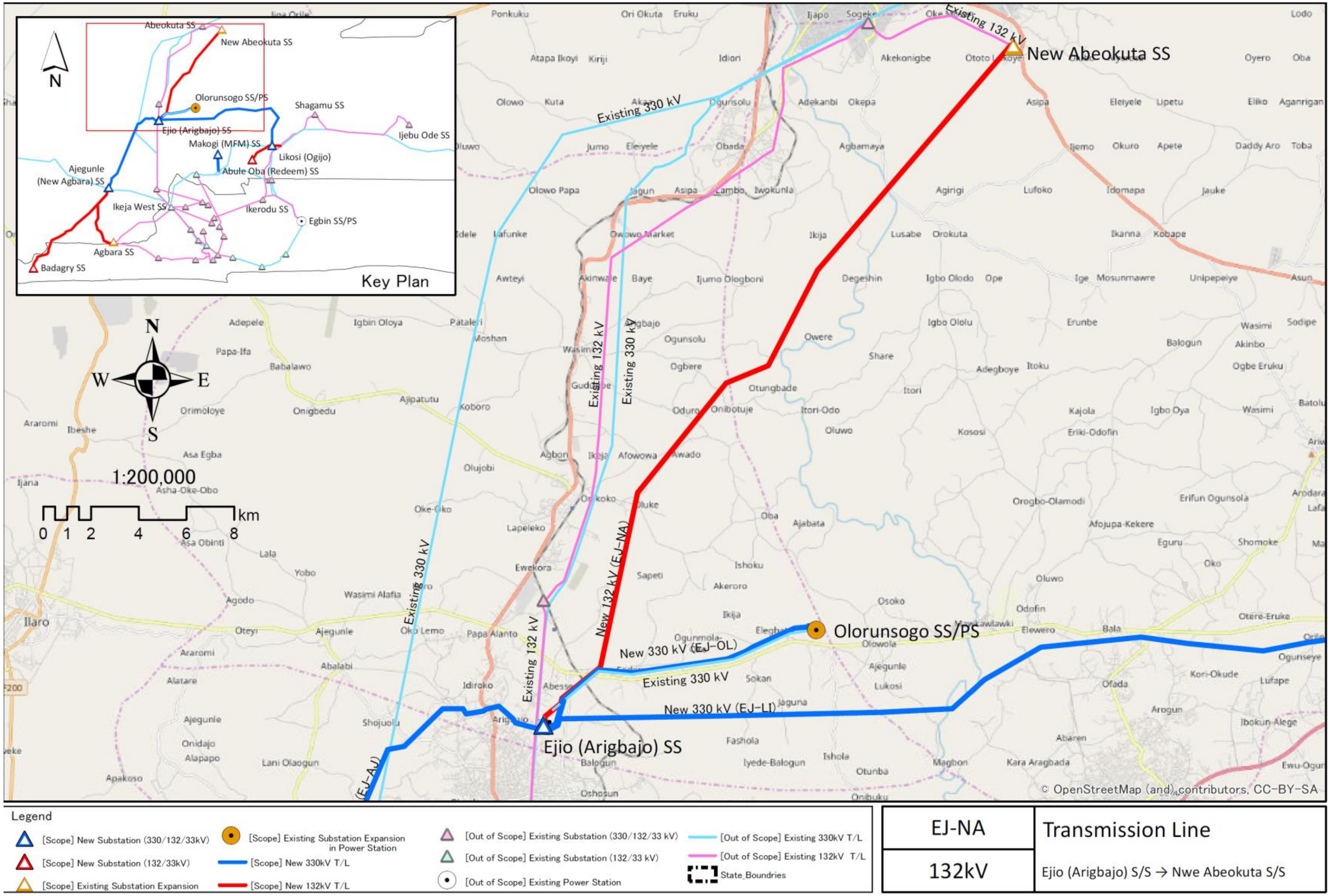
Figure 4-19 AJ-AG and AJ-BA Route Diagram

g) Transmission line: Ejio (Arigbajo) S/S-New Abeokuta S/S line (EJ-NA)

This transmission line is a 132kV double-circuit line between Ejio (Arigbajo) S/S and New Abeokuta S/S, with a length of approx. 35.5 km. Concerning the elevation along the route, the transmission lines run from the Ejio (Arigbajo) S/S which is situated at about 80 m, to a location about 15km north which is also about 80 m and the sections beyond this point are relatively level at about 20 m. About 10 km before New Abeokuta S/S, the line crosses a river. New Abeokuta S/S is almost completed except for the control system and is thus expected to be handed over soon. The space for incoming bay in the existing New Abeokuta, which EJ-NA connects, is occupied by the existing Old Abeokuta-New Abeokuta line, a modified layout is required to secure space in the substation. The modification involves relocating the existing incoming bay to the next bay. A shallow foundation (spread footing) is considered adequate for the proposed on-site development according to the soil investigation result. Route information and map are shown in Table 4-25 and Figure 4-20.

Table 4-25 EJ-NA Route Information

EJ-NA	From:	Ejio (Arigbajo) S/S
	To:	New Abeokuta S/S (Under construction by TCN)
Length	Approx. 35.5 km	
Voltage	132kV	
Layout	Double-circuit, vertical.	



Source: JICA Study Team

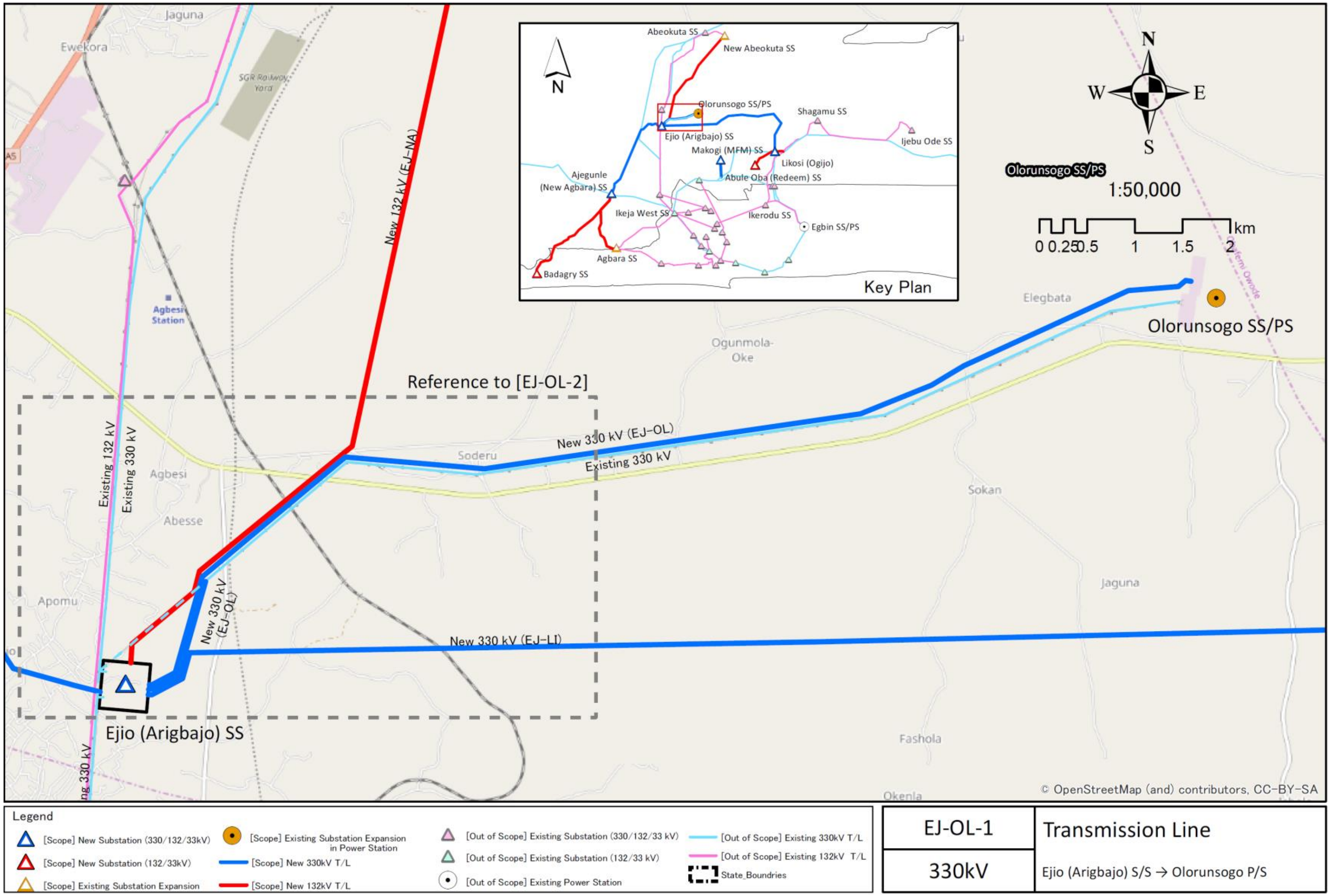
Figure 4-20 EJ-NA Route Map

h) Transmission line: Ejio (Arigbajo) S/S-Olorunsogo P/S line with turn in existing Ejio (Arigbajo) S/S-Olorunsogo P/S line and turning in/out Ikeja West S/S-Ayede S/S line (EJ-OL)

The new 330kV double-circuit transmission line will be constructed between the existing Olorunsogo P/S and Ejio (Arigbajo) S/S, with length of approx. 12.5 km. This transmission line is installed alongside the existing 330kV double-circuit transmission line. In addition, an additional transmission line between Ejio (Aregbajo) S/S and the existing Ejio (Arigbajo)-Olorunsogo line is necessary as shown in the Figure 4-22 and 1.4 km long, making a total length of 13.9 km. The EJ-OL transmission line is installed to increase transmission capacity, since the existing one does not suffice to accommodate the capacity of the existing Olorunsogo P/S. The altitude of Ejio (Arigbajo) S/S is approx. 80 m while the altitude of the existing Olorunsogo P/S is approx. 28 m, so the transmission route spans mostly flat topography, with only a few houses en route. A shallow foundation (spread footing) is considered adequate for the proposed on-site development according to the soil investigation result. The existing 330 kV single-circuit transmission line from Ikeja West S/S to Ayede S/S traverses Ejio (Arigbajo) S/S and connects at Ejio (Arigbajo) S/S by open connection. Route information and map are shown in Table 4-26, Figure 4-21 and Figure 4-22.

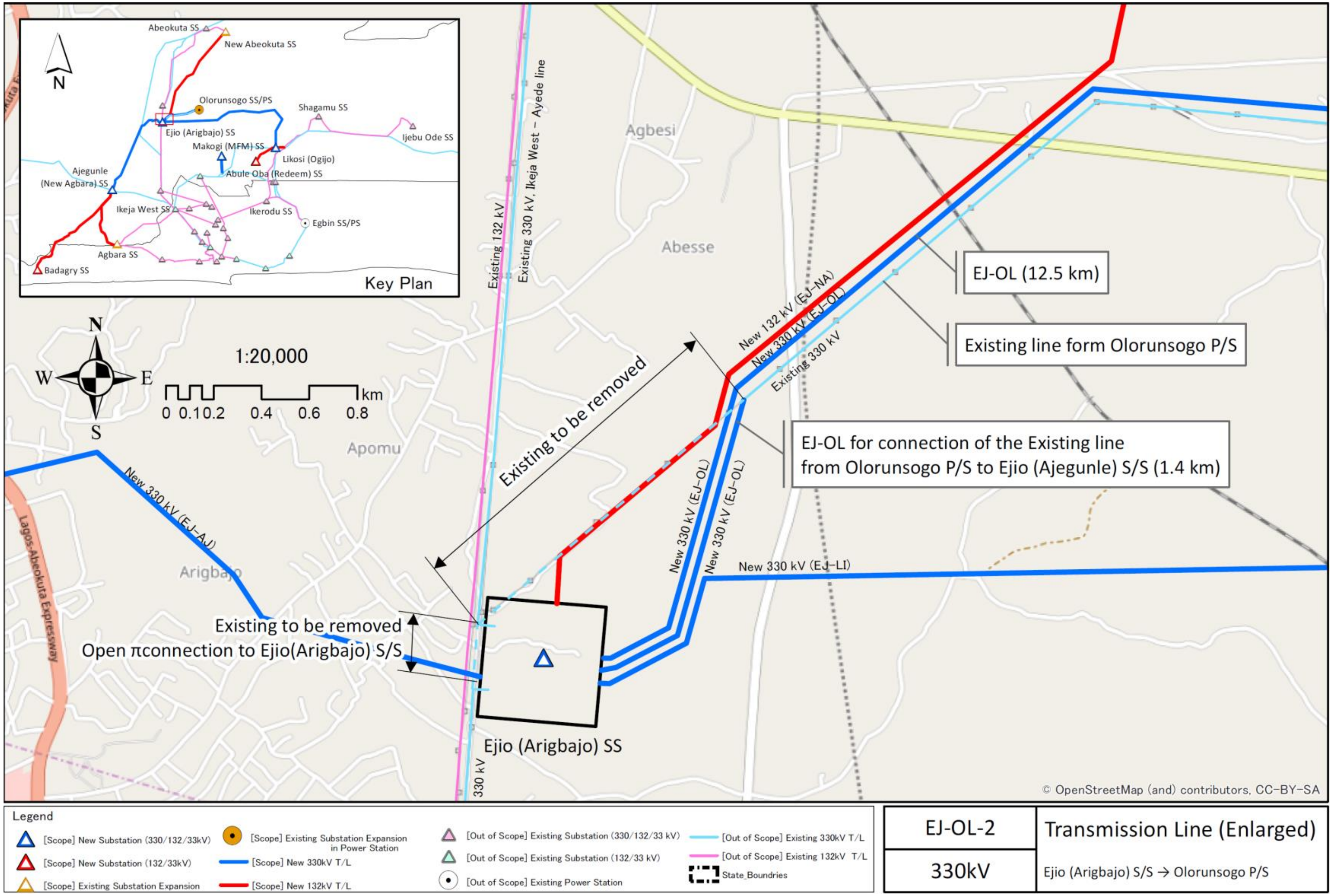
Table 4-26 EJ-OL Route Information

EJ-OL	From: Ejio (Arigbajo) S/S
	To: Olorunsogo P/S (Existing)
Length	Approx. 13.9 km
Voltage	330kV
Layout	Double-circuit, vertical. Including as follows: - Existing Ejio (Ajegunle) S/S-Olorunsogo P/S line - Turn in/out of Ikeja West S/S-Ayede S/S line at Ejio (Arigbajo) S/S



Source: JICA Study Team

Figure 4-21 EJ-OL Route Map



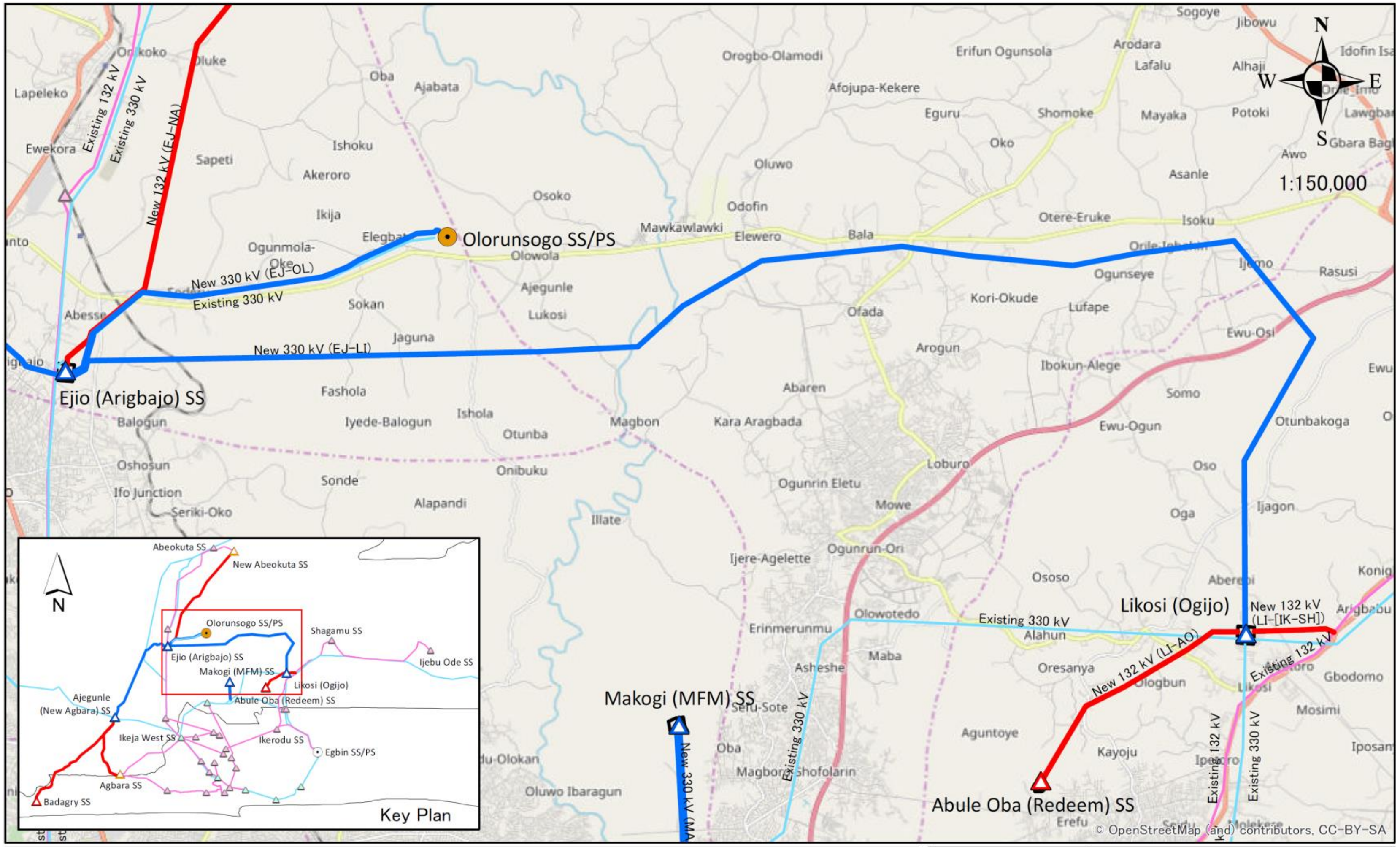
Source: JICA Study Team

Figure 4-22 EJ-OL Route Map (Enlarged)

i) Transmission line: Ejio (Arigbajo) S/S-Likosi (Ogijo) S/S line with turn in Likosi (Ogijo) S/S-Omotosho P/S line and turn in Likosi (Ogijo) S/S-Egbin P/S via Paras Energy P/S line (EJ-LI) This tranrosses the Ogun River three times to avoid the same. A shallow foundation (spread footing) is considered adequate for the proposed on-site development according to the soil investigation result. Route information and map are shown in Table 4-27 and Figure 4-23.

Table 4-27 EJ-LI Route Information

EJ-LI	From: Ejio (Arigbajo) S/S
	To: Likosi (Ogijo) S/S
Length	Approx. 48.8 km
Voltage	330kV
Layout	Double-circuit, Vertical Including the incoming line at Likosi（Ogijo）S/S are as follows. - Incoming line from Omotosho P/S to Likosio S/S（4 Circuits） - Incoming line from Egbin P/S via Paras Energy P/S to Likosio S/S（2 Circuits） - Incoming line from MAKOGI (MFM) S/S to Likosio S/S（2 Circuits）



Legend

- [Scope] New Substation (330/132/33kV)
- [Scope] New Substation (132/33kV)
- [Scope] Existing Substation Expansion
- [Scope] Existing Substation Expansion in Power Station
- [Scope] New 330kV T/L
- [Scope] New 132kV T/L
- [Out of Scope] Existing Substation (330/132/33 kV)
- [Out of Scope] Existing Substation (132/33 kV)
- [Out of Scope] Existing Power Station
- [Out of Scope] Existing 330kV T/L
- [Out of Scope] Existing 132kV T/L
- State_Boundries

EJ-LI	Transmission Line
330kV	Ejio (Arigbajo) S/S → Likosi (Ogijo) S/S

Source: JICA Study Team

Figure 4-23 EJ-LI Route Map

2) Layout around Likosi (Ogijo) S/S and Ejio (Arigbajo) S/S

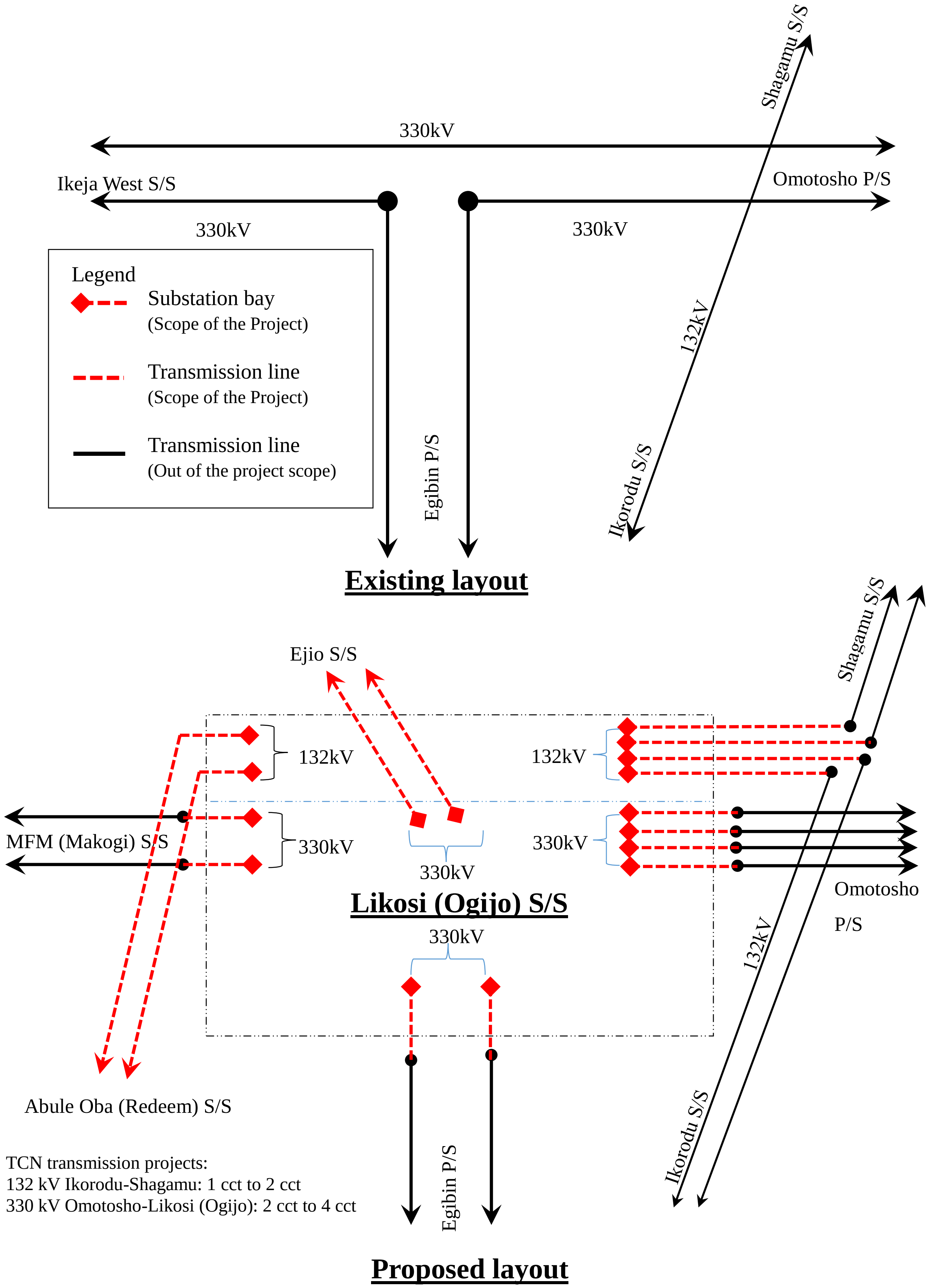
There are transmission lines around Likosi (Ogijo) S/S and Ejio (Arigbajo) S/S. Therefore, the incoming and outgoing feeders of these transmission lines were also included in this project since they are indispensable for the stability of the transmission system. Further details are found in the below sections.

a) Layout around Likosi (Ogijo) S/S

The existing 330kV transmission line between Ikeja West S/S and Omotosho P/S is a double-circuit line. The construction of Likosi (Ogijo) S/S is planned around a branching point. Figure 4-24 shows the tower near the branching point; on the left side is a 330kV double-circuit transmission line connecting to Ikeja West S/S and on the right a 330kV double-circuit transmission line to Omotosho P/S. The transmission line in the front of the Figure is the existing 330kV double-circuit transmission line connecting to Egbin P/S. TCN is planning an additional double-circuit between Likosi (Ogijo) S/S and Omotosho P/S, which will change the double-circuit line into a four-circuit line in total, the date of contract award is December 2010, however the construction is ongoing at 2018 because it is delayed by inadequate funding by FGN, the expected completion year is 2020 before the construction of Likosi S/S. Therefore the delay does not affect the construction of Likosi S/S. The existing layout and proposed layout at Likosi (Ogijo) S/S are as shown in Figure 4-25.

Source: JICA Study Team

Figure 4-24 Existing transmission line at Likosi (Ogijo) S/S



Source: JICA Study Team

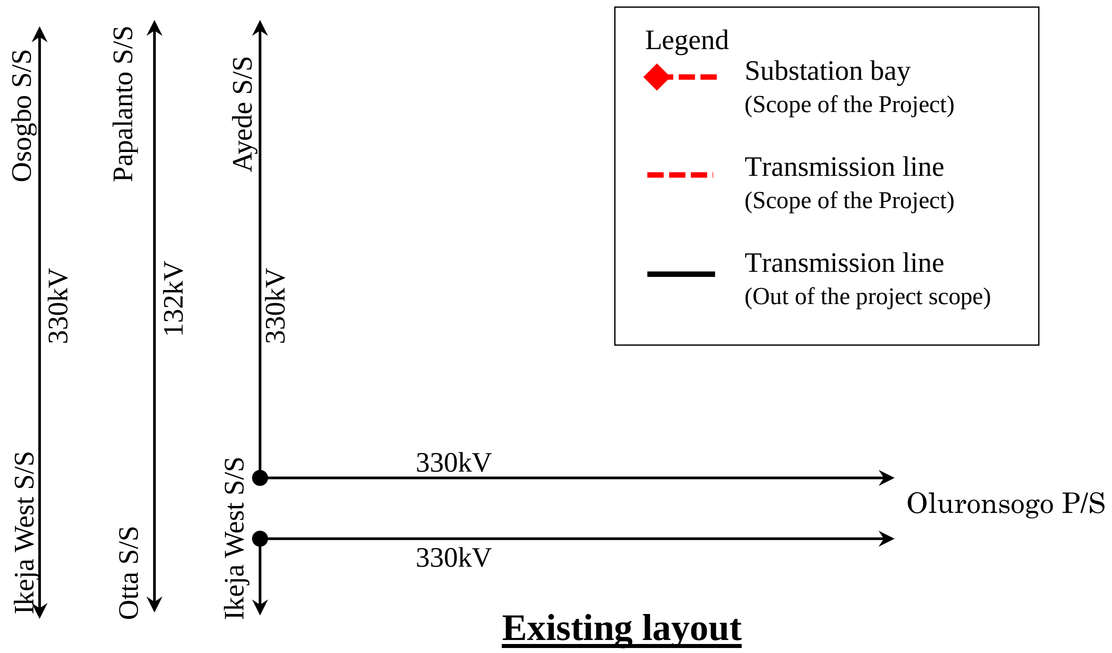
Figure 4-25 Existing layout and Proposed layout at Likosi (Ogijo) S/S

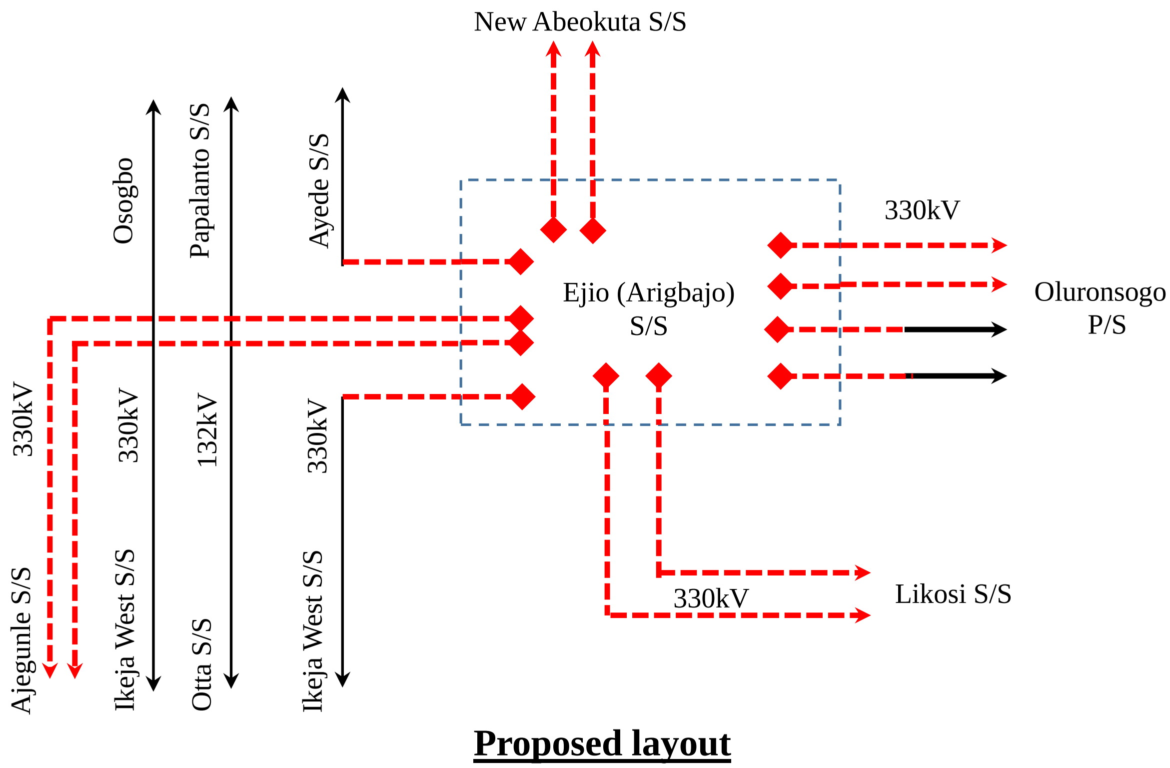
b) Layout around Ejio (Arigbajo) S/S

The existing 330kV transmission line around Ejio (Arigbajo) S/S is shown in the Figure below, the tower in the front is the existing 330kV double-circuit line from Olorunsogo P/S, the tower in the back is the existing transmission line from Ikeja West S/S to Ayede S/S. The existing layout and the proposed layout are shown in Figure 4-27.

JICA Study Team

Figure 4-26 Existing transmission line at Ejio (Arigbajo) S/S





Source: JICA Study Team

Figure 4-27 Existing layout and proposed layout at Ejio (Arigbajo) S/S

(3) Construction Methods

1) Material Transport Methods

- Access Road Construction Method

Lagoon and Swamp Area:
In places where the water is shallow, foundations will be built on fill (sand, laterite and 0 mm – 40 mm crushed rock for repair, with steel mat if necessary). A Hume drainage pipe shall be installed in the fill, to allow the water to flow under the access road and minimize ecological impact. In places where water is deep, rafts made of a collection of boats and small barges will be used. In principle, access roads will be removed once construction is complete. The access road shall have a road width of 3.5 m + shoulder width of 0.75 x 2 = total width of 5.0 m. If no access roads are available, an access road is planned along the transmission line route in the right of way.

Flatlands:
If no access roads are available, an access road is planned along the transmission line route in the right of way.

- Land Needed for Access Roads

The construction cost for temporary access roads will be included in the contract amount of contractor. It is expected that the route of temporary access roads will be selected to avoid any involuntary resettlement therefore no cost for compensation of relocation is required. The cost to secure the land required for the temporary access roads will be covered by TCN.

2) Construction Method for Construction-Related Temporary Facilities

- Cargo-Handling Equipment within the Towers

Lagoons and Wetlands:
In areas with soft ground, a derrick assembly will be used.

Flatlands:
A jib crane will be used.

- Retaining Walls

In principle, towers will be situated in locations which do not require retaining walls, but if they are necessary, the site shall be leveled before the retaining wall is built to avoid a one-sided extension.

- Work Gantries/Heavy Scaffolding Gantries

In principle, towers will be positioned in locations which avoid slopes and narrow areas. However, if slight inclines are present, work scaffolding will not be installed.

- Temporary Fencing

  In residential areas, it is expected that a guard fence will be installed and monitored by a security guard.

- Electricity and Water

  It is expected that a generator and water for concrete work are secured.

- Construction-Related Electrical Utilities

  It is expected that a submersible pump and vibrator will be used for foundation construction and tower assembly and a motorized oil compressor (100t) will be used for aerial line work.

- Other Facilities

  Break Rooms and Toilets:
  Mobile break rooms and toilets mounted on a truck will be used for transmission line construction.

  Materials Storage:
  The scale of the materials storage space will be determined based on the materials procurement plan, but it is estimated that at least 100 m x 100 m of space at minimum will need to be secured for each route.

  Construction Land:
  The land area used for foundation and tower construction shall be approximately (tower margin + 10 m) × (tower margin+10 m).

3) Tower Foundation Construction Methods

- Tower Foundation Construction Methods

  Lagoons and Wetlands:
  Based on previous construction performance in Nigeria, prefabricated pile (length 10-16 m) was used in wetlands, while cast-in-place pile (bore hole pile, φ400-800 mm, depth approx. 40 m, independent footing foundation pile cap) is used in lagoons.

  Prefabricated pile requires larger machinery, so it will be used in wetlands where transport of such machinery is possible. In areas where the ground is too soft to allow the transport of heavy machinery, cast-in-place pile (bore hole pile) will be used.

  If independent footing foundation is used as a pile cap, a quadruped can be created by linking together concrete beams poured on-site, as a measure against uneven settling. The details will be confirmed on site with the pile foundation contractor.

  Flatlands:

The foundation type will be determined based on the N-value from the results of the soil survey. In principle, inverted T-shape foundations will be used.

- Retaining Wall Shoring

Lagoons and Wetlands:
Steel sheet pile is strong enough to be used as retaining wall shoring, but requires a large-scale crane and pile driver, so it must be confirmed whether these could be available on site. Liner plates will be assembled within the excavations as the excavation progresses and this may be possible in wetland areas with sufficient installation of water drainage facilities.

Flatlands:
Simple steel sheet pile and shoring shall be used for retaining walls for inverted-T-shape foundation steel tower construction.

- Concrete Pouring

It will be necessary to confirm whether a ready-mixed concrete plant, mixer truck and pump truck will be usable on site. Without a ready-mixed concrete plant, an appropriate mix shall need to be designed in advance so that a batcher plant may be used.

4) Steel Tower Assembly Method

- Steel Tower Assembly Method

Lagoons and Wetlands:
Long-span steel towers shall be used to reduce the number of towers needed and towers will be assembled by hand via derrick assembly. Therefore, a longer time period will be needed for the assembly of each tower.

Flatlands:
A jib crane will be used.

5) Aerial Line Construction Methods

- Drum Space, Engine space

The ground area needed shall be approximately 30 m×30 m for the drum space and 10 m×10 m for the engine space. Drum space is expected to include drum unloading, truck and crane parking, temporary installation of the next drum and tensioner installation space. In addition, it is expected to include space to install a fixing anchor for the engine and tensioner.

- Line Extension Method

The conventional method is applied for line extension, drum is located at the end of required span and winch is located at the other side, stringing sheaves are installed at each of the towers, rope and/or wire are installed on the stringing sheaves, conductor is jointed with the rope and/or wire, the rope and/or are wire is pulled by the winch and the rope brings the conductor.

- Sagging Method

The conventional method is applied for sagging, the required sag is adjusted by pulling the conductor at the tension towers, the conductor is clumped in the required sag and the conductor is attached to the suspension insulator at the suspension towers.

6) Strict Compliance with Construction-Related Laws

- Noise

Compliance with the Nigeria Environmental (Construction Sector) Regulation 2011 mentioned below.

- Vibrations

Compliance with the Nigeria Environmental (Construction Sector) Regulation 2011.

- Water Pollution

  - Compliance with the Nigeria Environmental (Construction Sector) Regulation 2011.
  - Drainage Water Treatment During Concrete Pouring

If cast-in-place pile is used for foundation construction in lagoons and wetlands, the work will generate drainage water mixed with a considerable amount of cement. Drainage water containing dissolved cement is highly alkaline and can cause anomalous hydrogen ion concentrations in rivers and water turbidity which have an adverse ecological impact, so it is expect that drainage water will require treatment. A common treatment method for polluted water involves installation of a sedimentation tank and water filtration to remove floating impurities. The turbidity and hydrogen ion concentrations of the treated water are then tested and a neutralizer etc. is used to keep them below regulation value. Water is only released once the pollutant concentrations are below regulation value.

- Surplus Soil Treatment

  - Compliance with the Nigeria Environmental (Construction Sector) Regulation 2011.
  - Foundation construction will generate an amount of surplus soil equal to the volume of concrete poured. However, the soil will be handled on site and will not be transported. The same treatment has been used in previous similar projects in Nigeria.

7) Construction Contractors

The contractors listed below are contractors with previous experience executing similar construction projects in Nigeria. It is preferable that contractor has an experience of construction of four-circuit towers and has a branch office in Lagos.

- Company A

  Headquarters: Romania

  Field: Power Transmission Lines

  Business: Engineering/Construction

  Four-Circuit Towers: Experienced

  Construction in Lagos: Possible *Branch office in Lagos
- Company B

  Headquarters: India

  Field: Power Transmission Lines

  Business: Engineering, Manufacturing, Construction

  Four-Circuit Towers: Experienced

  Construction in Lagos: Possible *Branch office in Lagos
- Company C

  Headquarters: India

  Field: Substations

  Business: Unclear

  Four-Circuit Towers: None

  Construction in Lagos: Unclear
- Company D

  Headquarters: India

  Field: Power Transmission Lines

  Business: Unclear

  Four-Circuit Towers: None

  Construction in Lagos: Unclear
- Company E

  Headquarters: China

  Field: Power Transmission Lines/Substations

  Business: Unclear

  Four-Circuit Towers: None

  Construction in Lagos: Possible *Branch office in Lagos
- Company F

  Headquarters: Turkey

  Field: Substations

  Business: Unclear

  Four-Circuit Towers: None

  Construction in Lagos: Unclear
- Company G

  Headquarters: Serbia

  Field: Power Transmission Lines/Substations

  Business: Engineering, Manufacturing, Construction

Four-Circuit Towers: Experienced
Construction in Lagos: Possible *Branch office in Lagos
Other: Experience constructing the 160 km Omotosho-Erukan 330 kV transmission line

8) Materials Procurement

- Tower Steel

Because it is impossible to procure tower steel locally in Nigeria, the steel must be procured via import (Turkey, India, China, Thailand, Saudi Arabia). Steel vendors will be selected based on quality of service, accuracy and ease of meeting arrangements as required conditions.

- Cement

Cement used for tower foundations may be procured locally and must be anti-corrosion-type (for water chloride/sulfate).

9) Construction Period

The construction period is 3 years, the imlemantation schedule is shown in Figure 4-28.

NIGERIA 132kV & 330kV Assumed Construction Schedule

Work Description	Scheduled Work Speed	Gang No	RQ Months	Given Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30						
					1st Year												2nd Year												3rd Year											
Contract Award																																								
Mobilization		1	1.0	1.0	1																																			
Topo & Soil Survey	3 Towers per a Day	2	3.5	3.5		2	2	2	1																															
Design																																								
Plan & Profile	As Above	1	3.5	3.5			1	1	1	0.5																														
Tower	5 Days per a Type	1	2.0	2.0		1	1																																	
Tower Test	7 Days per a Type	1	2.8	3.0			1	1	1																															
Foundation	5 Days per a Type	1	2.0	2.0				1	1																															
Permission	All the necessary permissions shall be obtained prior to the first day of the work.																																							
Material Fabrication																																								
Stub	–									FAB Batch N0.1			Ship	FAB Batch No.2				Ship	FAB Batch No.3				Ship	FAB Batch No.4				Ship	FAB Batch No.5											
Tower	–									FAB Batch N0.1			Ship	FAB Batch No.2				Ship	FAB Batch No.3				Ship	FAB Batch No.4				Ship	FAB Batch No.5											
Conductor	–																	Ship	FAB Batch No.1				Ship	FAB Batch No.2				Ship	FAB Batch No.3											
Insulator	–																	Ship	FAB Batch No.1				Ship	FAB Batch No.2				Ship	FAB Batch No.3											
Makogi-Ikeja West-Likosi																																								
Foundation	(T No x 8 +30) / G.No	2	4.2	5.0													2	2	2	2	2																			
Tower Erection	(T No x 10) / G.No	2	4.7	5.0															2	2	2	2	2																	
Stringing	21days / 5 km	1	1.4	2.0																				1	1															
Ejio-Ajegunde																																								
Foundation	(T No x 8 +30) / G.No	2	10.6	11.0																		2	2	2	2	2	2	2	2	2	2	2								
Tower Erection	(T No x 10) / G.No	3	8.4	8.7																				2	2	2	2	3	3	3	3	3	3							
Stringing	21days / 5 km	1	4.1	5.0																								1	1			1	1	1						
Ejio-Olorunsogo																																								
Foundation	(T No x 8 +30) / G.No	2	5.3	5.5												2	2	2	2	2	1																			
Tower Erection	(T No x 10) / G.No	2	6.0	6.0													2	2	2	2	2	2																		
Stringing	21days / 5 km	1	1.8	2.0																		1	1																	
Ejio-Likosi																																								
Foundation	(T No x 8 +30) / G.No	3	11.6	11.7														2	2	2	2	2	2	2	2	2	2	3	3	3	3	3								
Tower Erection	(T No x 10) / G.No	3	14.1	14.3															1	3	3	3	3	3	3	3	3	3	3	3	3	3	3							
Stringing	21days / 5 km	1	6.8	7.0																						1	1			1	1	1	1	1						
Likosi-Shagamu-Ikorodu																																								
Foundation	(T No x 8 +30) / G.No	2	2.9	3.0												2	2	2																						
Tower Erection	(T No x 7) / G.No	2	2.1	3.0													2	2	2																					
Stringing	21days / 5 km	1	0.7	1.0																	1																			
Likosi-Abule Oba																																								
Foundation	(T No x 8 +30) / G.No	3	2.6	3.0															3	3	3																			
Tower Erection	(T No x 7) / G.No	2	3.0	3.0																2	2	2																		
Stringing	21days / 5 km	1	1.1	2.0																		1	1																	
Ajegunle-Badagry																																								
Foundation	(T No x 8 +30) / G.No	3	11.6	11.0																		3	3	3	3	3	3	3	3	3	3	3								
Tower Erection	(T No x 7) / G.No	3	9.9	10.0																				3	3	3	3	3	3	3	3	3	3							
Stringing	21days / 5 km	1	5.1	6.0																								1		1	1	1	1	1						
Ajegunle-Agbra																																								
Foundation	(T No x 8 +30) / G.No	3	7.2	7.0												3	3	3	3	3	3	3																		
Tower Erection	(T No x 7) / G.No	3	6.0	6.0														3	3	3	3	3	3																	
Stringing	21days / 5 km	1	3.0	3.0																				1	1				1											
Ejio-New Abeokuba																																								
Foundation	(T No x 8 +30) / G.No	4	8.4	8.5																			3	3	3	3	3	3	4	4	4	4								
Tower Erection	(T No x 7) / G.No	3	9.5	9.7																				3	3	3	3	3	3	3	3	3	2							
Stringing	21days / 5 km	1	5.0	5.0																						1	1			1			1	1						
	Required Gang No for Foundation Work															7	9	11	12	12	11	10	10	10	10	10	10	11	12	12	12	12	0	0	0	0	0	0	0	0
	Required Gang No for Erection Work																4	7	10	12	12	12	8	11	11	11	11	12	12	12	12	12	11	0	0	0	0	0	0	0
	Required Gang No for Stringing Work																				1	2	2	2	2	2	2	2	2	3	2	3	4	4	0	0	0	0	0	0

JICA Study Team

Figure 4-28 Proposed Implemantation schedule of 330 kV and 132 kV transmission line

10) Maintenance Roads Following Construction

In lagoons, wetlands and flatlands, maintenance roads shall be installed along the transmission line routes within the right of way.

(4) Configuration of the Steel Towers for the Transmission Lines

1) Type of the Steel Towers for the Transmission Lines

The steel towers are generally used for the new transmission lines because of adequate performance results. Single-circuit towers or double-circuit towers are generally used for existing 132kV and 330kV transmission line. The use of four-circuit towers is considered to minimize resettlement on four-circuit transmission line routes. The JICA Study Team explained the risks involved in operation and maintenance to TCN during the discussion concerning the adoption of four-circuit towers. It is concluded that four-circuit towers is applied for this project.

2) Four-Circuit Steel Towers

The only existing TCN transmission line route using four-circuit steel towers is the Benin-Onitsha route (330kV double-circuit +132kV double-circuit, approx. 9 km). According to the consultant who fabricated this route, the separation distance between the circuits was considered during the design of the four-circuit to s wers, as a prevention measure against induced current from the towers. To protect the transmission lines, distance, ground faults and short faults are being investigated, but no notable problems have occurred. However, on four-circuit towers, various factors combine to cause breakdowns, so it is best that a contractor with experience designing four-circuit towers be engaged for the design stage.

The details concerning the routes using four-circuit steel towers in this project is as stated below.

- The double-circuit line for Ikorodu S/S and the double-circuit line for Shagamu S/S will share a four-circuit steel tower as part of the S/N 18-1 line (132kV, 4.82 km length in double circuit) connecting to Likosi (Ogijo) S/S.
- About 6 km section of the AJ-AG (132kV) and AJ-BA (132kV) lines will share two circuits leading to the Agbara S/S and two circuits leading to the Badagry S/S, connecting to the Ajegunle (New Agbara) S/S.

4-3-2 Conductor, Ground wire and Insulator Strings to be used

The specifications for the conductor, ground wire and insulator strings to be used are accordance with TCN standard specifications.

(1) Conductor for Overhead Electric Wire

Aluminum conductor steel-reinforced wire (ACSR) is used as the standard conductor for TCN transmission lines, the nominal cross-sectional area for 132kV is 264 mm^2 (Bear), while the nominal cross-sectional area for 330kV is 381 mm^2 (Bison). The 132kV conductor (Bear) is single conductor and 330kV conductor (Bison) is a dual-conductor as twin bundle. Low-Loss ACSR (LL-ACSR) and Low-Loss TACSR (LL-TACSR) are proposed as conductor type for this project by JICA Study Team. GAP conductor is also proposed as a comparison. The followings are design concept of each conductor.

Table 4-28 Proposed conductor specifications

Elements		132kV	330kV
Line Type	-	Low-Loss Conductor LL-ACSR	Low-Loss Conductor LL-ACSR
No./Phases	-	1	2
External Diameter	mm	23.45	27.00
Cross-sectional area (AL/ST mm2)	mm^2	357.2/ 37.16	494.3/ 31.67
Unit Mass	kg/m	1.251	1.590
Max. Tension	kN/conductor	111.2	120.9
Elastic Modulus	-	74.0	70.3
Linear Expansion Coefficient	10^{-6}	20.3	21.0

Source: JICA Study Team

1) Design concept of proposed conductor

- LL-ACSR

Maximized aluminum section area by Trapezoid shaped aluminum and minimized steel core section area by Ultra high strength material, it reduces transmission loss up to 25 %.

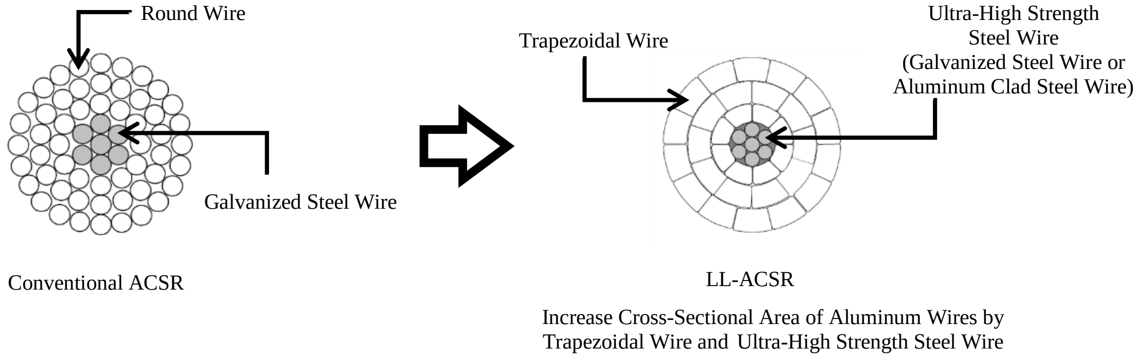


Figure 4-29 Design concept of LL-ACSR

- LL-TACSR

High Current Capacity is achieved by Thermal-Resistant Aluminum Alloy, Maximized aluminum section area by Trapezoid shaped aluminum and minimized steel core section area by ultra-high strength material, it reduces transmission loss up to 25%.

- GAP

To achieve high temperature operation with low-sag, only steel core bears tension during high temperature operation, aluminum does not bear any tension due to thermal expansion as shown in Figure 4-30. The aluminum section area smaller than LL-ACSR because the section area reduced by the followings, thus the resistance of GAP increases higher than LL-ACSR.

✓ To secure a gap between Aluminum and Steel core for low-sag mechanism

✓ To reduce the weight of Aluminum to compensate heavy weight of grease

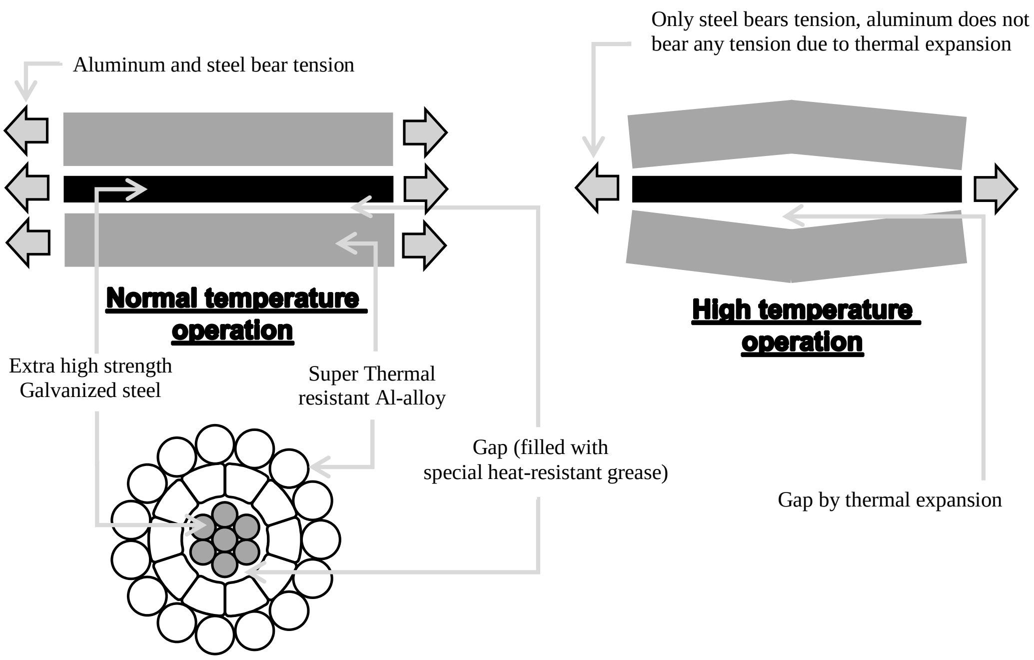


Figure 4-30 Design concept of GAP

2) Comparison of proposed conductor

A comparison of ACSR and LL-ACSR is shown in Table 4-29. LL-ACSR is recommended due to its merits in terms of economical and energy-saving efficiency by low-loss, especially considering that the conductors will be used for over 40 years and with future demand increases in Nigeria in mind. If high capacity is required, LL-TACSR is recommended because of double capacity and low-loss. The size of LL-ACSR is based on TCN's standard size, so that TCN standard accessories can be used with the conductor. On the other hand, GAP is not recommended because of high transmission loss and difficulty of installation and maintenance, it is better for reconductoring.

Table 4-29 Comparison of ACSR, LL-ACSR and GAP

Conductor	ACSR	LL-ACSR *Recommended	LL-TACSR *Recommended	GAP (GZTACSR)
Overall Diameter	Base	Same	Same	Smaller
Strength	Base	Same	Same	Same or lower
Weight	Base	Approx. 10% heavier	Approx. 10% heavier	Same or lighter
Current capacity	Base	10% higher	2 times	1.6 - 2 times
Sag of wire on load	Base	Slightly larger (Less than 1 m)	Slightly larger (Less than 1 m)	Same
Transmission Loss	Base	**Lower (Up to 25% reduction)**	**Lower (Up to 25% reduction)**	Same or higher
Transmission loss in Maximum temperature operation	Base	**Lower**	**Lower**	Higher
Cost benefit of Transmission loss	Base	High	High	Finalcial loss resulting from high transmission loss
Operational experience	Base	Good (More than 35 years)	Good (More than 35 years)	Good (More than 45 years)
Construction period	Base	Same	Same	Longer (Two times)
Installation and maintenance	Base	**Same (Same method and tools)**	**Same (Same method and tools)**	Difficult Note: Multiple Mid-Span Joint is not applicable, only one Mid-Span Joint is applicable. It needs special skill and tools for installation and maintenance, Poor product or improper installation/maintenance of GAP causes Sag problems and dangerous accidents.
Installation and maintenance cost	Base	Same	Same	Higher (Skilled workers and a longer construction period required)
Tower and foundation cost	Base	Almost same (Less than 3% of Total transmission line cost)	Less than 6% of Total transmission line cost	Same (Lower in case of smaller size)
Conductor cost	Base	Approx. 15 % Higher	Approx. 15 % Higher	Approx. 15 % Higher (Lower in case of smaller size)
Purpose	Base	Low-loss for New line	Low-loss with high capacity for New line	High capacity for existing Line by reconductoring

Source: JICA Study Team

A comparison of resistance between ACSR, LL-ACSR and GAP is shown in Table 4-30 and Table 4-31. LL-ACSR is recommended in terms of reduction of transmission loss because of its low resistance.

Table 4-30 Comparison of resistance between ACSR, LL-ACSR and GAP in 330 kV line

Conductor	Rated Tensile Strength (kN)	Outside diameter (mm)	Weight (kg/m)	Cross sectional area (AL/ST mm^2)	DC resistance at 20 ℃	Current (A)	Conductor Temperature (℃)	Sag at 400 m (m)	AC Resistance (Ω/km)
Bison 381 mm^2	120.9	27	1.443	381.7/49.48	0.0702	668	80	13.94	0.0977
						762	90	14.31	0.1012
LL-ACSR 490 mm^2	120.9	27	1.590	494.3/31.67	0.0575	764	80	15.15	**0.0747**
LL-TACSR 490 mm^2	120.9	27	1.590	494.3/31.67	0.0582	760	80	15.15	**0.0756**
						1228	141	17.38	**0.0903**
						1312	150	17.69	**0.0926**
GZTACSR Goose 310 mm^2	113.8	24.4	1.227	313.1/43.11	0.0941	763	80	11.64	0.1211
						1000	150	13.00	0.1500
						1227	210	14.15	0.1741

Source: JICA Study Team

Table 4-31 Comparison of resistance between ACSR, LL-ACSR and GAP in 132 kV line

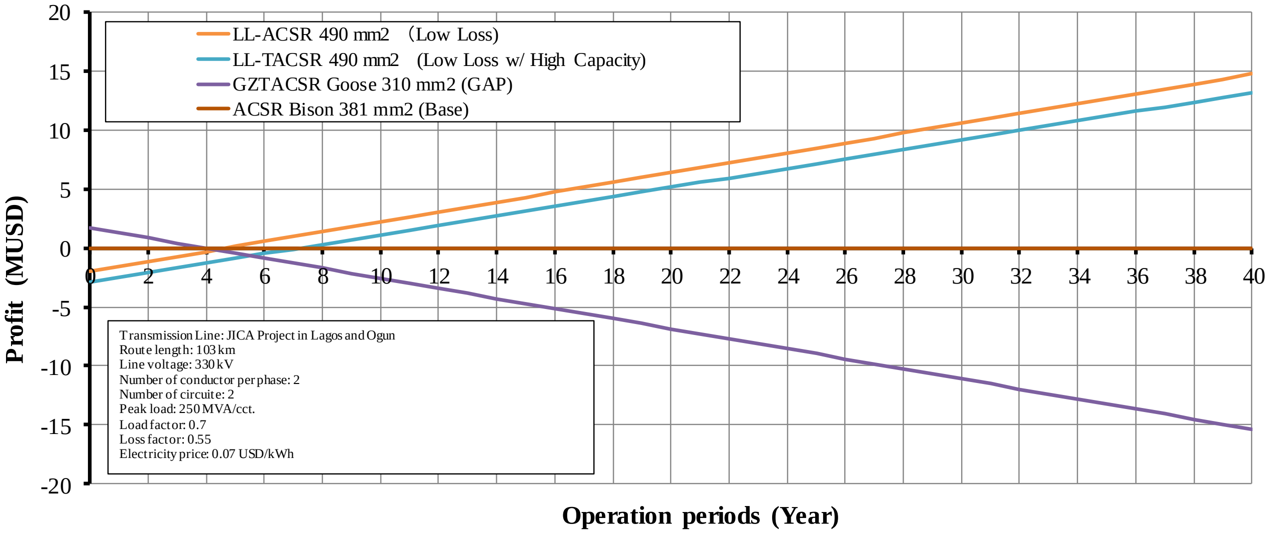
Conductor	Rated Tensile Strength (kN)	Outside diameter (mm)	Weight (kg/m)	Cross sectional area (AL/ST mm^2)	DC resistance at 20 ℃	Current (A)	Conductor Temperature (℃)	Sag at 300 m (m)	AC Resistance (Ω/km)
Bear 264 mm^2	111.2	23.45	1.214	264.4/61.7	0.1093	540	80	7.95	0.1400
						635	93	8.38	0.1463
LL-ACSR 360 mm^2	111.2	23.45	1.251	357.2/37.16	0.0788	633	80	8.32	**0.1016**
LL-TACSR 360 mm^2	62.4	23.45	1.251	357.2/37.16	0.08	629	80	8.32	**0.1031**
						851	109	9.32	**0.1135**
						1070	150	10.61	**0.1277**
GZTACSR Lynx 185 mm^2	62.4	17.8	0.700	184.5/21.99	0.16	416	80	6.99	0.2061
						632	129	7.74	0.2404
						852	210	9.00	0.2955

Source: JICA Study Team

3) Cost merit of proposed conductor

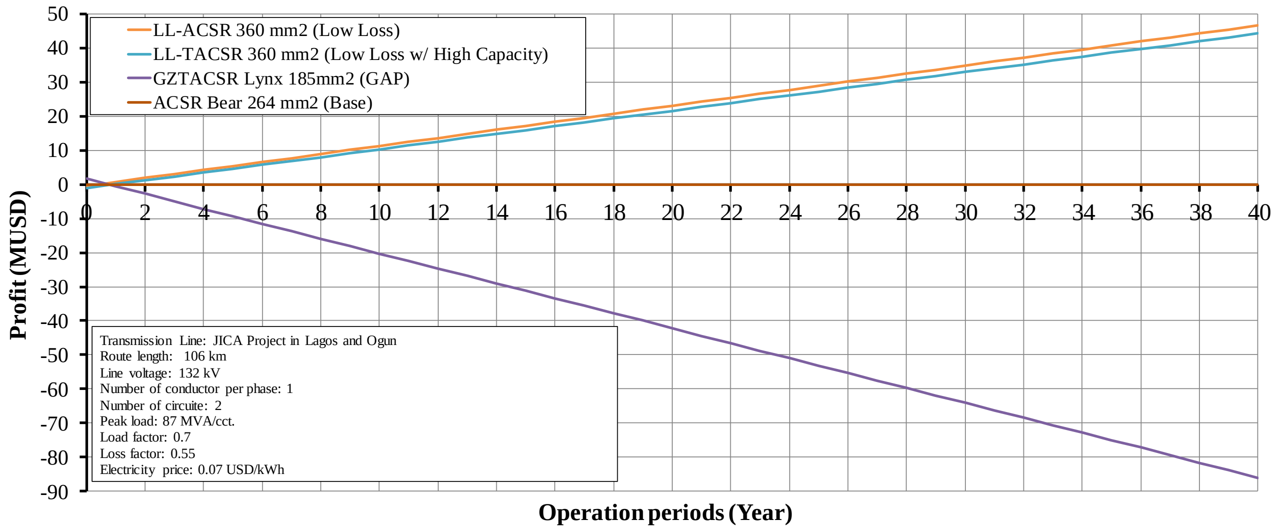
Regarding 330 kV transmission lines, although introducing LL-ACSR is costlier than the conventional transmission line using ACSR (Bison), the reduced transmission loss may ultimately elicit an overall profit, as shown in Figure 4-30. The difference in the cost of introducing LL-ACSR and Bison will be repaid within 5 years or so (8 years in the case of LL-TACSR) after installation, whereupon profit of around 0.4 million USD will be generated every year and approximately 230 GWh of energy savings will be achieved over 40 years.

Regarding 132-kV transmission lines, the cost of introducing LLACSR also exceeds that of conventional transmission lines using ACSR (Bear), but the reduced power loss can ultimately elicit an overall profit, as shown in Figure 4-31. The difference in the cost of introducing LL-ACSR and Bear will be repaid about 1 year (also 1 year in the case of LL-TACSR) after installation, whereupon profit of around 1.2 million USD will be generated annually. In this case approximately 640 GWh of energy savings will be achieved over 40 years.



Source: JICA Study Team

Figure 4-31 Profit by 330 kV line LL- (T)ACSR compared to GAP and ACSR



Source: JICA Study Team

Figure 4-32 Profit by 132 kV line LL- (T)ACSR compared to GAP and ACSR

4) Cost impact of LL-ACSR on tower and foundation design

The cost impact on the tower and foundation and scale in the event of changing from ACSR to a low-loss transmission conductor (LL-ACSR) is shown below. Regarding tower and tower foundation, total cost up by LL-ACSR is maximum 3% only in compared with conventional ACSR.

Table 4-32 Cost impact of LL-ACSR on Tower and Foundation design

Design for LL-ACSR	Method of solution	Cost up compared with conventional ACSR	Total cost up compared with conventional ACSR
Maximum allowable tension same as conventional ACSR	Not require new design on tower and foundation	0%	Less than 3% of Total transmission line cost
Sag increasing by 1.0 m	Only 1m extension of tower	less than 3% of raw material	

Design for LL-ACSR	Method of solution	Cost up compared with conventional ACSR	Total cost up compared with conventional ACSR
	legs under standard design	cost of Steel Towers *1	
Heavier conductor weight	If needed, it is to be changed to stronger element of tower, and increase volume of foundation because max. 15% bigger vertical load by increasing conductor weight of LL-ACSR (max. 15%)	3% at the worst case (raw material and construction cost of steel towers and foundation) *2 Vertical load is not the critical condition of tower design.	

*1, *2 : In a typical condition
Source: JICA Study Team

(2) Overhead Ground Wire and Insulators

Two overhead ground conductors will be installed in each transmission line. Overhead Galvanized Steel Ground Wire (GSW) will be used for one and Optical Fiber Composite Overhead Grounding Wire (OPGW) will be used for the other. The specifications of the overhead ground wire are as shown in Table 4-33. OPGW is used for SCADA systems between the NCC (National Control Center) and substation or power plant. The specifications of Insulatior is as shown in Table 4-34 and Table 4-35.

Table 4-33 Ground Wire Specifications

Item	Specifications
Overhead Galvanized Steel Ground Wire (GSW)	Zinc-coated steel wire strand Number of wires: 7 Wire diameter: 3.25 mm Overall diameter: 9.8 mm Steel area: 58.1 mm^2 Mass: 460 kg/km
Optical Fiber Composite Overhead Grounding Wire (OPGW)	Number of fibers: 24 Type of fibers: Single mode Short-circuit current capacity at 400°C: 125 kA^{2}s Short-circuit current withstand for 0.25s: 20 KA

Source: JICA Study Team

Table 4-34 Suspension Insulator Strings

		132kV		330kV	
Insulator Type	-	250mm Suspension			
No. of Insulators	-	Single	Double	Single	Double
Insulator String Length	mm	2,000	2,050	4,000	4,100

Source: JICA Study Team

Table 4-35 Tension Insulator Strings

		132kV		330kV	
Insulator Type	-	250mm Tension			
No. of Insulators	-	Single	Double	Single	Double
Insulator String Length	mm	2,500	2,550	4,500	4,600

Source: JICA Study Team

4-3-3 Types of the Steel Towers to be Used and Design Conditions

(1) Steel Towers

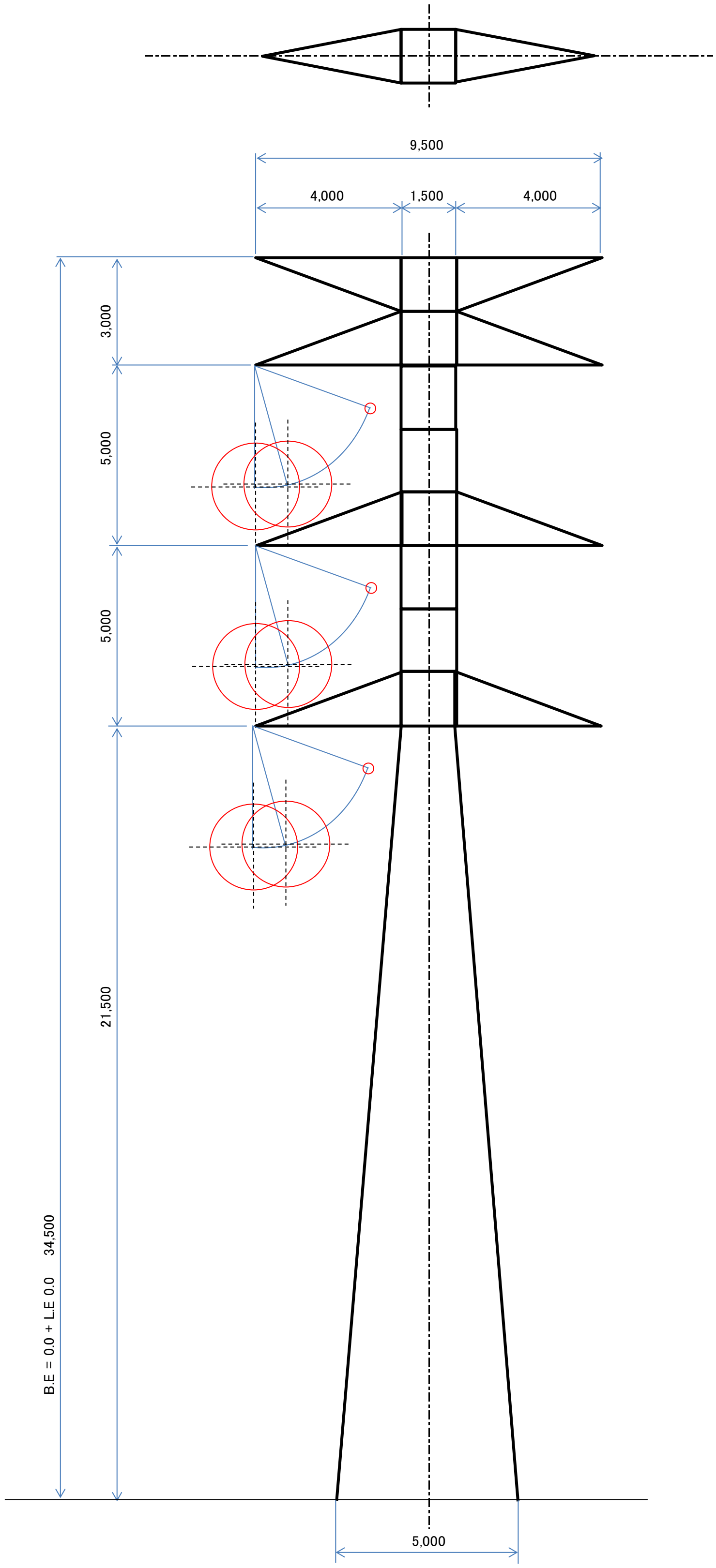
Standard square steel towers will be used for suspension- and tension-type towers. Four-circuit towers will be applied for 132kV transmission line. The standard towers to be used are shown below.

Table 4-36 Standard Transmission Tower Model

Model	Max. Horizontal Angle	132kV		330kV
		Double-Circuit Transmission Tower	Four-Circuit Transmission Tower	Double-Circuit Transmission Tower
Suspension Tower	0 - 2°	132AD	132AQ	330AD
Low-Angle Steel Tower	0 - 10°	132BD	132BQ	330BD
Medium-Angle Steel Tower	10 - 30°	132CD	132CQ	330CD
Steep-Angle Steel Tower	30 - 60°	132DD	132DQ	330DD
Dead-End Tower	60 - 90°	132ED	132EQ	330ED

Source: JICA Study Team

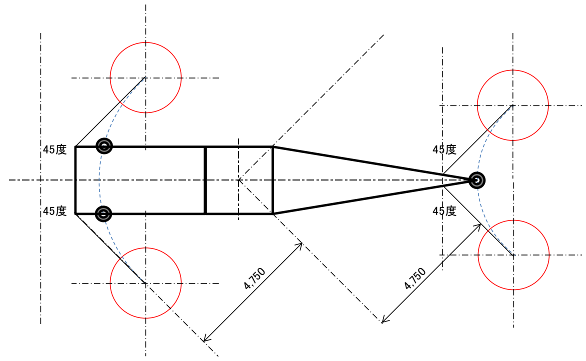
Regarding 4-Circuit Transmission Tower, if the operation between the upper double circuit and the lower double circuit are different, the sag of the upper and the lower are also different. It is necessary to consider the vertical phase clearance between the upper and the lower because it should be larger than the clearance of normal condition. The foundation used for the steel towers is a spread foundation with concrete footing. The nine types of standard steel towers used in this project are shown in Figure 4-33 to Figure 4-35.

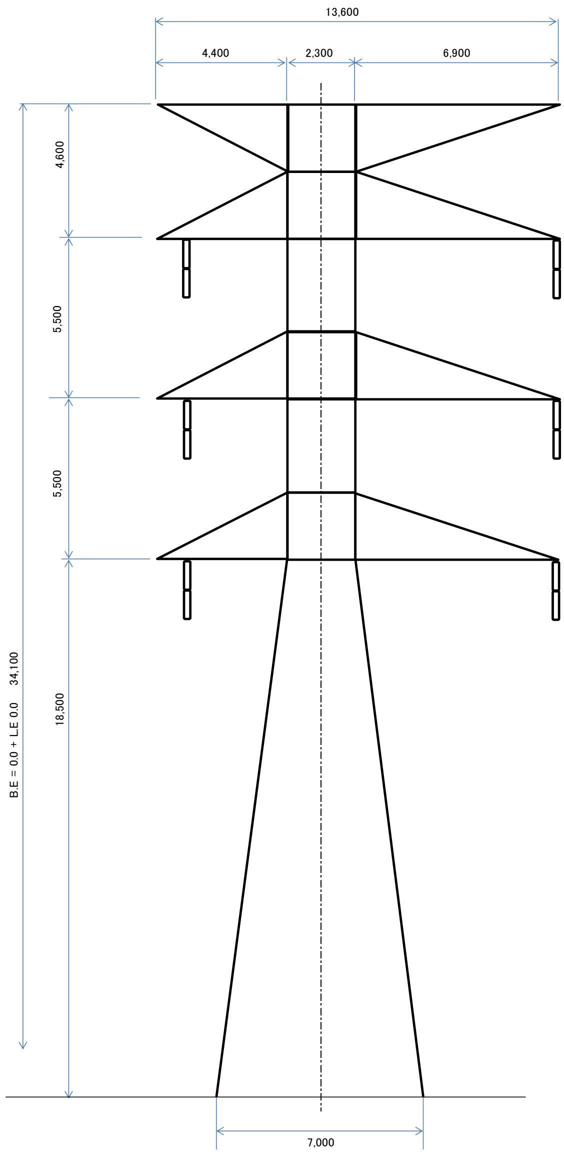


Suspension (A)
132kV, Angle 0 - 2°, 2 circuits, Vertical

Source: Made by the JICA Study Team based on TCN information

Figure 4-33 Outline Drawing of the Steel Tower (132kV)



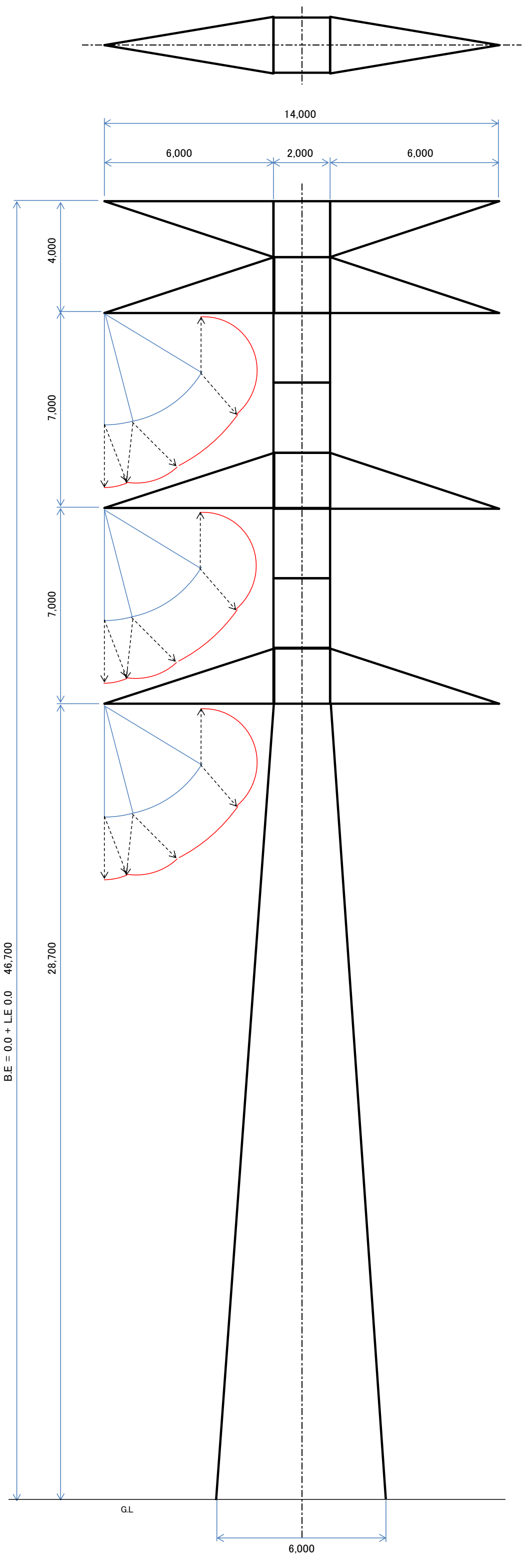


Tension (E)

132kV, Angle 60 - 90° or Dead-End, 2 circuits, Vertical

Source: Made by the JICA Study Team based on TCN information

Figure 4-34 Outline Drawing of the Steel Tower (132kV)

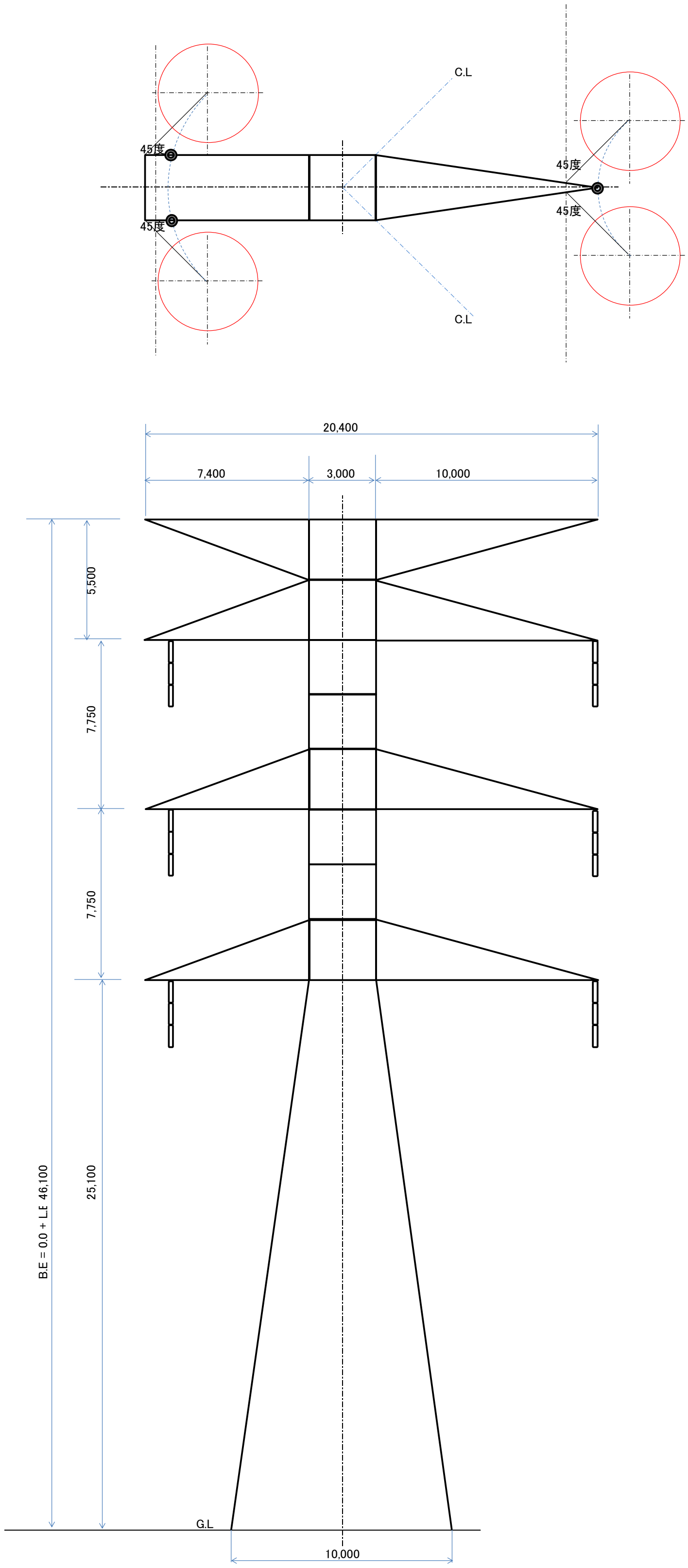


Suspension (A)

330kV, Angle 0 - 2°, 2 circuits, Vertical

Source: Made by the JICA Study Team based on TCN information

Figure 4-35 Outline Drawing of the Steel Tower (330kV)



Tension (E)

330kV, Angle 60 - 90° or Dead-End, 2 circuits, Vertical

Source: Made by the JICA Study Team based on TCN information

Figure 4-36 Outline Drawing of the Steel Tower (330kV)

(2) Design Span, Electrical Clearance and Separation Distance

The results of calculations for the design span, electrical clearance and separation distance based on TCN's standard specifications are shown below.

Table 4-37 Design Span

Design Span	132 kV		330 kV	
Standard Span	350	m	450	m
Wind Span	350	m	450	m
Weight Span	425	m	520	m

Source: JICA Study Team

Table 4-38 Insulator/Jumper Deflection Angle and Necessary Insulation Distance

Type		Suspension Type		Zone-A (°)	Zone-B (°)	Zone-C (°)	Zone-D (°)
132 kV	Suspension	1,200	mm	0 - 15	0 - 15	0 - 15	0 - 15
		270	mm	60	70	76	79
	Tension	1,200	mm	0 - 15	0 - 15	0 - 15	0 - 15
		270	mm	45	59	67	71
330 kV	Suspension	2,250	mm	0 - 15	0 - 15	0 - 15	0 - 15
		2,000	mm	45	59	63	63
	Tension	2,250	mm	0 - 15	0 - 15	0 - 15	0 - 15
		1,700	mm	30	45	55	60

Source: JICA Study Team

Table 4-39 Necessary Separation Distance

Target Item	330kV (m)	132kV (m)
Ground Surface	8.0	6.7
Road Crossing	9.0	8.3
Building	5.2	5.0
Highway	10.0	10.0
Shipping Route	15.0	15.0
Pipeline	10.0	10.0
Low-Voltage Transmission lines/Communication Lines	4.6	3.6
Railway	9.0	8.3

Source: JICA Study Team

(3) 132kV Tower Assembly Study

1) Maximum Usage Tension and Normal Tension

Based on TCN's standard specifications, the maximum tension on ground wire and conductor will be less than the conditions listed below and remain within the scope of allowable tension.

Table 4-40 Temperature Conditions

Temperature Conditions		
Cold Season	Ground wire/Conductor	10°C
EDS*	Ground wire/Conductor	25°C
Hot Season	Ground wire	55°C
	Conductor	75°C

*EDS: Everyday Stress
Source: JICA Study Team

Table 4-41 Wind Pressure Conditions

Wind Pressure Conditions (kg/m^2)				
Wind Pressure	Zone-A	Zone-B	Zone-C	Zone-D
Ground wire	67.07	110.10	157.26	198.13
Conductor	52.56	86.29	123.28	155.28
Steel Towers	98.52	161.73	231.00	291.04

* Calculated based on Zone-B.
Source: JICA Study Team

Table 4-42 Allowable Tension Conditions

Allowable Tension Conditions	
Maximum Tension =	Must be less than 40% of the breaking tension of the conductor and ground wire.
Normal Tension =	Must be less than 20% of the breaking tension of the conductor and ground wire.

Source: JICA Study Team

2) Design Conditions

The design conditions for the 132kV steel towers are shown below.

Table 4-43 132kV Steel Tower Design Conditions

Standard Span	350	m
Wind Span	350	m
Weight Span	425	m
Vertical Phase Clearance	5.000	m
Max. Span	500	m
Min. Span	200	m
Max. Distance between Adjacent Spans	300	m
Normal Unbalanced Tension	500	kg

* Only tension towers considered
Source: JICA Study Team

3) The height combinations for 132kV steel towers

Table 4-44 132kV Steel Tower Height Combinations

Tower Body Extension Height (m)	Tower Leg Extension Height (m)	Sag	Separation from Ground Level Height (m)	Steel Tower Height (m)	
-9.0	0	1.5	8.0	22.5	* Min. Height
	+ 1.5	3.0		24.0	
	+ 3.0	4.5		25.5	
-4.5	0	6.0		27.0	
	+ 1.5	7.5		28.5	
	+ 3.0	9.0		30.0	
±0	0	10.5		31.5	* Standard Type
	+ 1.5	12.0		33.0	
	+ 3.0	13.5		34.5	
+4.5	0	15.0		36.0	
	+ 1.5	16.5		37.5	
	+ 3.0	18.0		39.0	
+9.0	0	19.5		40.5	
	+ 1.5	21.0		42.0	
	+ 3.0	22.5		43.5	* Max. Height

Source: JICA Study Team

(4) 330kV Tower Assembly Study

1) Maximum Usage Tension and Normal Tension

Based on TCN's standard specifications, the maximum tension of the ground wire and conductor will be less than the conditions listed below and remain within the scope of allowable tension.

Table 4-45 Temperature Conditions

Temperature Conditions		
Cold Season	Ground wire/Conductor	10°C
EDS	Ground wire/Conductor	25°C
Hot Season	Ground wire	55°C
	Conductor	75°C

Source: JICA Study Team

Table 4-46 Wind Pressure Conditions

Wind Pressure Conditions (kg/m^2)				
Wind Pressure	Zone-A	Zone-B	Zone-C	Zone-D
Ground wire	67.07	110.10	157.26	198.13
Conductor	52.56	86.29	104.89	155.28
Steel Towers	98.52	161.73	231.00	291.04

* Calculated based on Zone-B.
Source: JICA Study Team

Table 4-47 Allowable Tension Conditions

Allowable Tension Conditions		
Maximum Tension	=	Must be less than 40% of the breaking tension of the conductor and ground wire.
Normal Tension	=	Must be less than 20% of the breaking tension of the conductor and ground wire.

Source: JICA Study Team

2) Design Conditions

The design conditions for the 330kV steel towers are shown below.

Table 4-48 330kV Steel Towers and Design Conditions

Standard Span	450	m
Wind Span	450	m
Weight Span	520	m
Vertical Phase Clearance	7.000	m
Max. Span	600	m
Min. Span	100	m
Max. Distance between Adjacent Spans	500	m
Normal Unbalanced Tension	750	kg

* Only tension towers considered
Source: JICA Study Team

3) Height combinations for 330kV steel towers

Table 4-49 330kV Steel Tower Height Combinations

Tower Body Extension Height (m)	Tower Leg Extension Height (m)	Sag	Separation from Ground Level Height (m)	Steel Tower Height (m)	
	0	8.1		37.7	* Min. Height
-9.0	+ 1.5	9.6		39.2	
	+ 3.0	11.1		40.7	
	0	12.6		42.2	
-4.5	+ 1.5	14.1		43.7	
	+ 3.0	15.6		45.2	
	0	17.1		46.7	* Standard Type
±0	+ 1.5	18.6	8.0	48.2	
	+ 3.0	20.1		49.7	
	0	21.6		51.2	
+4.5	+ 1.5	23.1		52.7	
	+ 3.0	24.6		54.2	
	0	26.1		55.7	
+9.0	+ 1.5	27.6		57.2	
	+ 3.0	29.1		58.7	* Max. Height

Source: JICA Study Team

(5) Determining Tower Locations

As an overall design policy to determine tower locations, angle points on the transmission route were determined, whereupon, based on TCN’s basic standard tower type specifications (suspension, light-angle tension, heavy-angle tension, Dead-End, long-span suspension and long-span tension types), design spans were allotted between the angle points and a summary calculation was made to determine the number of towers of each type required. Furthermore, when considering differences in elevation along the transmission routes, given scope for load spans to exceed the design values, the estimation span was set at 80% of the standard span (330kV = 360 m, 132kV = 270 m). It is also expected that long-span towers will be used to reduce the number of towers along transmission routes traversing lagoons and wetland areas.

4-4 Schematic Design of Substations

4-4-1 Summary of Substations for the Project (New construction)

(1) Likosi (Ogijo) substation

<table>
<tr><th>Item</th><th colspan="2">Content</th></tr>
<tr><td>General Description</td><td colspan="2">This is a new substation construction originally requested by TCN.</td></tr>
<tr><td>Area size</td><td colspan="2">Approx. 25.00ha</td></tr>
<tr><td>Location</td><td colspan="2">Ogun state
558609.058mE, 748529.402mN</td></tr>
<tr><td>Component</td><td colspan="2">New construction of the 330/132/33kV substation at Likosi (Ogijo)</td></tr>
<tr><td>Photo</td><td>
Existing 330kV transmission tower where the Likosi (Ogijo) substation shall be constructed</td><td>
Existing 330kV transmission line to be connected to the Likosi (Ogijo) substation</td></tr>
<tr><td>Incoming bay / Outgoing bay for transmission line</td><td colspan="2">Incoming bay from Omotosho P/S: 330kV-four-circuit line
Incoming bay from Egbin P/S: 330kV-double-circuit line
Incoming bay from Makogi (MFM) S/S: 330kV-double-circuit line
Incoming bay from Ejio (Arigbajo) S/S: 330kV-double-circuit line
Incoming bay from Shagamu S/S: 132kV-double-circuit line
Incoming bay from Odogunyan S/S: 132kV-double-circuit line
Outgoing bay to Abule Oba (Redeem) S/S: 132kV-double-circuit line</td></tr>
<tr><td>Option</td><td colspan="2">There are two options for the substation layout and facility plan related to the 330kV incoming feeders from the Ejio (Arigbajo) substation
1. To adapt a 330kV-line bay with an overhead line crossing above the 132kV-line bay for Redeem
2. To adapt a 330kV-line bay with an underground cable. In the substation</td></tr>
</table>

(2) Makogi (MFM) substation

Item	Content
Area size	Approx. 15.12ha
Location	Ogun state 541828.351mE, 746341.760mN
Component	New construction of the 330/132/33kV substation at Makogi (MFM)
Photo	 Location of the land to construct Makogi (MFM)
General Description	This is a new substation construction originally requested by TCN.
Incoming bay / Outgoing bay for transmission line	Incoming bay from Likosi (Ogijo) S/S: 330kV-double-circuit line Incoming bay from Ikeja West S/S: 330kV-double-circuit line
Option	N/A

(3) Abule Oba (Redeem) substation

Item	Content
Area size	Approx. 9.62ha
Location	Ogun state 552665.00 m E, 744540.00 m N
Component	New construction of a 132/33kV substation at Abule Oba (Redeem)
Photo	 Location where Abule Oba (Redeem) shall be constructed
General Description	This is a new substation construction originally requested by TCN. Based on the surveying results, the area was changed from 8.73 → 9.62 hectares, but based on geography and landforms, there was no need to change substation locations from the initial plan. Dependent on the Auditorium expansion plans.
Incoming bay / Outgoing bay for transmission line	Incoming bay from Likosi (Ogijo) S/S: 132kV-double-circuit line
Option	N/A

(4) Ajegunle (New Agbara) substation

Item	Content
Area size	Approx. 34.067ha
Location	Ogun state 507792.00mE, 735774.00mN
Component	New construction of a 330/132/33kV substation at Ajegunle (New Agbara)
Photo	 Location where Ajegunle (New Agbara) shall be constructed
General Description	This is a new substation construction originally requested by TCN. The location is under the existing 330kV transmission line connecting Ikeja West substation and Sakete - Republic of Benin.
Incoming bay / Outgoing bay for transmission line	Incoming bay from Ejio (Arigbajo) S/S: 330kV-double-circuit line Incoming bay from Ikeja West S/S: 330kV-single-circuit line Outgoing bay to Sakete S/S: 330kV-single-circuit line Outgoing bay to Agbara S/S: 132kV-double-circuit line Outgoing bay to Badagry S/S: 132kV-double-circuit line
Option	N/A

(5) Badagry substation

Item	Content
Area size	Approx. 25.29ha
Location	Lagos state 484038.34 m E, 710913.02 m N
Component	New construction of a 132/33kV substation at Badagry
Photo	 Location where (1) the Badagry substation shall be constructed
General Description	This is a new substation construction originally requested by TCN. The substation site was relocated a few times to avoid a swampy area and private land.
Incoming bay / Outgoing bay for transmission line	Incoming bay from Ajegunle (New Agbara) S/S: 132kV-double-circuit line
Option	Following a request from TCN, an outdoor conventional type for switchgear is planned for facilities. However, there are two options to minimize the land development area for environmental reasons in addition to securing safety and reliability: 1. GIS (Gas-Insulated Switchgear (Indoor type)) 2. C-GIS (Cubicle-Gas-Insulated Switchgear (Outdoor type))

(6) Ejio (Arigbajo) substation

Item	Content
Area size	Approx. 34.067ha
Location	Ogun state 507792.00mE, 735774.00mN
Component	New construction of a 330/132/33kV substation at Ejio (Arigbajo)
Photo	 Existing 330kV transmission tower where the Ejio (Arigbajo) substation shall be constructed  Current condition of the land for a new substation
General Description	This is a new substation construction additionally requested by TCN. Originally, the plan was for TCN to construct this substation and some bay construction work was supposed to be included in the scope of this project.
Incoming bay / Outgoing bay for transmission line	Incoming bay from Olorunsogo P/S: 330kV-four-circuit line Incoming bay from Ikeja West S/S: 330kV- single-circuit line Outgoing bay to Likosi (Ogijo) S/S: 330kV-double-circuit line Outgoing bay to Ajegunle (New Agbara) S/S: 330kV-double-circuit line Outgoing bay from Ayede S/S: 330kV-single-circuit line Outgoing bay to New Abeokuta S/S: 132kV-double-circuit line
Option	Upon request from TCN, an outdoor conventional type for switchgear is planned for facilities. However, there are two options to minimize the land development area for environmental reasons in addition to securing safety and reliability: 1. GIS (Gas-Insulated Switchgear (Indoor type)) 2. C-GIS (Cubicle-Gas-Insulated Switchgear (Outdoor type))

4-4-2 Summary of Substations for the Project (Expansion)

(1) Agbara substation

Item	Content	
Area size	(within the existing substation area)	
Location	Ogun state 509275.967mE, 718978.996mN	
Component	Extension of the line bay of the existing 132/33kV substation at Agbara	
Photo	 Switchyard of the existing 132/33kV Agbara substation	 Location of the planned bay extension
General Description	This is extension work for an additional line bay originally requested by TCN. At the current substation supplied with power from either the Ikeja West or Ojo substation.	
Incoming bay / Outgoing bay for transmission line	Incoming bay from Ajegunle (New Agbara) S/S: 132kV-double-circuit line	
Option	N/A	

(2) New Abeokuta substation

Item	Content
Area size	(within the existing substation area)
Location	Ogun state 543153.42mE, 785272.222mN
Component	Extension of line bay of the existing 132/33kV substation at New Abeokuta
Photo	 Existing line bay for Abeokuta substation  Switchyard of the existing 132/33kV New Abeokuta substation
General Description	This is extension work for the additional line bay originally requested by TCN. As things stand, the substation is connected to the Abeokuta substation and there are plans to connect it to the Igbora substation located in Oyo state.
Incoming bay / Outgoing bay for transmission line	Incoming bay from Ejio (Arigbajo) S/S: 132kV-double-circuit line
Option	N/A

(3) Olorunsogo power station

Item	Content
Area size	(within the existing power station area)
Location	Ogun state 534667.199mE, 760577.598mN
Component	Extension of line bay of the existing 330kV switchyard at Olorunsogo power station
Photo	 Existing 330kV switchyard
General Description	This is extension work for the additional line bay originally requested by TCN. As things stand, there are two 330kV outgoing feeders and two additional feeders (line bay) shall be constructed under the project. All the 330kV lines shall be connected to the Ejio (Arigbajo) substation when this project is implemented.
Incoming bay / Outgoing bay for transmission line	Outgoing line bay to Ejio (Arigbajo): 330kV-double-circuit line
Option	N/A

4-4-3 Outline of substation bay and main equipment

The type of substation bays, size of transformers, content of the other main equipment, bill of quantities and specification of the main equipment procured and installed under the project are shown in Table 4-50 and 4-51 respectively.

Table 4-50 Outline of the Candidate Substations

Substation	New Substation						Expansion of incoming bay / outgoing bay		
	Likosi (Ogijo)	Makogi (MFM)	Abule Oba (Redeem)	Ajegunle (New Agbara)	Badagry	Ejio (Arigbajo)	Agbara	New Abeokuta	Olorunsogo
330kV incoming / outgoing bay of transmission line	10 bays	4 bays	-	4 bays	-	10 bays	-	-	2 bays
132kV incoming / outgoing bay of transmission line	6 bays	-	2 bays	4 bays	2 bays	2 bays	2 bays	2 bays	-
33kV outgoing bay of distribution line	6 bays	6 bays	6 bays	6 bays	6 bays	6 bays	-	-	-
330kV protection facility of transformer	2 bays	2 bays	-	2 bays	-	2 bays	-	-	-
132kV protection facility of transformer	4 bays	4 bays	2 bays	4 bays	2 bays	4 bays	-	-	-
33kV protection facility of transformer	2 bays	2 bays	2 bays	2 bays	2 bays	2 bays	-	-	-
330/132kV transformer (300MVA)	2 units	-	-	-	-	-	-	-	-
330/132kV transformer (150MVA)	-	2 units	-	2 units	-	2 units	-	-	-
132/33kV transformer (100MVA)	2 units	-	-	-	-	-	-	-	-
132/33kV transformer (60MVA)	-	2 units	2 units	2 units	2 units	2 units	-	-	-
330kV bus-bar facility	1 unit	1 unit	-	1 unit	-	1 unit	-	-	-
132kV bus-bar facility	1 unit	1 unit	1 unit	1 unit	1 unit	1 unit	-	-	-
33kV bus-bar facility	1 unit	1 unit	1 unit	1 unit	1 unit	1 unit	-	-	-
Control device, Protection device	1 unit	1 unit	1 unit	1 unit	1 unit	1 unit	1 set	1 set	1 set
Control room	1 unit	1 unit	1 unit	1 unit	1 unit	1 unit	-	-	-

Source: JICA Study Team

Table 4-51 Specification of the Main equipment (New substation)

Equipment type	Specification
Power transformer	Type: Outdoor type, including load-ratio control transformer, three-phase transformer (single phase transformer x 3) Rated voltage: 330/132/34.5kV Rated capacity: 300MVA Cooling system: ONAN / ONAF Wire connection and Phase shift: YNa0d11 Other: including OLTC (+4×1.25%, -12×1.25%)
	Type: Outdoor type, including load-ratio control transformer, three-phase transformer (single phase transformer x 3) Rated voltage: 330/132/34.5kV Rated capacity: 150MVA Cooling system: ONAN / ONAF Wire connection and Phase shift: YNa0d11 Other: including OLTC (+4×1.25%, -12×1.25%)
	Type: Outdoor type, including load-ratio control transformer, normal three-phase transformer (separated coil) Rated voltage: 132/34.5kV Rated capacity: 100MVA Cooling system: ONAN / ONAF Wire connection and Phase shift: YNd11 Other: including OLTC (+4×1.25%, -12×1.25%)
	Type: Outdoor type, including load-ratio control transformer, normal three-phase transformer (separated coil) Rated voltage: 132/34.5kV Rated capacity: 60MVA Cooling system: ONAN / ONAF Wire connection and Phase shift: YNd11 Other: including OLTC (+4×1.25%, -12×1.25%)
Shunt Reactor	Type: Reactor: Three-phase shunt reactor Rated voltage: 330kV Maximum usage voltage: 362kV Rated capacity: 75MVar Cooling system: ONAN
Circuit Breaker	Type: Outdoor type, Insulator type (creepage distance of insulator: 31mm/kV), Three phases Rated voltage: exceeds 362kV Rated current: exceeds 4,000A Rated breaking current: exceeds 50kA Rated breaking time: fewer than three cycles Rated short-time withstand current: exceeds 50kA (2sec.) Operation duty: O-0.3sec.-CO-3min.-CO Rated impulse withstand voltage: exceeds 1,175kV Rated power-frequency withstand voltage (1 minute): exceeds 520kV Control voltage: 110V DC Accessories: Operation number counter, Local operation box, etc.
	Type: Outdoor type, Insulator type (creepage distance of insulator: 31mm/kV), Three phases Rated voltage: exceeds 145kV Rated current: exceeds 2,000A Rated breaking current: exceeds 31.5kA Rated breaking time: fewer than three cycles Rated short-time withstand current: exceeds 31.5kA (2sec.) Operation duty: O-0.3sec.-CO-3min.-CO Rated impulse withstand voltage: exceeds 650kV Rated power-frequency withstand voltage (1 minute): exceeds 275kV Control voltage: 110V DC Accessories: Operation number counter, Local operation box, etc.
Disconnector	Type: Outdoor type, Insulator type (creepage distance of insulator: 31mm/kV), Horizontal two-point Rated voltage: exceeds 362kV

Equipment type	Specification
	Rated current: exceeds 2,000A Rated short-time withstand current: exceeds 31.5kA (2sec.) Rated impulse withstand voltage: exceeds 1,175kV Rated power-frequency withstand voltage (1 minute): exceeds 520kV Control voltage: 110V DC Local operation box: Electric control unit Other: Manual opening/closing handle, etc. (Disconnector with ground earth should have an electric earth device.)
	Type: Outdoor type, Insulator type (creepage distance of insulator: 31mm/kV), Horizontal two-point Rated voltage: exceeds 145kV Rated current: exceeds 2,000A Rated short-time withstand current: exceeds 31.5kA (2sec.) Rated impulse withstand voltage: exceeds 650kV Rated power-frequency withstand voltage (1 minute): exceeds 275kV Control voltage: 110V DC Local operation box: Electric control unit Other: Manual opening/closing handle, etc. (Disconnector with ground earth should have an electric earth device.)
Instrument transformer (Current transformer)	Type: Outdoor type, Insulator type (creepage distance of insulator: 31mm/kV) Rated voltage: exceeds 362kV Rated primary current: 800A/1,600A Rated secondary current: 1A Accuracy class: Core 1 0.2, Core 2～4 Class X Rated secondary load: exceeds 30VA Rated short-time withstand current: exceeds 31.5kA (2sec.) Rated impulse withstand voltage: exceeds 1,175kV Rated power-frequency withstand voltage (1 minute): exceeds 510kV
	Type: Outdoor type, Insulator type Rated voltage: exceeds 362kV Rated primary current: 800A/1,600A Rated secondary current: 1A Accuracy class: Core 1 0.2, Core 2～4 Class X Rated secondary load: exceeds 30VA Rated short-time withstand current: exceeds 31.5kA (2sec.) Rated impulse withstand voltage: exceeds 650kV Rated power-frequency withstand voltage (1 minute): exceeds 275kV
Instrument transformer (Voltage transformer)	Type: Outdoor type, condenser type (creepage distance of insulator: 31mm/kV) Rated voltage: exceeds 362kV Rated primary voltage: 330/√3kV Rated secondary voltage: 110/√3V Accuracy class: for measurement; class 0.2, for protection class 3P Rated secondary load: exceeds 50VA Rated impulse withstand voltage: exceeds 1,175kV Rated power-frequency withstand voltage (1 minute): exceeds 510kV
	Type: Outdoor type, condenser type (creepage distance of insulator: 31mm/kV) Rated voltage: exceeds 145kV Rated primary voltage: 132/√3kV Rated secondary voltage: 110/√3V Accuracy class: for measurement; class 0.2, for protection class 3P Rated secondary load: exceeds 50VA Rated impulse withstand voltage: exceeds 650kV Rated power-frequency withstand voltage (1 minute): exceeds 275kV
Lightning arresters	Type: Outdoor type, Zinc oxide, Single phase (creepage distance of insulation: 31mm/kV) Maximum system voltage: 362kV Rated voltage: 288kV Rated electric discharge: 20kA
Lightning arresters	Type: Outdoor type, Zinc oxide, Single phase (creepage distance of insulation: 31mm/kV) Maximum system voltage: 145kV Rated voltage: 120kV Rated electric discharge: 10kA
Wave trap	Rated voltage: 362kV

Equipment type	Specification
(Power line carrier communication)	Rated current: 2000A Rated inductance: 1.0mH
	Rated voltage: 145kV Rated current: 2000A Rated inductance: 1.0mH

Source: JICA Study Team

4-4-4 Outline design drawing

Outline design drawings, such as single-line diagrams, substation layout plans and architectural drawings, are shown as follows:

Single-Line Diagrams

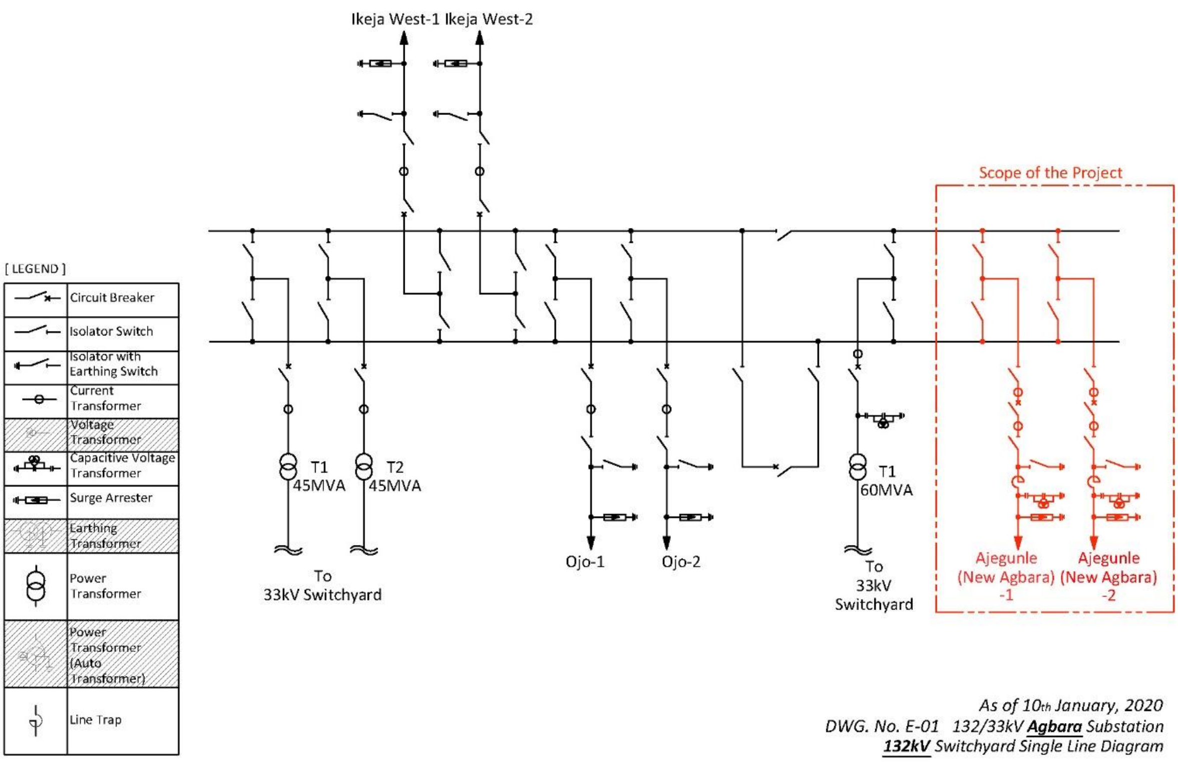
Drawing Number	Drawing Name
E-01	132/33kV Agbara Substation Draft 132kV Switchyard Single-Line Diagram
E-02	132/33kV New Abeokuta Substation Draft 132kV Switchyard Single-Line Diagram
E-03	330/132/33kV Likosi (Ogijo) Substation Draft 330kV Switchyard Single-Line Diagram
E-04	330/132/33kV Likosi (Ogijo) Substation Draft 1320kV Switchyard Single-Line Diagram
E-05	330/132/33kV Likosi (Ogijo) Substation Draft 33kV Switchyard Single-Line Diagram
E-06	330/132/33kV Makogi (MFM) Substation Draft 330kV Switchyard Single-Line Diagram
E-07	330/132/33kV Makogi (MFM) Substation Draft 132kV Switchyard Single-Line Diagram
E-08	330/132/33kV Makogi (MFM) Substation Draft 33kV Switchyard Single-Line Diagram
E-09	132/33kV Abule Oba (Redeem) Substation Draft 132kV Switchyard Single-Line Diagram
E-10	132/33kV Abule Oba (Redeem) Substation Draft 33kV Switchyard Single-Line Diagram
E-11	330/132/33kV Ajegunle (New Agbara) Substation Draft 330kV Switchyard Single-Line Diagram
E-12	330/132/33kV Ajegunle (New Agbara) Substation Draft 132kV Switchyard Single-Line Diagram
E-13	330/132/33kV Ajegunle (New Agbara) Substation Draft 33kV Switchyard Single-Line Diagram
E-14	132/33kV Badagry Substation Draft 132kV Switchyard Single-Line Diagram
E-15	132/33kV Badagry Substation Draft 33kV Switchyard Single-Line Diagram
E-16	330/132/33kV Ejio (Arigbajo) Substation Draft 330kV Switchyard Single-Line Diagram
E-17	330/132/33kV Ejio (Arigbajo) Substation Draft 132kV Switchyard Single-Line Diagram
E-18	330/132/33kV Ejio (Arigbajo) Substation Draft 33kV Switchyard Single-Line Diagram

Outline layout drawing

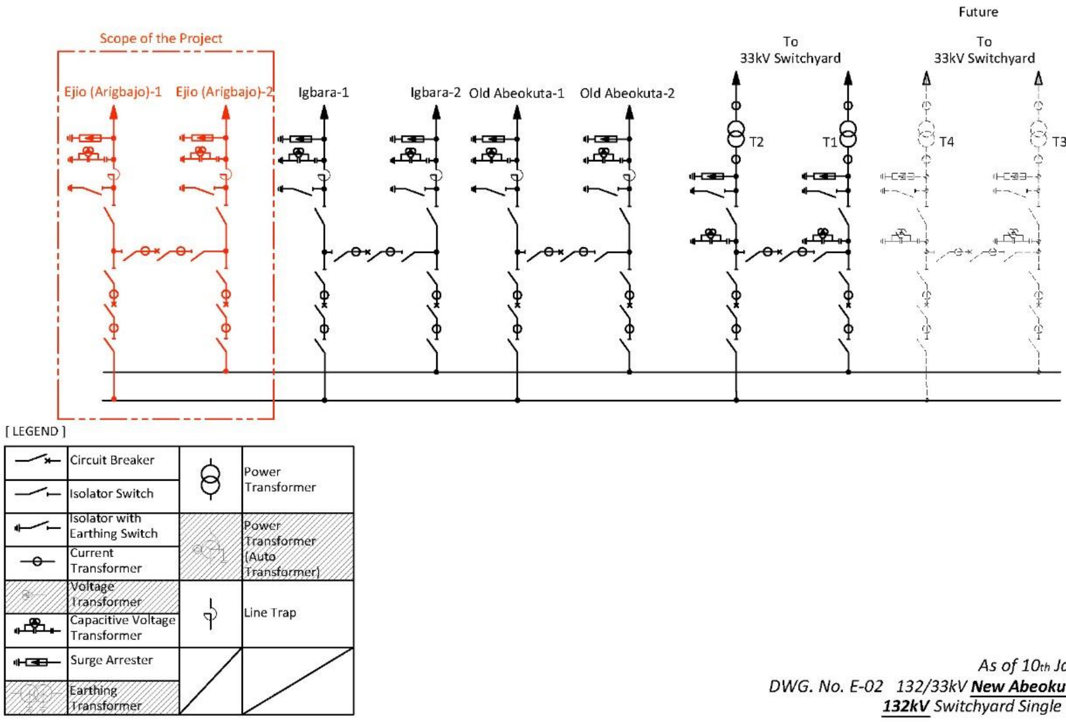
Drawing Number	Drawing Name
L-01	DRAFT LAYOUT PLAN 330 / 132 / 33kV LIKOSI (OGIJO) SUBSTATION
L-02	DRAFT LAYOUT PLAN 330 / 132 / 33kV MAKOGI (MFM) SUBSTATION
L-03	DRAFT LAYOUT PLAN 330 / 132 / 33kV ABULE OBA (REDEEM) SUBSTATION
L-04	DRAFT LAYOUT PLAN 330 / 132 / 33kV AJEGUNLE (NEW AGBARA) SUBSTATION
L-05	DRAFT LAYOUT PLAN 330 / 132 / 33kV BADAGRY SUBSTATION
L-06	DRAFT LAYOUT PLAN 330 / 132 / 33kV EJIO (ARIGBAJO) SUBSTATION

Architectural drawing

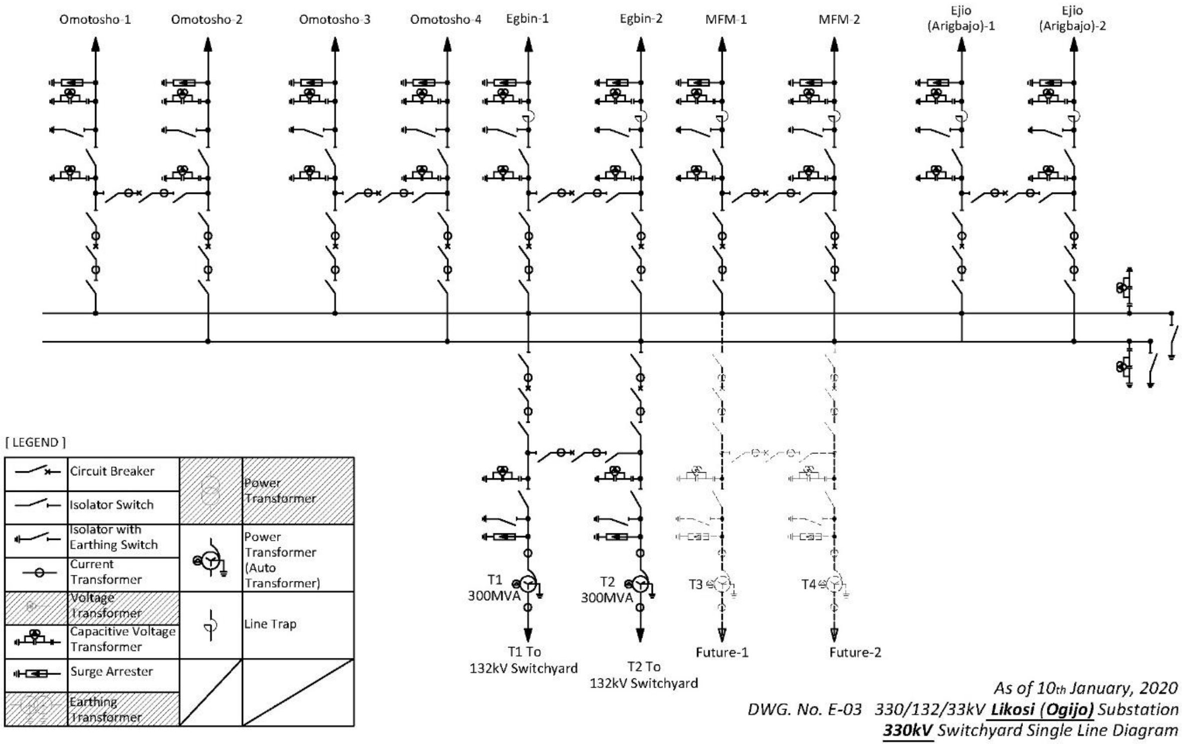
Drawing Number	Drawing Name
A-01	Control Building Floor Plan, Elevation and Section (Common)



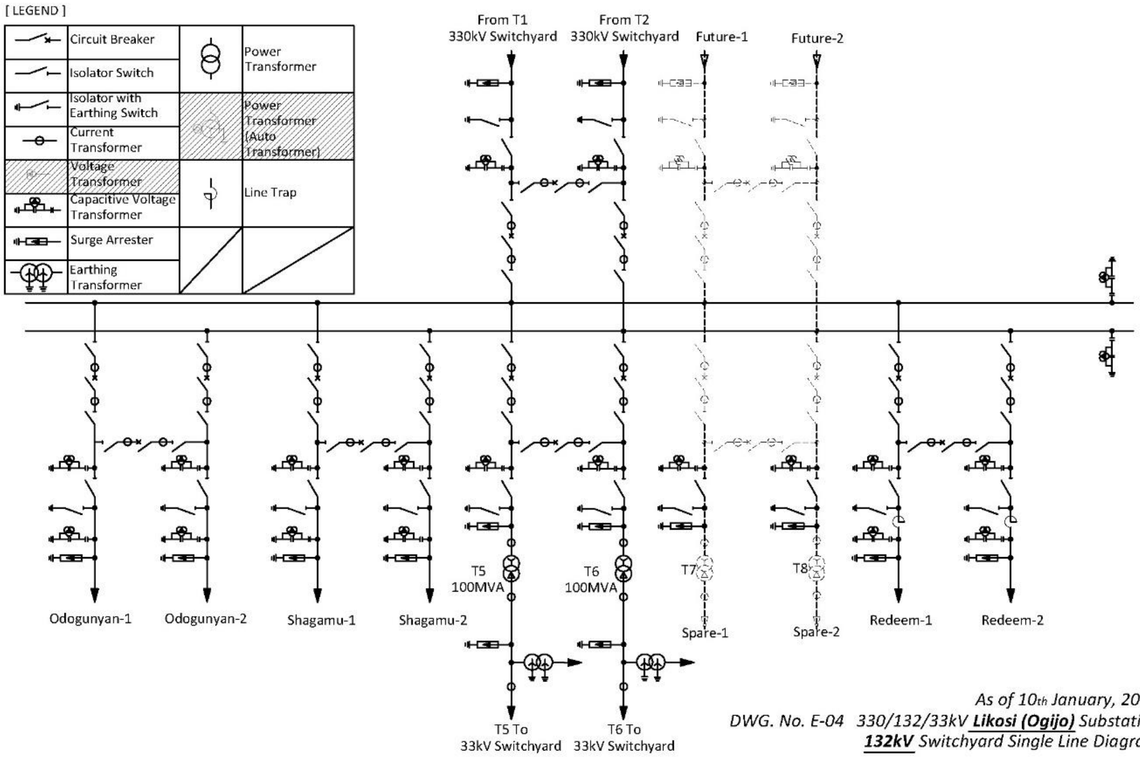
As of 10th January, 2020
*DWG. No. E-01 132/33kV **Agbara** Substation*
***132kV** Switchyard Single Line Diagram*



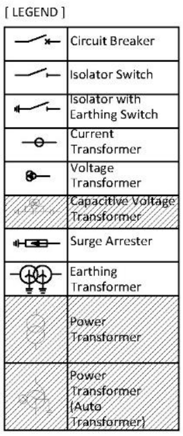
As of 10th January, 2020
*DWG. No. E-02 132/33kV **New Abeokuta** Substation*
***132kV** Switchyard Single Line Diagram*

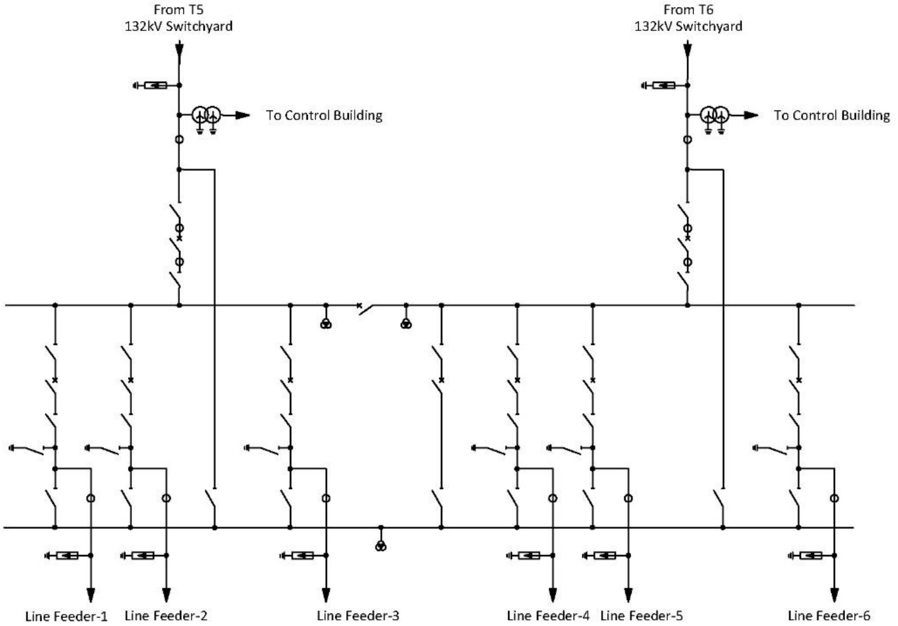


As of 10th January, 2020
*DWG. No. E-03 330/132/33kV **Likosi (Ogijo)** Substation*
***330kV** Switchyard Single Line Diagram*

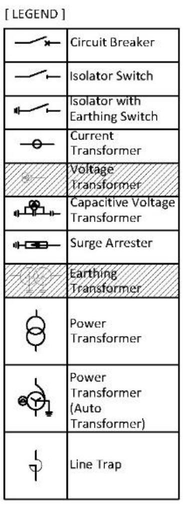


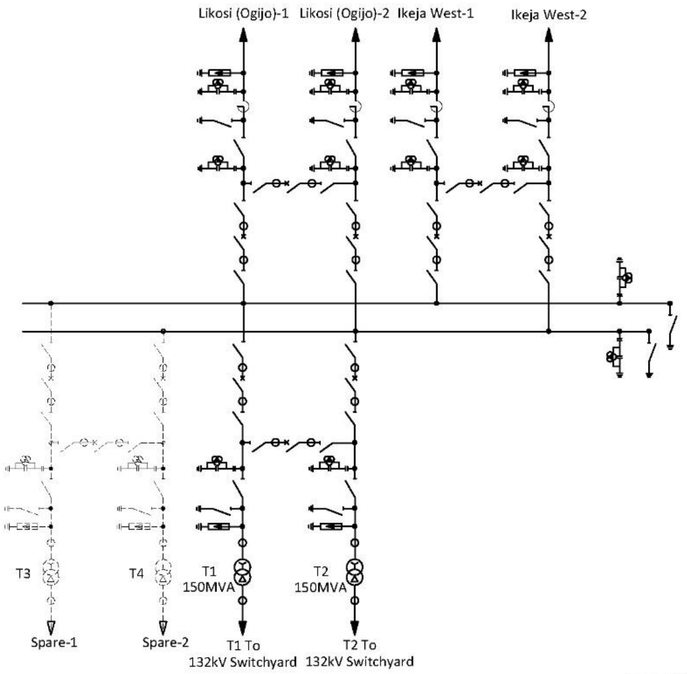
As of 10th January, 2020
*DWG. No. E-04 330/132/33kV **Likosi (Ogijo)** Substation*
***132kV** Switchyard Single Line Diagram*



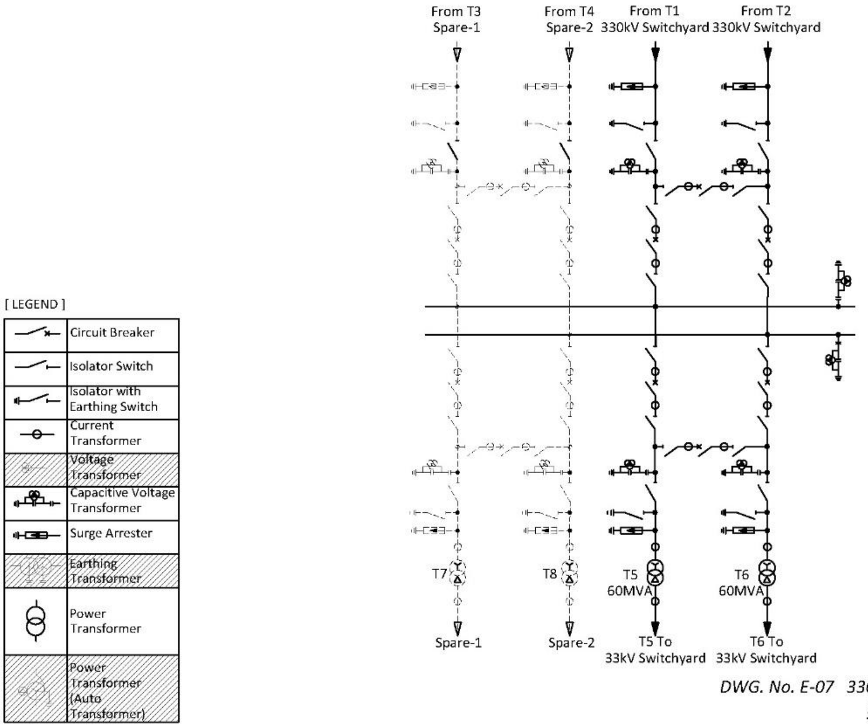


As of 10th January, 2020
DWG. No. E-05 330/132/33kV ***Likosi (Ogijo)*** *Substation*
33kV *Switchyard Single Line Diagram*

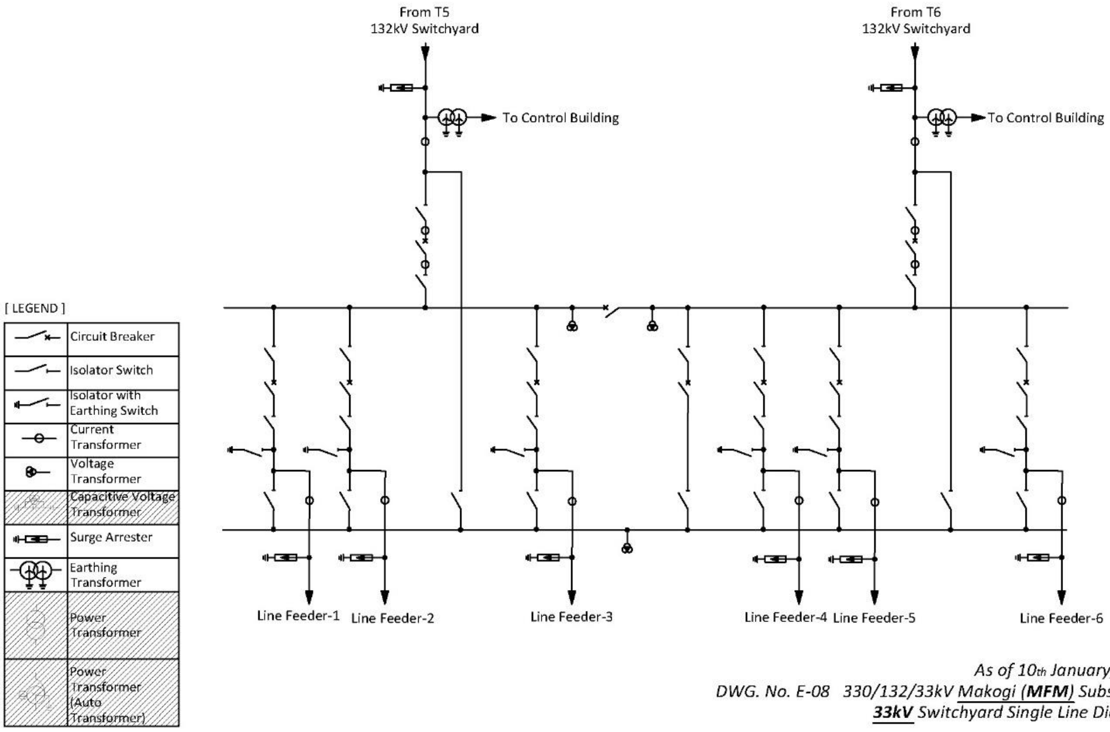




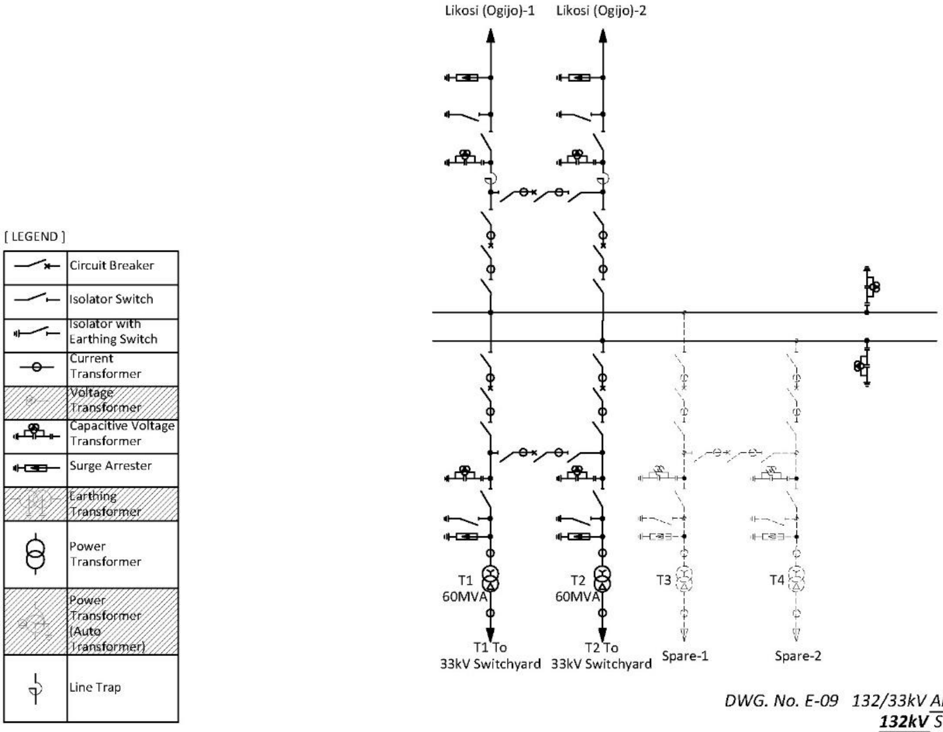
As of 10th January, 2020
*DWG. No. E-06 330/132/33kV Makogi (****MFM****) Substation*
330kV *Switchyard Single Line Diagram*



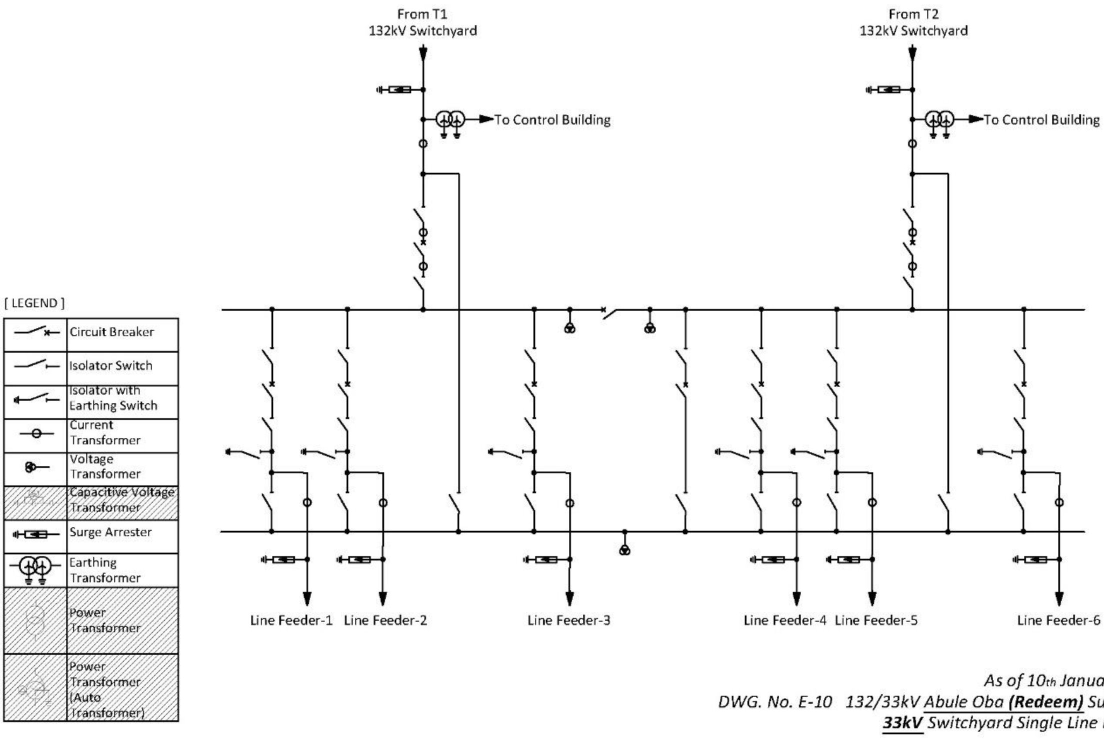
As of 10th January, 2020
*DWG. No. E-07 330/132/33kV Makogi (**MFM**) Substation*
***132kV** Switchyard Single Line Diagram*



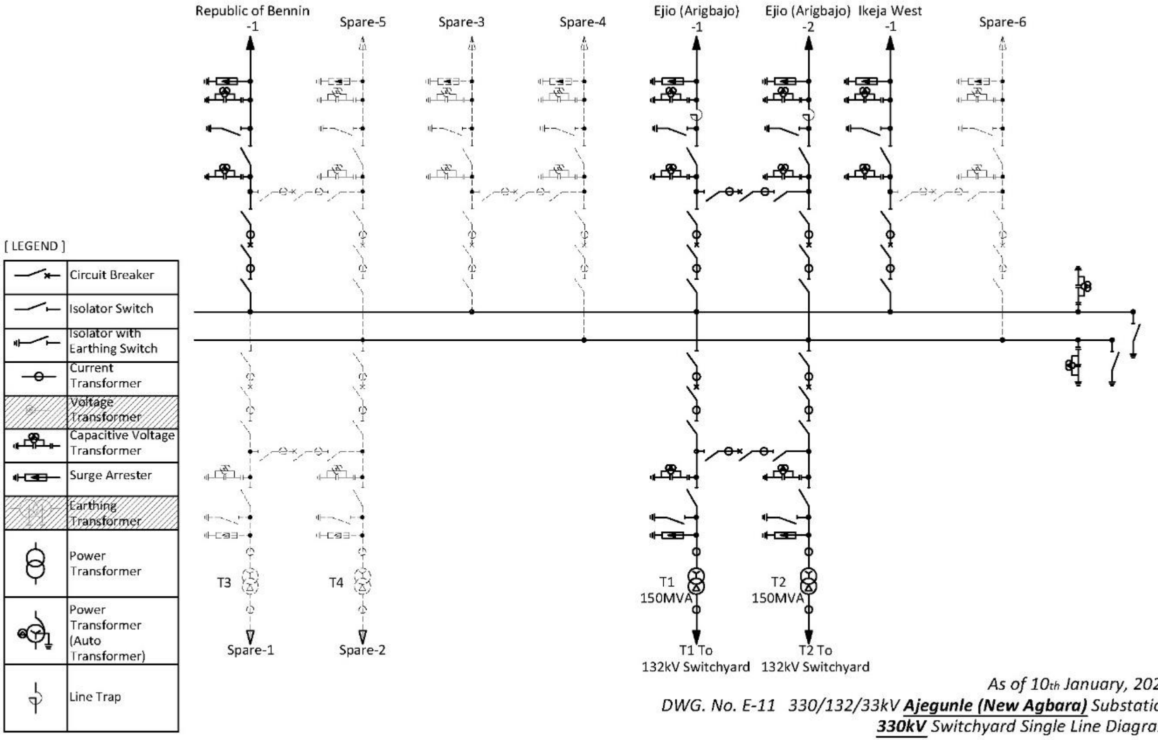
As of 10th January, 2020
*DWG. No. E-08 330/132/33kV Makogi (**MFM**) Substation*
***33kV** Switchyard Single Line Diagram*



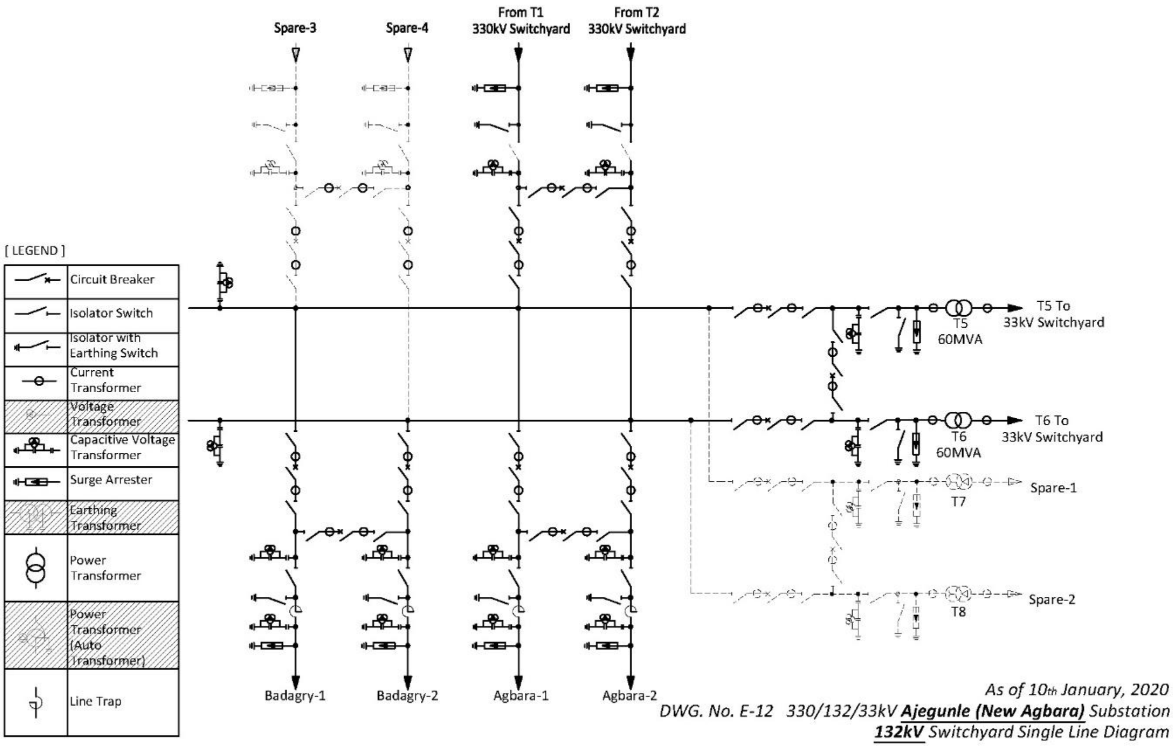
As of 10th January, 2020
*DWG. No. E-09 132/33kV Abule Oba **(Redeem)** Substation*
***132kV** Switchyard Single Line Diagram*



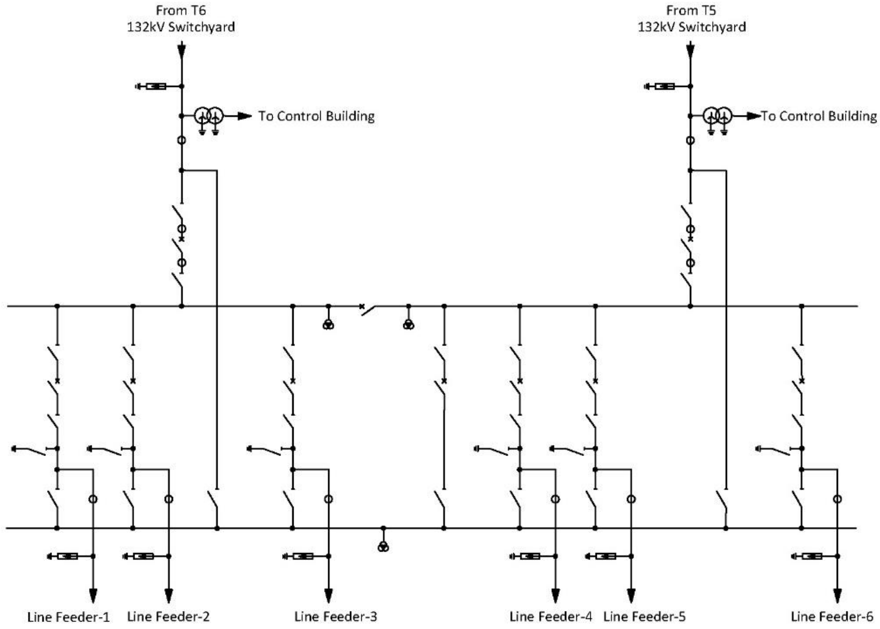
As of 10th January, 2020
*DWG. No. E-10 132/33kV Abule Oba **(Redeem)** Substation*
***33kV** Switchyard Single Line Diagram*

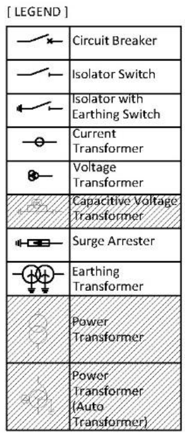


As of 10th January, 2020
*DWG. No. E-11 330/132/33kV **Ajegunle (New Agbara)** Substation*
*<u>**330kV**</u> Switchyard Single Line Diagram*

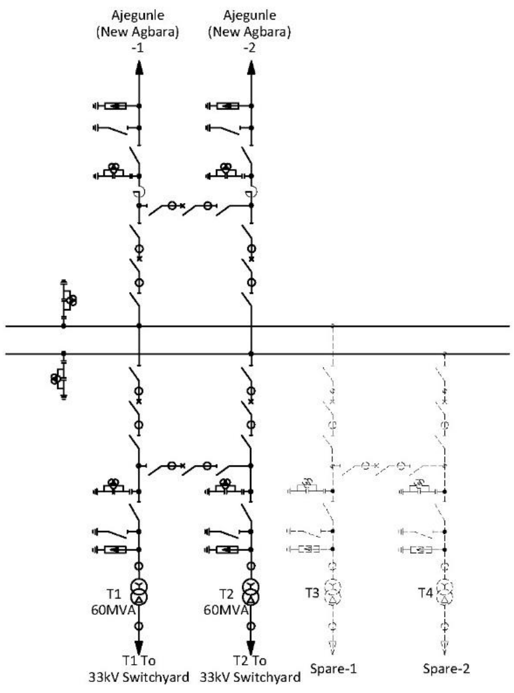


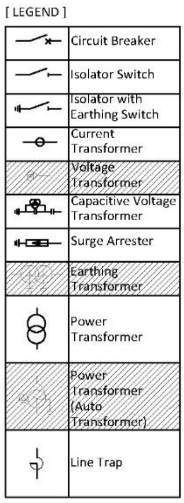
As of 10th January, 2020
*DWG. No. E-12 330/132/33kV **Ajegunle (New Agbara)** Substation*
*<u>**132kV**</u> Switchyard Single Line Diagram*



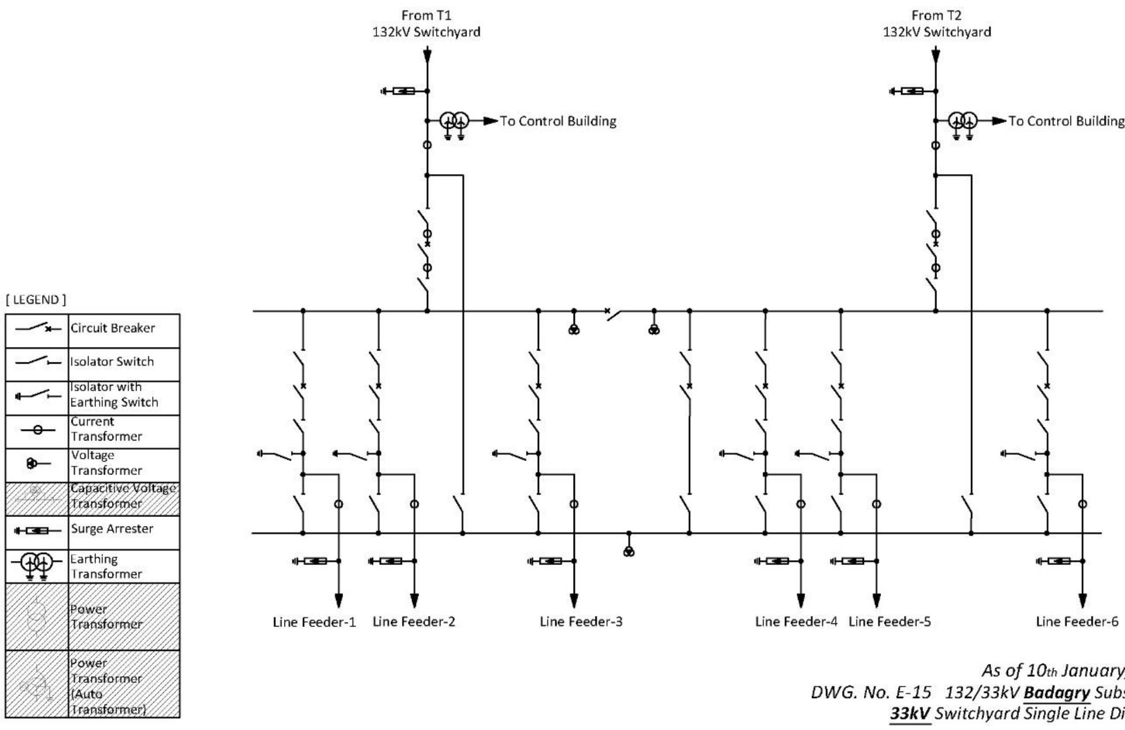


As of 10th January, 2020
*DWG. No. E-13 330/132/33kV **Ajegunle (New Agbara)** Substation*
__33kV__ Switchyard Single Line Diagram

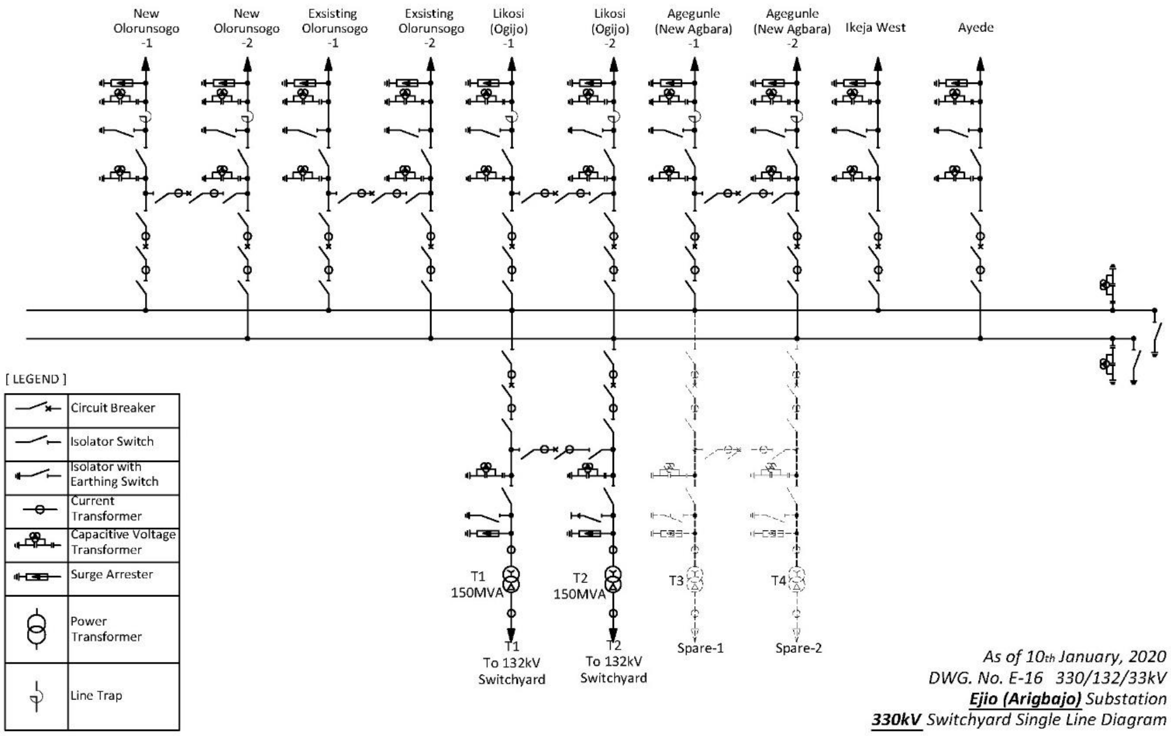




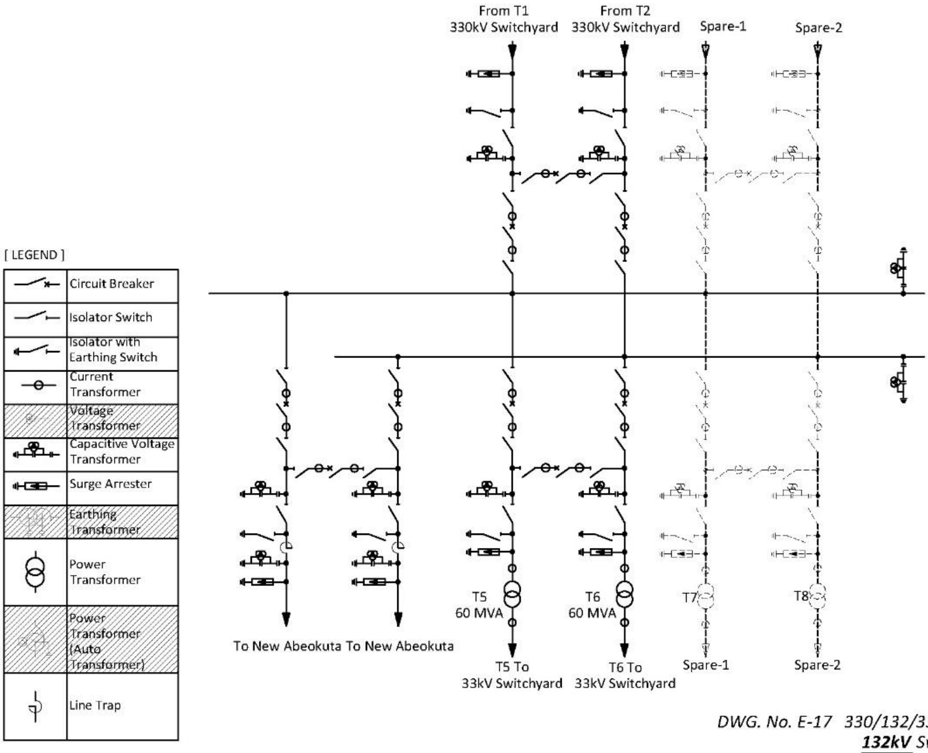
As of 10th January, 2020
*DWG. No. E-14 132/33kV **Badagry** Substation*
__132kV__ Switchyard Single Line Diagram



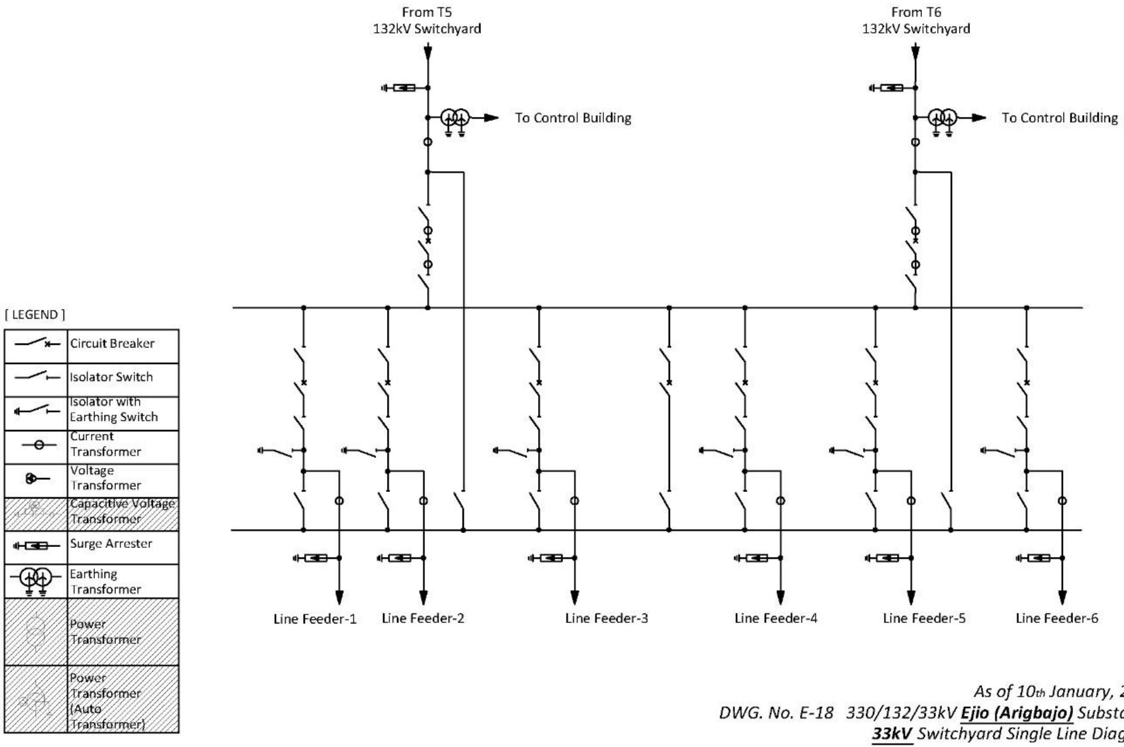
As of 10th January, 2020
*DWG. No. E-15 132/33kV **Badagry** Substation*
***33kV** Switchyard Single Line Diagram*



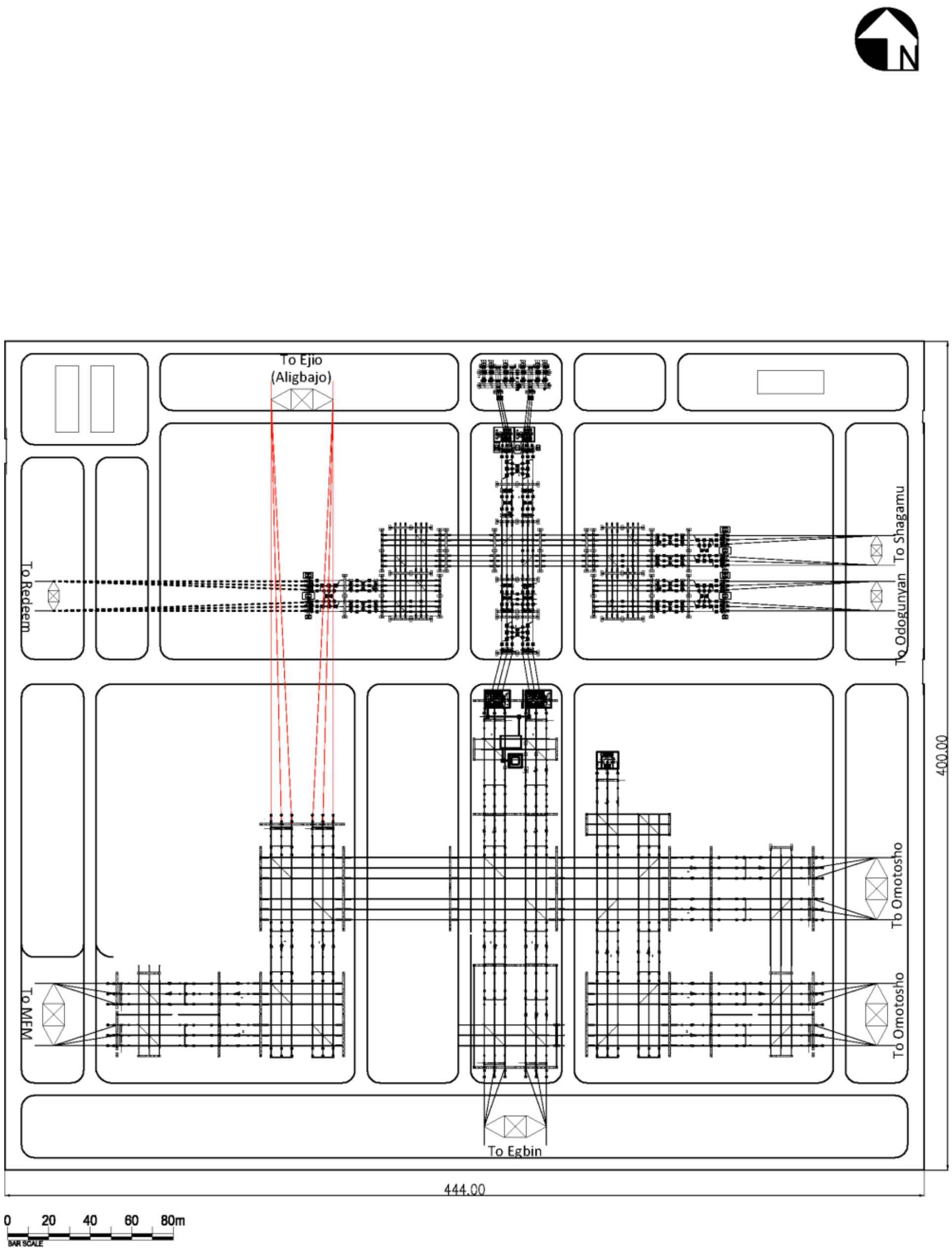
As of 10th January, 2020
DWG. No. E-16 330/132/33kV
***Ejio (Arigbajo)** Substation*
***330kV** Switchyard Single Line Diagram*



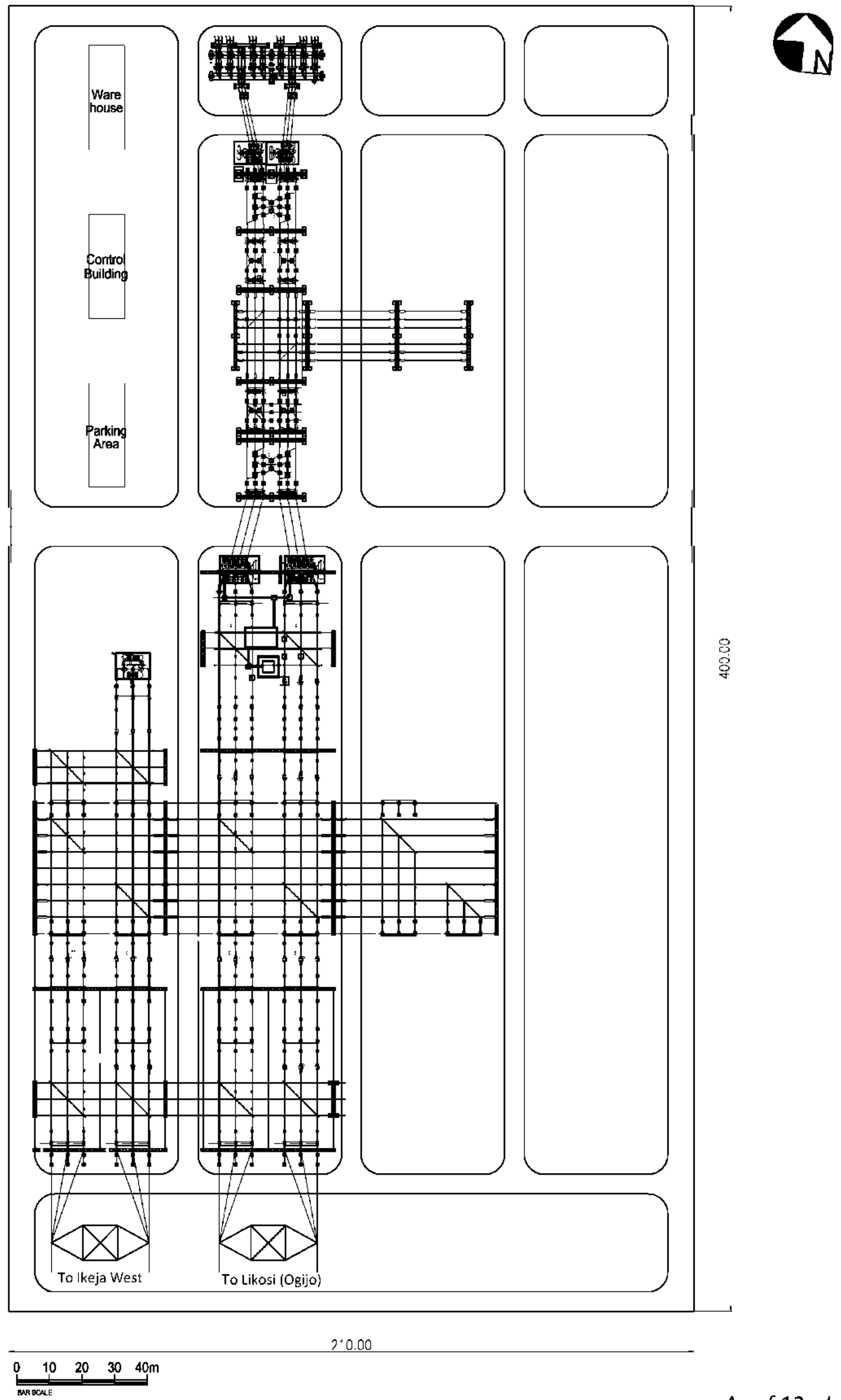
As of 10th January, 2020
DWG. No. E-17 330/132/33kV ***Ejio (Arigbajo)*** *Substation*
132kV *Switchyard Single Line Diagram*



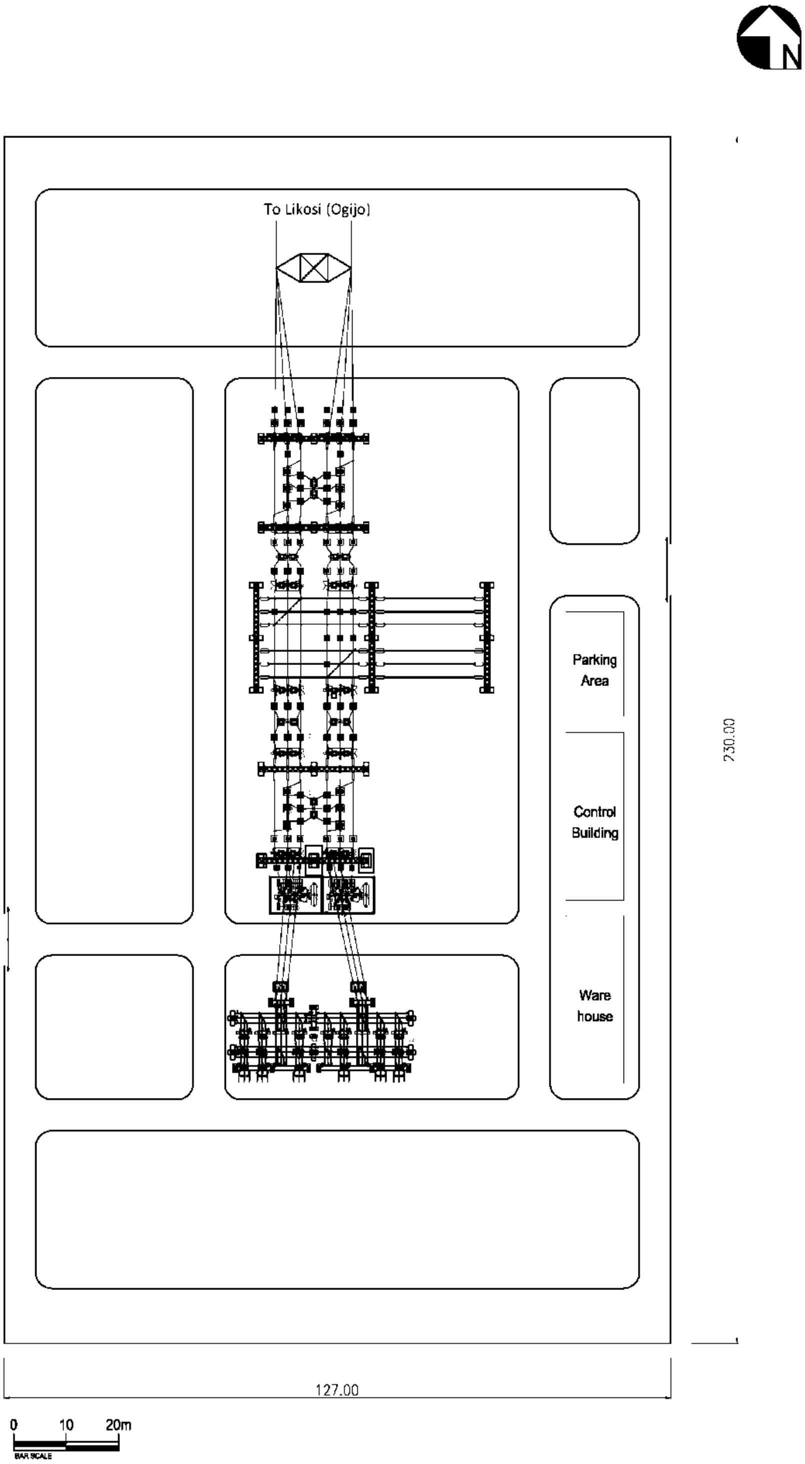
As of 10th January, 2020
DWG. No. E-18 330/132/33kV ***Ejio (Arigbajo)*** *Substation*
33kV *Switchyard Single Line Diagram*



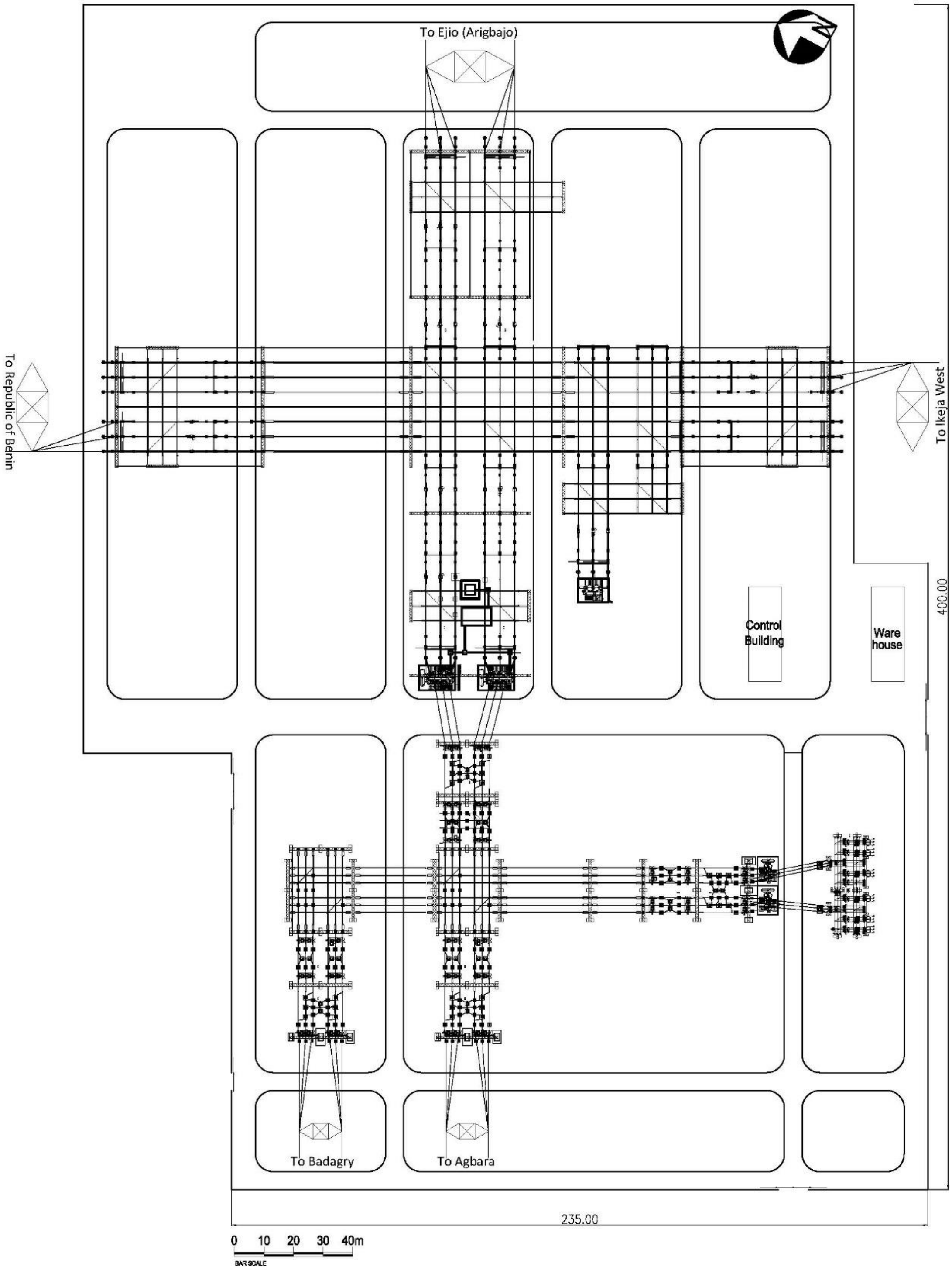
As of 12th July, 2018
DWG. No. L-01 DRAFT LAYOUT PLAN
330 / 132 / 33kV LIKOSI (OGIJO) SUBSTATION



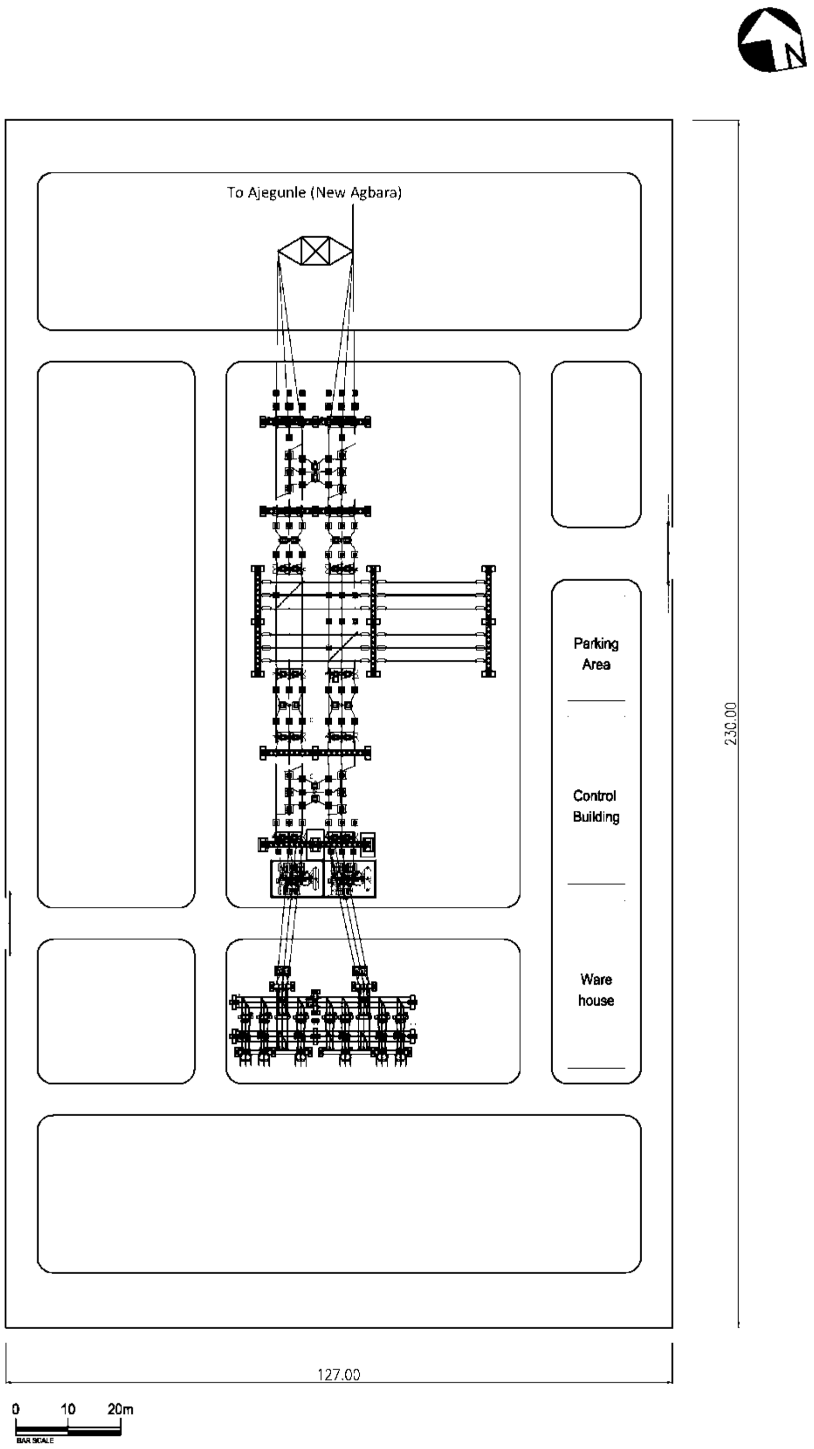
As of 12th July, 2018
DWG. No. L-02 DRAFT LAYOUT PLAN
330 / 132 / 33kV MFM SUBSTATION



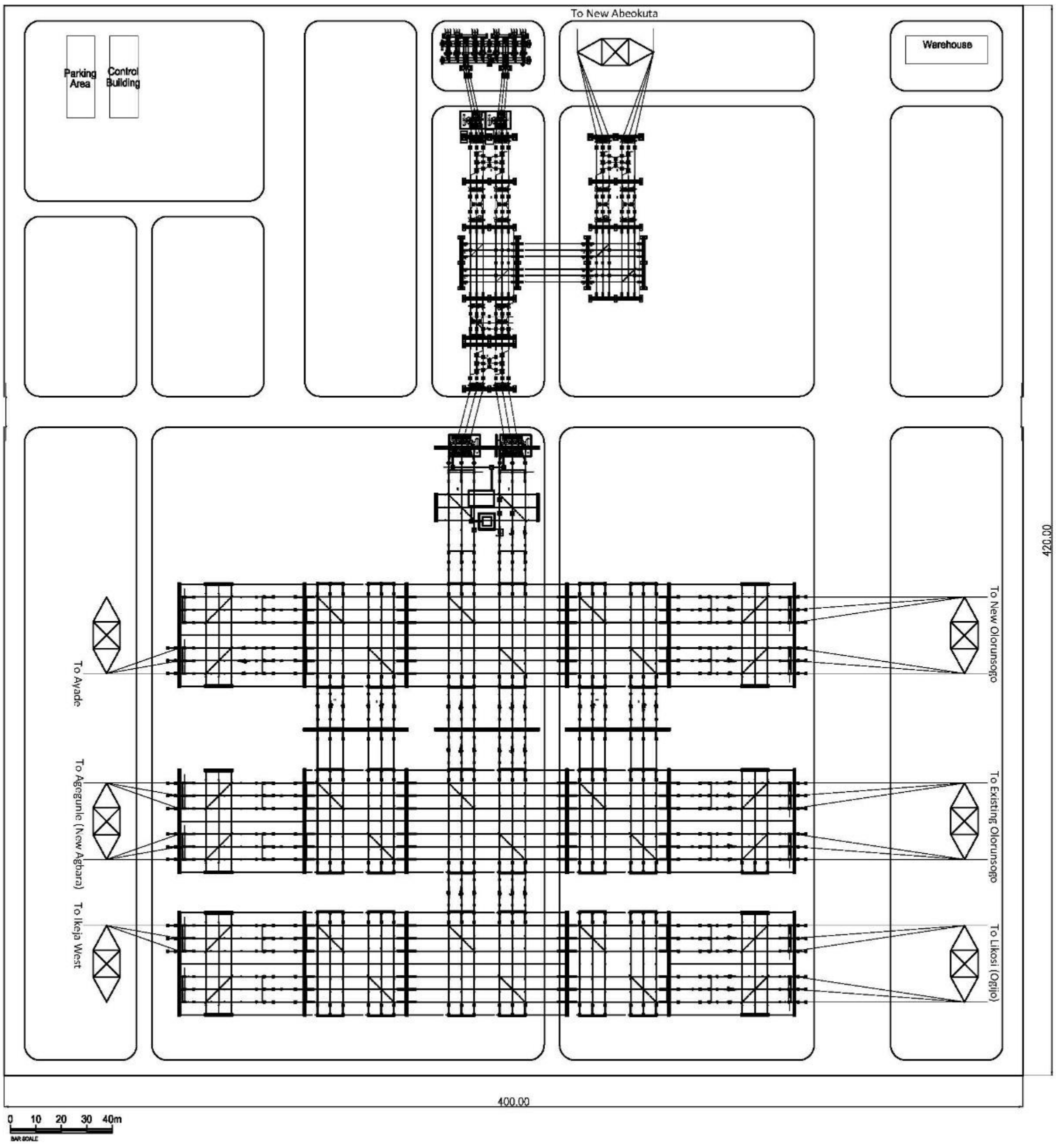
As of 12th July, 2018
DWG. No. L-03 DRAFT LAYOUT PLAN
132 / 33kV REDEEM SUBSTATION



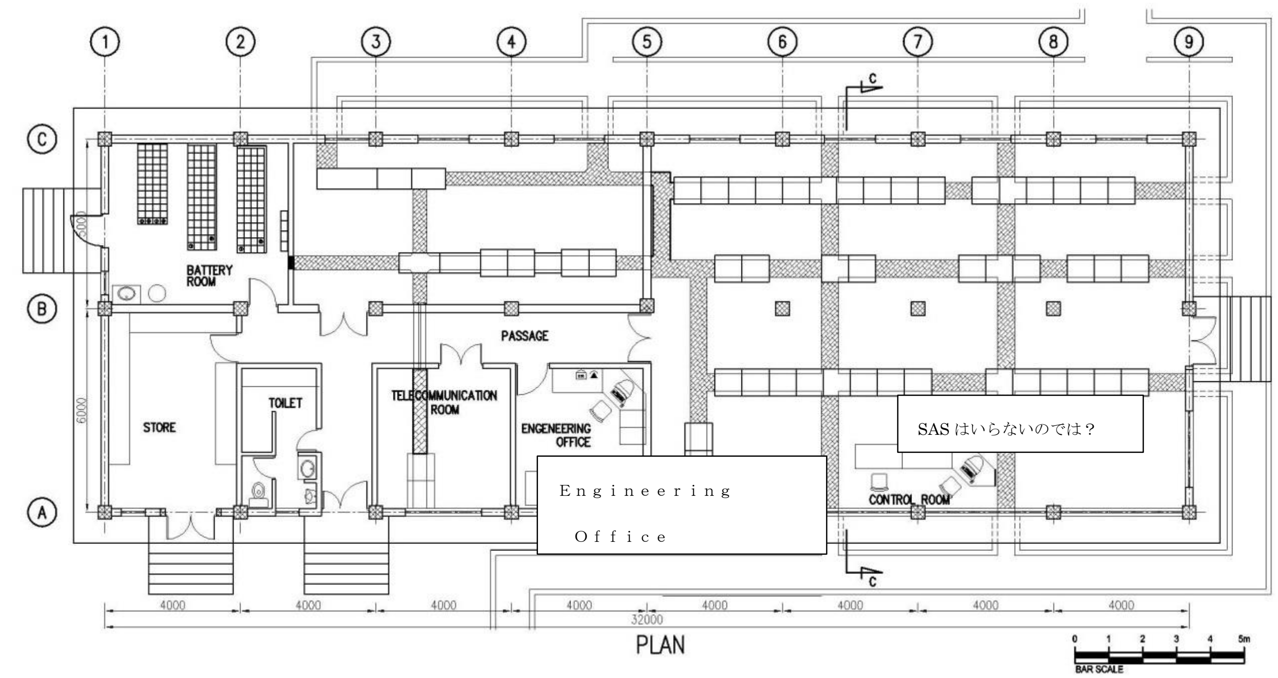
As of 20th December, 2018
DWG. No. L-04 DRAFT LAYOUT PLAN
330 / 132 / 33kV AJEGUNLE (NEW AGBARA) SUBSTATION

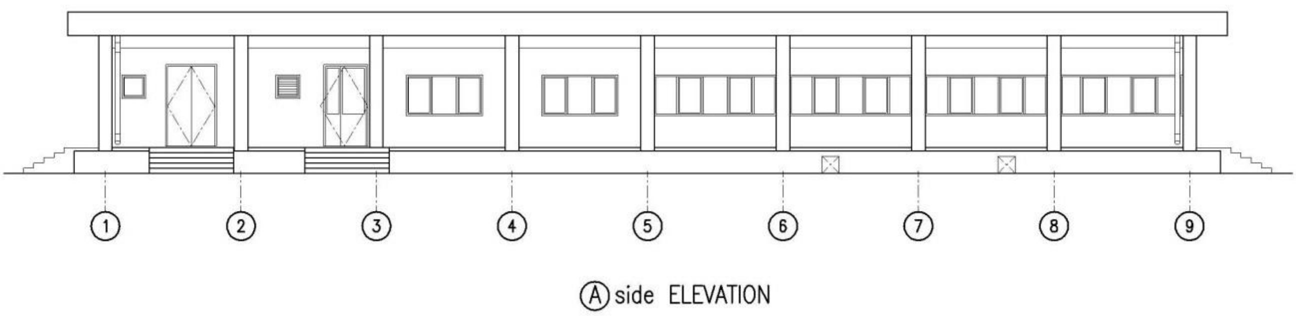


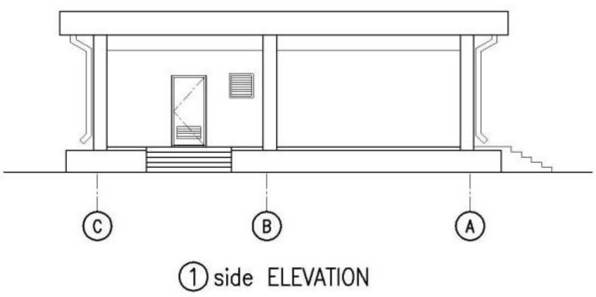
As of 12th July, 2018
DWG. No. L-05 DRAFT LAYOUT PLAN
330 / 132 / 33kV BADAGRY SUBSTATION

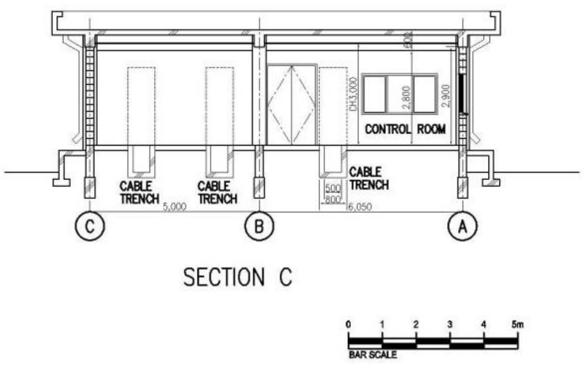


As of 13th November, 2018
DWG. No. L-06 DRAFT LAYOUT PLAN
330/132/33kV Ejio (Arigbajo) Substation









As of 20th April, 2015
DWG. No. A-01 Control Building
Floor Plan, Elevation and Section (Common)

Chapter 5 Power-flow analysis

Chapter 5 Power-flow analysis

To confirm the validity and effectiveness of the candidate transmission and the substation components for the power transmission project, the power system was analyzed by considering the load demand forecast from 2025 to 2030.

5-1 Criteria of the Power-flow analysis

- Regulation

  TCN Grid Code Version 2

- Voltage control range

Table 5-1 Voltage control range

Voltage level kV	Minimum Voltage kV (PU)	Maximum Voltage kV (PU)
330	280.5 (0.85)	346.5 (1.05)
132	112.2 (0.85)	145.2 (1.10)

Source: TCN Grid Code Version 2

- Frequency control range

  The nominal system frequency shall be 50Hz and the national control center will attempt to limit the system frequency to within a narrow operating band of +/- 0.5% from 50Hz (49.75-50.25 Hz), but under System Stress the Power System frequency may vary within the limits of 50 Hz +/- 2.5% (48.75-51.25 Hz).

- Current-carrying capacity of the transmission line

Table 5-2 Current-carrying capacity per circuit

Voltage level kV	Transmission capacity per circuit	Transmission capacity at N-1 contingency
330	777 MVA	854 MVA
132	125 MVA	137 MVA

Source: TCN

5-2 Case of Power-flow analysis

The cases of Power-flow analysis is shown as Table 5-3, Load allocation and Power generation allocation are shown in Table 5-3 and Table 5-4, with no overload, voltage violation, short-circuit current violation, N-1 contingency of the 330 kV line in these cases.

Table 5-3 Case of Power-flow analysis

Case	Target Year	Load (MW)	Description	Super grid	Project Components	Purpose
1	2025	16,356	Model without the project in 2025 All project comments are excluded from the Power system. The load is reduced until the system is in an operable state without any overload or voltage violation, etc in order to confirm the transmission capacity without the project component	No	None	To confirm the effectiveness and validity by transmission capacity without the project component as a zero option.
2	2025	19,243	Suppressed generation model in 2025 Power generation planning in Lagos and Ogun (5,362 MW) is suppressed to 3,187 MW due to finacial issue, etc., the suppressed generation is supplied from power stations outside Lagos and Ogun.	No	All	To confirm overload, voltage violation, short-circuit current and N-1 contingency of 330kV line in 2025, Suppressed generation in Lagos is expected, TCN requested a case study.
3	2030	27,277	Master plan model in 2030 2030 model of Master Plan Study on National Power System Development in the Fedrral Republic of Nigeira, 2019	Yes	All	To confirm overload, voltage violation, short-circuit current and N-1 contingency of 330kV line in 2030

Source: JICA Study Team

Table 5-4 Load of Power-flow analysis

Region	Sub-stations	National Demand			Average Annual Growth		
		2025 PSS/E	2025	2030	2020-2025	2025-2030	2020-2030
		MW	MW	MW	%	%	%
Central,	Ijora	147.2	147.2	160.0	9.9	1.7	5.7
South & East	Alagbon	150.5	140.0	220.0	8.3	9.5	8.9
EKEDC	Akangba	163.2	163.2	260.0	9.9	9.8	9.8
	Isolo	165.3	85.0	120.0	7.2	7.1	7.2
	Itire	68.8	60.0	90.0	6.9	8.4	7.7
	Ojo	148.1	70.0	100.0	7.0	7.4	7.2
	Apapa Road	80.1	80.1	129.0	10.0	10.0	10.0
	Amuwo Odofin	98.6	90.0	130.0	7.9	7.6	7.8
	Akoka	115.5	100.0	140.0	6.8	7.0	6.9
	Ajegunle/New Agbara	101.7	101.7	163.8	9.9	10.0	10.0
	Ajah	157.7	157.7	254.0	5.0	10.0	7.5
	Agbara	87.0	87.0	120.0	9.9	6.6	8.3
	Badagry	44.3	80.0	120.0	12.2	8.4	10.3
	Lekki	106.0	106.0	150.0	9.9	7.2	8.5
	Epe	50.1	70.0	112.7	9.2	10.0	-39.4
	Oko-oba	65.3	0.0	65.3	0.0	0.0	0.0
	EPZ	87.8	0.0	87.8	0.0	0.0	0.0
Sub-total		1,837.2	1,537.9	2,422.6	8.5	9.5	9.0
Central & West	Oke-Aro	97.0	90.0	160.0	11.2	12.2	11.7
IKEDC	Alimosho	118.1	100.0	140.0	9.2	7.0	8.1
	Ogba	246.4	180.0	260.0	6.0	7.6	6.8
	Alausa	110.8	100.0	160.0	10.6	9.9	10.2
	Ejigbo	266.2	200.0	280.0	7.4	7.0	7.2
	Ilupeju	84.6	65.0	100.0	7.1	9.0	8.1
	Maryland	88.4	80.0	120.0	10.7	8.4	9.6
	Igando		0.0	0.0	-	-	-
	Ayobo	22.4	92.4	148.8	12.9	10.0	11.4
	Oworon-shoki	99.0	80.0	120.0	8.2	8.4	8.3
	AFR Foundry	54.2	30.0	45.0	8.4	8.4	8.4
	Egbin	115.6	115.6	200.0	12.9	11.6	12.2
	Ikorodu	175.9	140.0	200.0	7.9	7.4	7.6
	Odogunyan	149.5	149.5	260.0	9.1	11.7	10.4
	Likosi/Ogijo	77.8	80.0	128.8	13.5	10.0	11.8
	MFM	99.1	99.1	159.6	9.3	10.0	9.6
	Redeem	74.0	74.0	119.2	12.9	10.0	11.5
	Ejio/Arigbajo	109.0	109.0	175.5	9.3	10.0	9.6
	Ikeja West	70.0	0.0	0.0	0.0	0.0	0.0
Sub-total		2,058.0	1,784.6	2,777.0	9.3	9.2	9.3
North & West	Otta	117.8	125.0	201.3	9.3	10.0	9.7
IBADAN	Papalanto	27.3	27.3	44.0	16.2	10.0	13.0
	Old Abeokuta	54.0	54.0	87.0	6.2	10.0	8.1
	New Abeokuta	68.3	68.3	110.0	17.2	10.0	13.5
	Igbora		-	-	-	-	-
	Lanlate	23.7	35.0	56.4	11.8	10.0	10.9
	Igangan	23.7	35.0	56.4	11.8	10.0	10.9
North & East	Shagamu	112.5	80.0	120.0	8.5	8.4	8.5
IBADAN	Shagamu Cement (Private)	28.5	25.0	35.0	10.8	7.0	8.8
	Shagamu Industry (Private)	85.3	25.0	35.0	10.8	7.0	8.8
	Shagamu Steel (Private)		32.2	45.0	10.0	6.9	8.4
	Monarch (Private)		22.0	32.0	12.9	7.8	10.3
	Real Infrastructure (Private)		25.0	35.0	10.8	7.0	8.8
	Phoenix (Private)		25.0	35.0	10.8	7.0	8.8
	Top Steel (Private)		30.0	45.0	8.4	8.4	8.4
	Paras Energy		0.0	0.0	0.0	0.0	0.0
	Ijebu Ode	105.0	70.0	100.0	7.1	7.4	7.3
	Olorunsogo	75.3	0.0	0.0	0.0	0.0	0.0
Sub-total		721.4	678.8	1,037.0	10.2	8.8	9.5
Benin	Sakete	360.0	360.0	500.0	6.7	6.8	6.8
Oyo	Ayede	173.6	140.0	200.0	8.3	7.4	7.9
Osun	Osogbo	124.6	124.7	200.8	16.2	10.0	13.1
Sub-total		658.2	624.7	900.8	8.6	7.6	8.1
Total		5,274.8	4,626.0	7,137.3	9.1	9.1	9.1

Source: JICA Study Team

Table 5-5 Generator allocation of Power-flow analysis

NCC No.	NAME OF STATION	PRIMARY ENERGY RESSOURCE	COMMERCIAL OPERATION DATE	NO. OF UNITS	GROSS UNIT CAPACITY (MW)	GROSS PLANT CAPACITY (MW)	GRID CONNECTION SUBSTATION	2020	2025	2030	2035	2040
Existing Power Plants (Category One)								2,033	1,832	1,052	930	930
4	EGBIN	STEAM	1985-1987	6	220	1320	ÊGBIN	1,182	401	0	0	0
9	OMOTOSHO I	GAS	2007	8	42	335	OMOTOSHO	137	113	75	75	75
10	OLORUNSOGO I	GAS	2007	8	42	335	PAPALANTO	151	151	75	75	75
14	OLORUNSOGO II NIPP	GAS	2011	4	120	480	PAPALANTO	216	432	422	432	432
14	OLORUNSOGO II NIPP	STEAM	2012	2	120	240	PAPALANTO	108	216	212	216	216
15	OMOTOSHO II NIPP	GAS	2012	4	120	480	OMOTOSHO	216	216	216	108	108
22	EBUTE BARGE *(CYREX) AES*	GAS	2002	9	31	279	EGBIN	0	279	0	0	0
28	PARAS ENERGY	GAS	2016	7	9.73	68	IKORODU-SHAGAMU	24	24	51	24	24
28	PARAS ENERGY	GAS	2016	2	22.00	44	IKORODU-SHAGAMU	0	0	0	0	0
Power Plants under Construction (Category Two)								0	0	0	0	0
Proposed Power Plants with Permits/licensing approvals (NERC, PPA & GCA) (Category Three)								0	446	486	486	486
	BRESSON Nigeria Ltd	GAS	2022	2	45	90	ALAUSA		41	81	81	81
	ONDO IPP - King Line	GAS	2021	1	200	200	OMOTOSHO		180	180	180	180
	ONDO IPP - King Line	GAS	2026	1	150	150	OMOTOSHO		135	135	135	135
	ONDO IPP - King Line	GAS	2029-2032	2	100	200	OMOTOSHO		90	90	90	90
PROPOSED GAS FIRED POWER PLANT CANDIDATES (Category Four)								0	909	5,224	4,603	5,494
	EGBIN 2+	GAS	2021	4	300	1200	EGBIN		540	1,080	1,080	1,080
	EGBIN 2+	STEAM	2021	2	350	700	EGBIN			630	630	630
	PARAS	GAS	2022	2	150	300	BENIN IKEJA WEST EGBIN		270	270	135	270
	LAFARGE PHASE I	GAS	2023	1	50	50	Papalant		0	0	0	0
	CALEB INLAND	GAS+STEAM	2023	2	250	500	OMOTOSHO EPE AJA		0	450	450	450
	LAFARGE PHASE II	GAS	2025	2	110	220	Ejio		99	198	99	0
	CALEB INLAND	GAS+STEAM	2025	2	250	500	OMOTOSHO EPE AJA		0	450	450	450
	OMOTOSHO II 2+	STEAM	2027	2	127	254	OMOTOSHO			229	229	229
	CALEB INLAND	GAS+STEAM	2027	2	250	500	OMOTOSHO EPE AJA			450	450	450
	OATS	GAS	2028	7	100	700	OMOTOSHO EPE AJA			270	270	630
	CHEVRON AGURA(*NNPC POWER BUSINESS PLAN*)	GAS	2030			780	EGBIN			702	450	450
	WESTCOM	GAS	2030	2	250	500	Likosi EGBIN			225	225	450
	HUDSON POWER	GAS	2030	1	150	150	OKE-ARO			135		
	BRESSON AS NIGERIA	GAS	2030	3	150	450	EGBIN-OKE ARO			135	135	405
Total （MW）								**2,033**	**3,187**	**6,761**	**6,019**	**6,910**

Source: JICA Study Team

5-2-1 Analytical result in each case

The analytical result in each case is shown in Table 5-6, while the power-flow diagrams for each case are shown in Appendices 1 to 6.

(1) Suppressed generation model in 2025 (Case 2)

The result of the power-flow analysis is shown in Attachment 1 for the Ogun area and Attachment 2 for the Lagos area respectively. The power flow comes from outside Lagos and Ogun in Case 2, it is the amount which the suppressed power generation is not able to meet the demand in Lagos and Ogun, which means the transmission line connected to outside Lagos and Ogun has to bear a significant load. However, there was no further line or transformer overload, no voltage or short-circuit current violation and no overload in the N-1 contingency of 330kV line once the recommendations below were put in place. It was concluded that the project for the suppressed generation model in 2025 would be feasible.

(2) Master plan model in 2030 (Case 3)

The result of the power-flow analysis is shown in Attachment 3 for the Ogun area and Attachment 4 for the Lagos area respectively. The demand is based on the 2030 Master Plan, it is assumed that a super grid interconnecting Osogbo and Benin substations via a four-bundle conductor. There was no further line or transformer overload, no voltage or short-circuit current violation and no overload in the N-1 contingency of 330kV line once the recommendations below were put in place. It was concluded that the project for the 2030 Master Plan Model would be feasible.

Table 5-6 Analytical result in each case

Line	Peak Load per Single Circuit by Year (MVA)				
	Case 2	Case 3	JICA Master Plan 2035	JICA Master Plan 2040	
	2025	2030	2035	2040	Average
330kV line (Ejio-Likosi 48.8 km)	252	233	279	415	295
330kV line (Ejio-Ajegunle with turn-in-out of Ikeja West-Sakete 29.6 km)	328	73	132	228	190
330kV line (Ejio-Olorunsogo with turn-in-out of Ikeja West-Ayede 13.9 km)	230	199	150	150	182
330kV line (Makogi-Likosi-Ikeja West 10.81 km)	479	204	309	344	334
132 kV line (Ikorodu_Shagamu-Likosi 4.82 km)	84	72	89	111	89
132 kV line (Likosi-Abule Oba 7.78 km)	41	63	78	97	70
132 kV line (Ejio-New Abeokuta 35.5 km)	58	106	125	125	104
132 kV line (Ajegunle-Badagry 36.2 km)	45	63	76	93	69
132 kV line (Ajegunle-Agbara 21.7 km)	59	105	125	125	104
330 kV Average	**322**	**177**	**218**	**284**	**250**
132 kV Average	**57**	**82**	**99**	**110**	**87**
Total	**1576**	**1117**	**1363**	**1688**	**1436**

Source: JICA Study Team

5-2-2 Effectiveness of the project

(1) Model without the Project in 2025 (Case 1)

The effectiveness of the project is shown in the form of its transmission capacity. The difference in load between Cases 1 and 2 (without and with the project, respectively) constitute the increased transmission capacity through the project. Case 1 involves a considerable overload (19,243 MW) compared to Case 2, which is why the load of Case 1 is reduced to avoid overload by 16,356 MW. The power flow is shown in Attachment 5 for the Ogun area and Attachment 6 for the Lagos area. The reduced load of 2,886 MW is estimated to constitute the increased transmission capacity of the project. It is concluded that the project achieves significantly improved transmission capacity through the increase of 2,886 MW in Lago and Ogun.

Table 5-7 Expansion of transmission capacity by the Project

Case	Load (MW)	Reduced load in only Lagos/Ogun area to avoid overload etc., increased transmission capacity by the Project (MW)
Case 1 (without the project)	16,356	2,886
Case 2 (with the project)	19,243	Base

Source: JICA Study Team

5-2-3 Recommendation for additional equipment in 2025 and 2030 (Cases 2 and 3)

Recommendations for additional equipment to prevent overload in 2025 and 2030 (Cases 2 and 3) are shown as below. No overload of the lines and transformers in Lagos and Ogun is caused by the additional equipment.

Table 5-8 Countermeasures for overload in 2025 and 2030 (Cases 2 and 3)

Component	Year	Type	Rehabilitation	Cost MUSD
132 kV 75 MVar Capacitor Bank at Likosi	2025	Substation	To alleviate overloaded 132 kV Ikorodu-Shagamu line	2.5
Additional 1 x 132/33 kV 60 MVA Transformer at Ejio Substation	2025	Substation	To alleviate overloaded 132/33 kV Transformer at Ejio Substation	1.6
Ajegunle Substation 330/132/33 kV 150 MVA Transformer	2025	Substation	To alleviate overloaded 132/33 kV Transformer at Ajegunle Substation	4.8
Replacement 132/33 kV 2 x 60 MVA Transformer at Apapa Road Substation	2025	Substation	To alleviate overload	2.9
Additional 132/33 kV 100 MVA Transformer at Ejigbo Substation	2025	Substation	To alleviate overload	2.4
Replacement 2 x 132/33 kV 60 MVA Transformer at Ijora Substation	2025	Substation	To alleviate overload	2.9
Additional 330/132/33 kV 150 MVA Transformer at Ikeja West Substation	2025	Substation	To alleviate overload	4.8
Replacement 132/33 kV 2 x 100 MVA Transformer at Odogunyan Substation	2025	Substation	To alleviate overload	3.8
Additional 132 kV 196 MVar Capacitor Bank at Alagbon Substation	2025	Substation	To alleviate overload	4.3
Additional 132 kV 271 MVar Capacitor Bank at Ayede Substation	2025	Substation	To alleviate overload	5.8
Additional 132 kV 692 MVar Capacitor Bank at Ikeja West Substation	2025	Substation	To alleviate overload	14.4
Reconductoring 132 kV Akangba 1 - Itire 1 Double circuit 3 km	2025	Transmission	Increase capacity by HTLS Conductor Reconductoring	0.5
Reconductoring 132 kV Alagbon 1 - Ijora 1 Double circuit 8 km	2025	Transmission	Increase capacity by HTLS Conductor Reconductoring	1.3
Subtotal for 2025 MUSD				52.0
Reconductoring 132 kV Ikorodu-Odogunyan 2 cct 13 km	2030	Transmission	Increase capacity by HTLS Conductor Reconductoring	2.5
330 kV Likosi (Ogijo)-Shagamu 2 cct 16 km	2030	Transmission	New Line to alleviate overload of 132 kV Likosi (Ogijo)-Shagamu line	5.8
132 kV Bay expansion at Akanba Substation	2030	Substation	Two bays expansion at Akangba substation for Apapa Road substation, Loop cut of Ojo and Amuwo Odofin to alleviate overload at 132 kV Agbara-Ojo line,	2.6
Additional 330/132/33 kV 300 MVA Transformer at Likosi Substation	2030	Substation	To alleviate overload	6.4
Additional 330/132/33 kV 150 MVA Transformer at Ejio (Arigbajo) Substation	2030	Substation	To alleviate overload	4.9
Additional 132/33 kV 60 MVA Transformer at Badagry Substation	2030	Substation	To alleviate overload	1.2
Additional 132/33 kV 60 MVA Transformer at Abule Oba (Redeem) Substation	2030	Substation	To alleviate overload	1.2
Additional 33 kV 37 MVar Capacitor Bank at New Abeokuta Substation	2030	Substation	To alleviate overload	1.9
Additional 33 kV 43 MVar Capacitor Bank at Likosi (Ogijo) Substation	2030	Substation	To alleviate overload	2.2
Additional 33 kV 53 MVar Capacitor Bank at Makogi (MFM) Substation	2030	Substation	To alleviate overload	2.5
Additional 33 kV 40 MVar Capacitor Bank at Abule Oba (Redeem) Substation	2030	Substation	To alleviate overload	2.0
Additional 33 kV 40 MVar Capacitor Bank at Badagry Substation	2030	Substation	To alleviate overload	2.0
Additional 33 kV 58 MVar Capacitor Bank at Ejio Substation	2030	Substation	To alleviate overload	2.8
Additional 33 kV 2 x 11 MVar Capacitor Bank at Agbara Substation	2030	Substation	To alleviate overload	1.7
Subtotal for 2030 MUSD				39.7
Total for 2030 MUSD				91.6

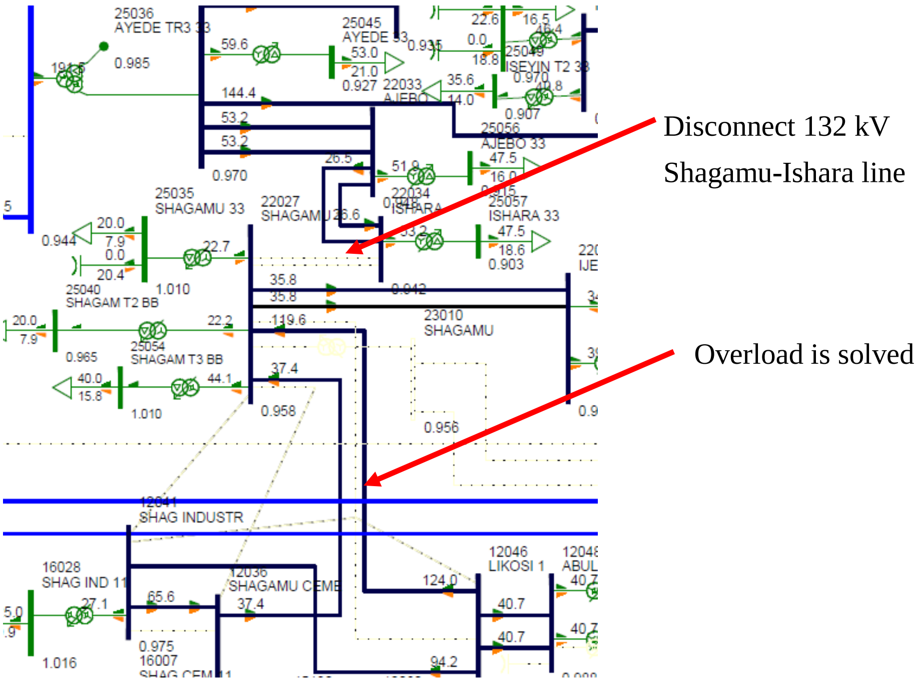
Source: JICA Study Team

5-2-4 Recommendation for power system modifications in 2025 and 2030 (Cases 2 and 3)

(1) Recommendation for power system modification in 2025 (Case 2)

1) Disconnection of the 132 kV Shagamu-Ishara line in 2025

The 132-kV Likosi-Shagamu line is overloaded because the Shagamu substation supplies the Ishara substation, but the overload will be solved if the 132-kV Shagamu-Ishara line is disconnected as shown in Figure 5-1.



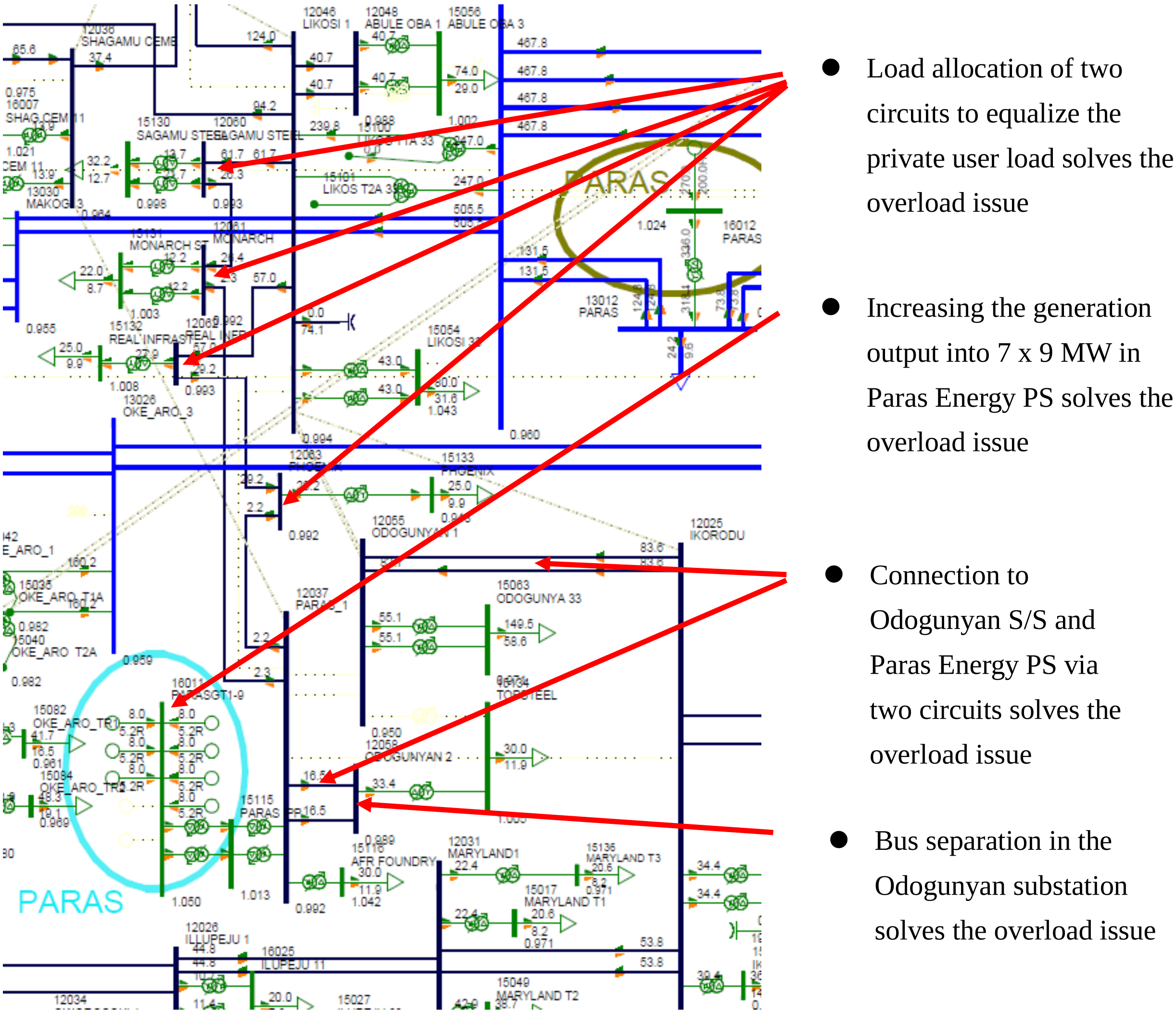
Source: JICA Study Team

Figure 5-1 Disconnection of the 132 kV Shagamu-Ishara line in 2025

2) Modifications around the 132 kV Ikorodu-Odogunyan-Paras Energy-Likosi line in 2025

The following modifications (refer to Figure 5-2) solve the overload and voltage violations of the 132 kV Ikorodu-Odogunyan-Paras Energy-Likosi line.

- Load allocation of two circuits to equalize the load of private users
- Increased generation output into 7 x 9 MW in Paras Energy PS
- Connection to Odogunyan S/S and Paras Energy PS by two circuits
- Bus separation in the Odogunyan substation



Source: JICA Study Team

Figure 5-2 Modifications around the 132 kV Ikorodu-Odogunyan-Paras Energy-Likosi line in 2025

3) Upgrading or Bus separation of switchgear in 2025

The following table shows the result of short-circuit analysis. If the short-circuit current exceeds the short-circuit withstand capacity of the existing switchgear, rehabilitation is needed to upgrade the capacity or to separate bus. The listed substations within the project scope should have capacity sufficiently higher than the current.

Table 5-9 Short-circuit analysis in 2025

Voltage (kV)	Bus No.	Substation	Short-circuit current (kA)
33	15016	EJIGBO BBI	23.0
33	15017	MARYLAND	21.6
33	15042	LEKKI	17.9
33	15050	IKORODU T3	19.1
33	15054	LIKOSI	22.4
33	15055	MAKOGI	18.4
33	15060	AJEGUNLE_3	22.0
33	15063	ODOGUNYA	21.6
33	15115	PARAS IPP	22.0
33	15118	ALAGBON T3T4	31.8

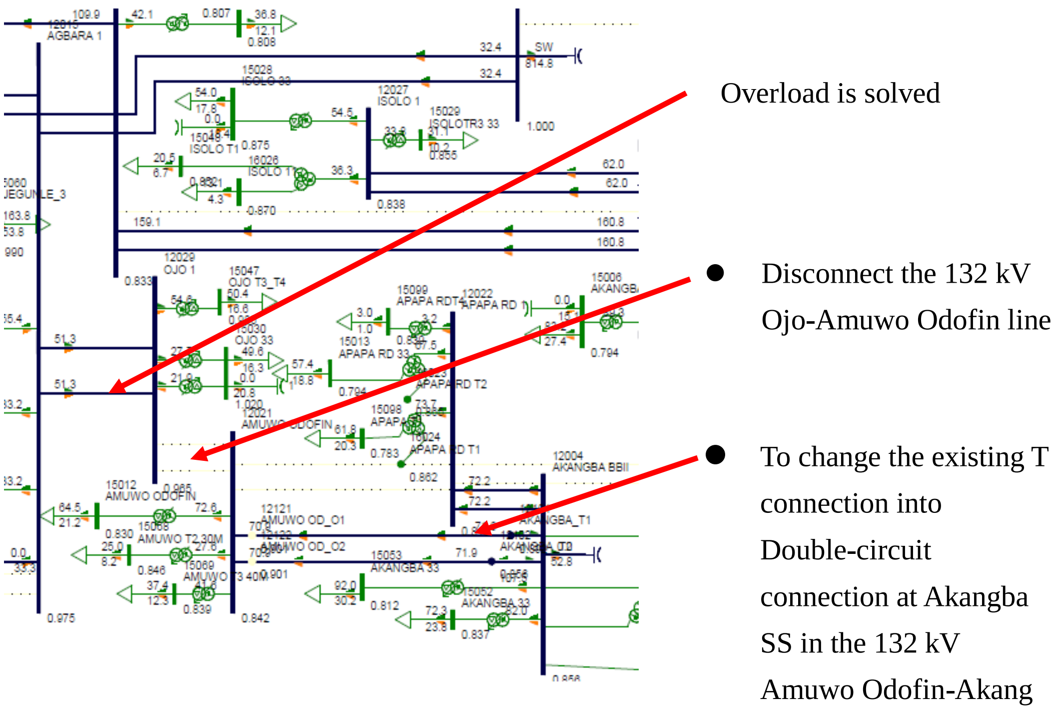
Source: JICA Study Team

(2) Recommendation for the power system modification in 2030 (Case 3)

1) Disconnection of the 132 kV Ojo-Amuwo Odofin line in 2030

The 132 kV Agbara-Ojo line is overloaded because the Ojo substation has to supply the Amuwo-Odofin substation. The overload is solved by the modification as follows and Figure 5-3.

- The 132 kV Ojo-Amuwo Odofin line is disconnected
- To change the existing T connection into Double-circuit connection at Akangba SS like Figure 5-3 in the 132 kV Amuwo Odofin-Akangba line

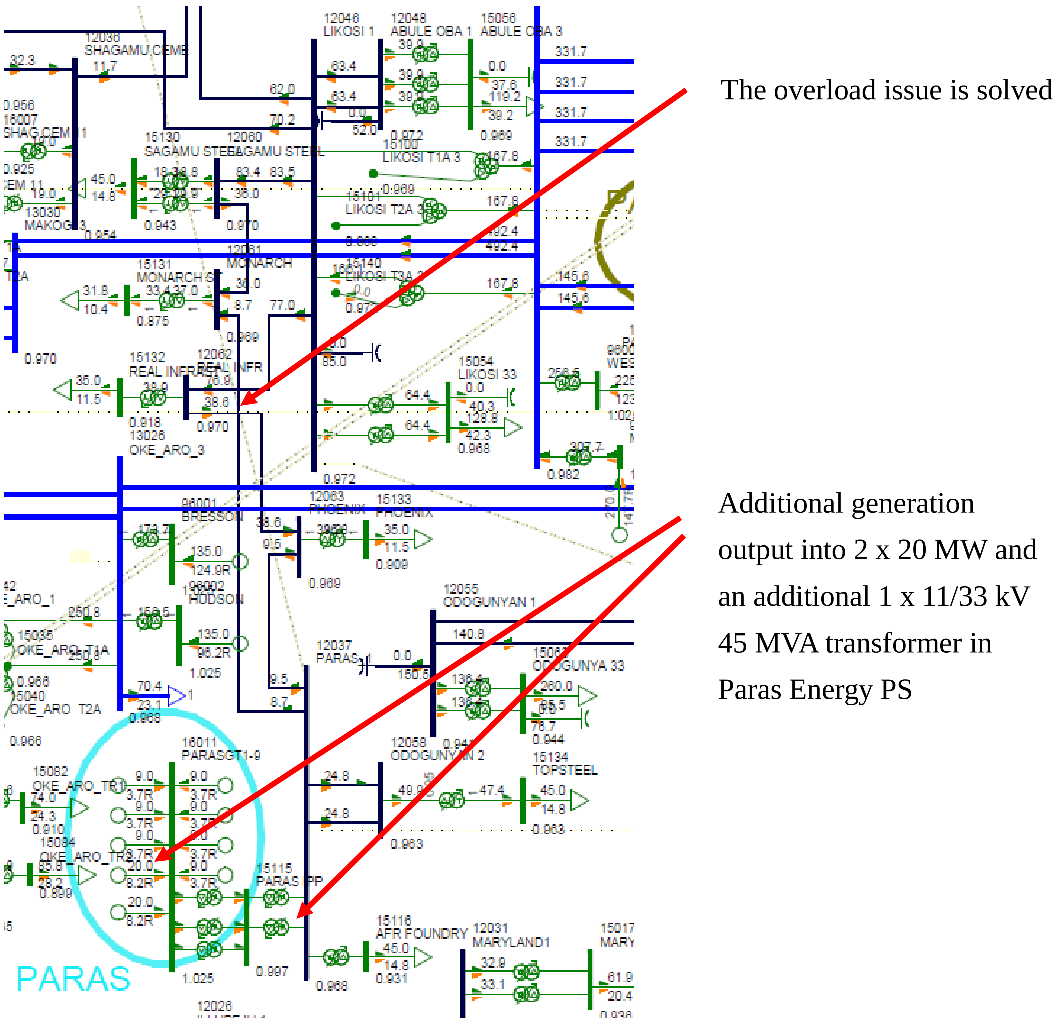


Source: JICA Study Team

Figure 5-3 Disconnection of the 132 kV Ojo-Amuwo Odofin line in 2030

2) Additional generation in Paras Energy PS in 2030

Additional generation of 2 x 20 MW and an additional 1 x 11/33 kV 45 MVA transformer in Paras Energy PS solves the overload in the 132 kV Paras Energy-Likosi line as shown in Figure 5-4.



Source: JICA Study Team

Figure 5-4 Increased generation output in Paras Energy PS in 2030

3) Upgrading or Bus separation of switchgear in 2030

The following table shows the result of short-circuit analysis. If the short-circuit current exceeds the short-circuit withstand capacity of the existing switchgear, rehabilitation is needed to upgrade the capacity or to separate bus. The listed substations within the project scope should have capacity sufficiently higher than the current.

Table 5-10 Short-circuit analysis in 2030

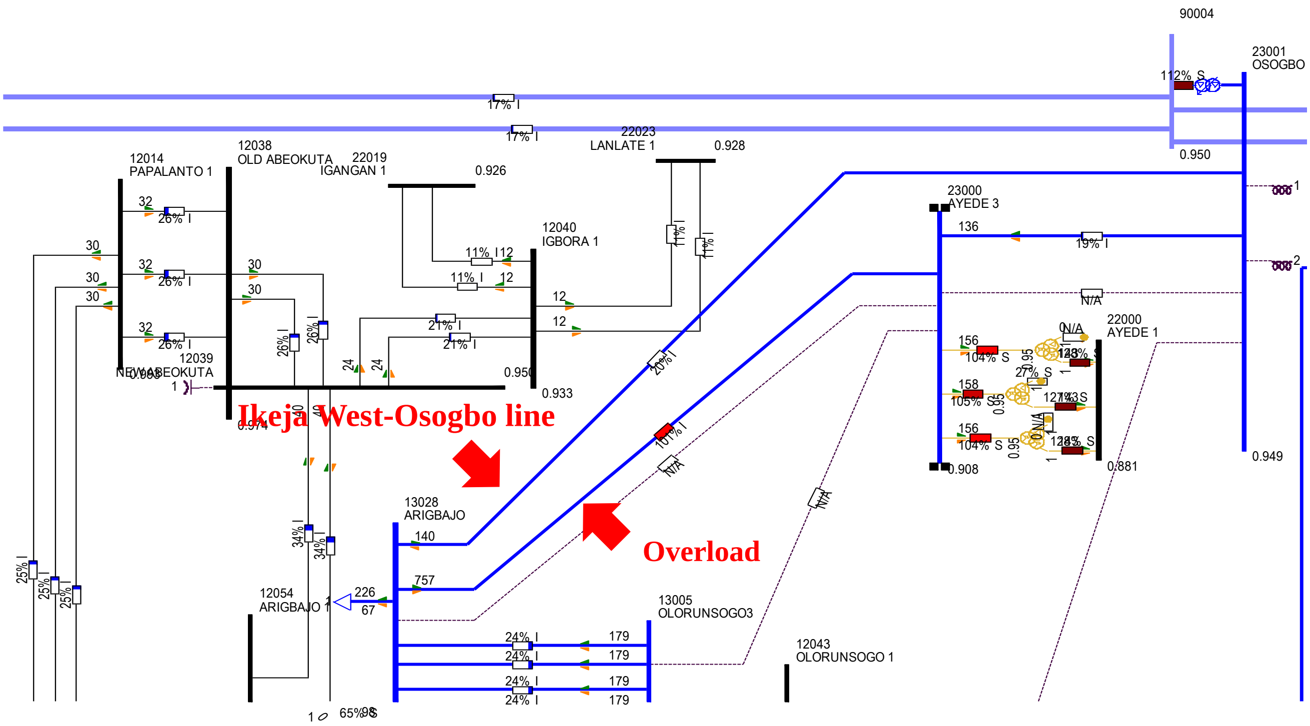
Voltage (kV)	Bus No.	Substation	Short-circuit current (kA)
33	15000	AKANGB5T 4B	48.6
33	15001	AKANGB5T 4A	48.6
33	15004	AJA TR3	49.3
33	15005	AJA TR2	49.4
33	15017	MARYLAND	21.1
33	15023	IKW T1A	54.0
33	15024	IKW T1B	54.0
33	15025	IKW T3B	54.0
33	15026	IKW T2B	49.5
33	15031	EGBIN TR1	55,5
33	15032	EGBIN TR2	55.5
33	15034	IKJW T1A/T2A	54.0
33	15039	BRESSON	19.0

Voltage (kV)	Bus No.	Substation	Short-circuit current (kA)
33	15042	LEKKI	18.6
33	15050	IKORODU	17.6
33	15051	AJA T3 TERT	45.5
33	15054	LIKOSI	24.8
33	15055	MAKOGI	18.7
33	15056	ABULE OBA	21.8
33	15058	OKO OBA	19.5
33	15059	EPZ	18.4
33	15060	AJEGUNLE	24.6
33	15062	EJIO	18.3
33	15090	EPE 33B	50.0
33	15092	AJEGUNLE_T1A	53.5
33	15093	AJEGUNLE_T2A	53.5
33	15094	EJIO T1A	91.7
33	15095	EJIO T2A	91.7
33	15096	MFM T1A	48.6
33	15097	MFM T1A	48.6
33	15098	APAPA T1	49.4
33	15099	APAPA RDT4	39.3
33	15102	AJEGUNLE_T3	53.5
33	15104	OKO_OBA_T1A	49.4
33	15105	OKO_OBA_T2A	49.4
33	15115	PARAS	26.1
33	15118	ALAGBON T3T	30.2
33	15141	EJIO T3A	91.7
33	15142	AJEGUNLE_T4A	53.5
132	12003	IKEJA WEST	34.7
132	12042	OKE ARO	32.0
330	13000	AJA	45.4
330	13002	EGBIN	60.3
330	13003	IKEJA WEST	42.3
330	13005	OLORUNSOGO	36.2
330	13012	PARAS	40.1
330	13025	EPE	40.3
330	13026	OKE ARO	37.6
330	13028	EJIO	40.2
330	13029	LIKOSI	47.2
330	13030	MAKOGI	36.1
330	13031	OKO OBA	32.7
330	13032	AJEGUNLE	46.5
330	13034	LEKKI	36.0

Source: JICA Study Team

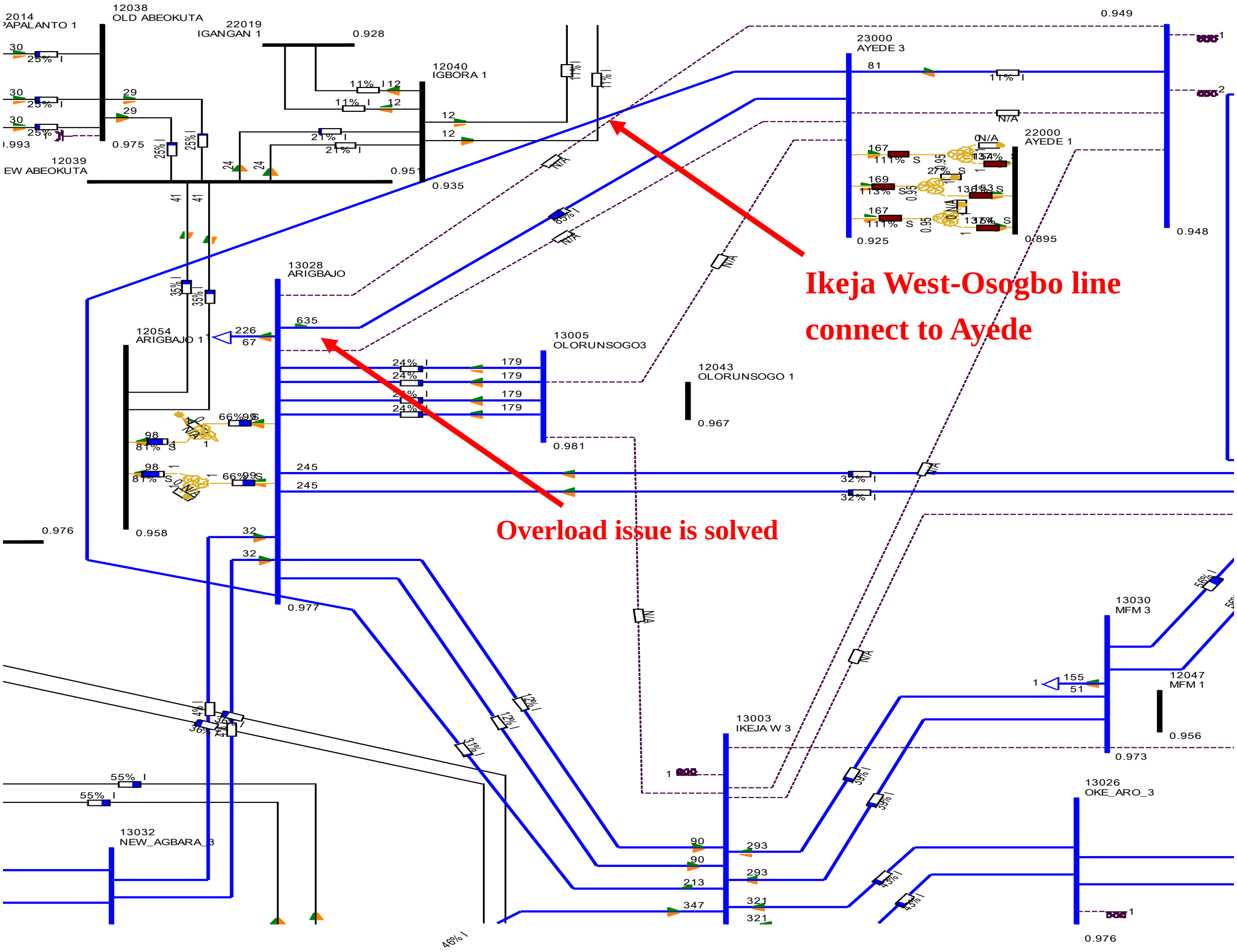
4) To connect the 330 kV Ikeja West-Osogbo line to the Ayede substation

The 330 kV Ejio (Arigbajo)-Ayede line is loaded at 757 MW, exceeding its thermal rating (749MW, 777MVA at power factor 0.964) as Figure 5-5. If the 330 kV Ikeja West-Osogo line connects to the Ayede substation, the overload is solved, thus it is better to connect the line to Ayede substation rather than Ejio (Arigbajo) substation. Accordingly, the recommendation is to connect the 330 kV Ikeja West-Osogbo line into the Ayede substation as Figure 5-6.



Source: JICA Survey Team

Figure 5-5 Power-Flow Results with the Ikeja West-Osogbo connection with Ejio (Arigbajo)



Source: JICA Survey Team

Figure 5-6 Power-Flow Results of the Ikeja West-Osogbo line connection with Ayede

5-2-5 Prioritization of the components

Prioritization of the components is shown in Table 5-10 and based on the result of the suppressed generation model in 2025 (Case 2). The methodology of prioritization involves assessing effectiveness of loading, enhanced reliability, urgency and load countermeasures.

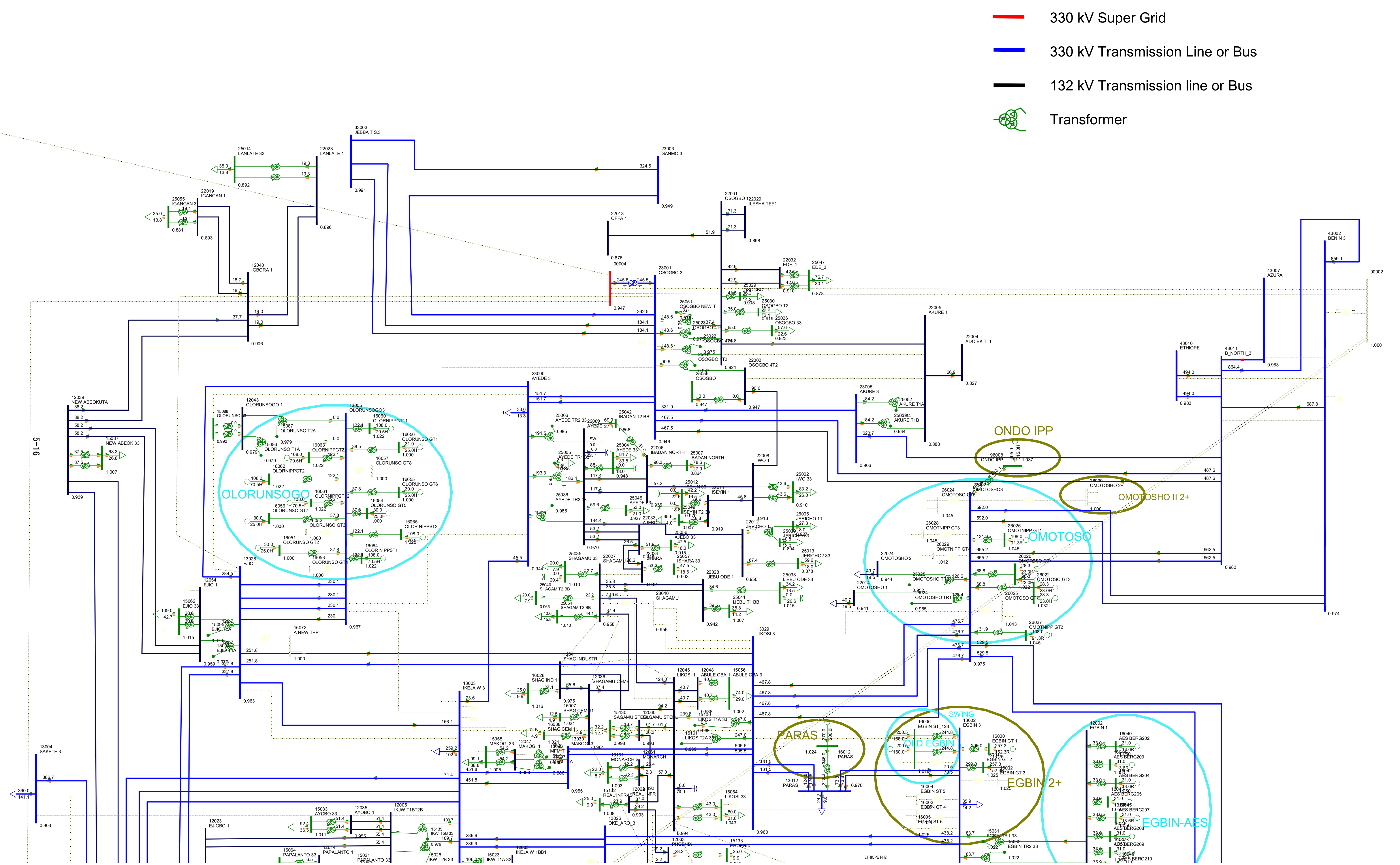
Table 5-11 Prioritization of components based on the Case 2 result

Lot	Priority (Group)	Voltage level	T/L S/S		Substation /Connection point	Description	Technical Evaluation Criteria: Effectiveness Loading	Effectiveness Each Score	Effectiveness Score (0~5)	Improvement of Reliability Each Score	Improvement of Reliability Score (0~5)	Urgency Each Score	Urgency Score (0~5)	Countermeasure against Load Each Score	Countermeasure against Load Score (0~5)	Total Score (0~20)
Lot1	1	2x330kV	New	T/L	Likosi (Ogijo) S/S ~ Ejio (Arigbajo) S/S	Could be a Diversion root	32.4%	2	2.0	3	3.0	3	3.0	3	3.0	11.0
	2	2x330kV	New	T/L	Ejio (Arigbajo) S/S ~ Olorunsogo P/S	Additional Incoming Power Source	29.6%	2	2.0	4	4.0	2	2.0	2	2.0	10.0
	2	2x330kV	New	T/L	Ejio (Arigbajo) ~ Ajegunle (New Agbara)	Necessary in case of no Supergrid	42.2%	3	3.0	4	4.0	1	1.0	2	2.0	10.0
	2	2x132kV	New	T/L	Likosi (Ogijo) S/S ~ Redeem S/S	Incoming Power Source	32.6%	2	2.0	2	2.0	3	3.0	3	3.0	10.0
	2	2x132kV	New	T/L	Ajegunle (New Agbara) S/S ~ Agbara S/S	Incoming Power Source	47.0%	3	3.0	2	2.0	2	2.0	3	3.0	10.0
	6	2x132kV	New	T/L	Ejio (Arigbajo) S/S ~ New Abeokuta S/S	Incoming Power Source	46.6%	3	3.0	2	2.0	2	2.0	2	2.0	9.0
	7	2x132kV	New	T/L	Ajegunle (New Agbara) S/S ~ Badagry S/S	Incoming Power Source	35.7%	2	2.0	2	2.0	2	2.0	2	2.0	8.0
Lot2	1	330/132/33kV	New	S/S	Likosi (Ogijo) S/S (2x300MVA)	Expected a lot of big consumers	82.3%	5	3.3	3	3.3	4	4.0	4	4.0	14.7
		2x330kV	Turn in	T/L	From Egbin P/S via Paras Energy	Incoming Power Source	16.9%	1		3		4		4		
		2x330kV	Turn in	T/L	From Omotosho P/S	Incoming Power Source	60.2%	4		4		4		4		
	3	2x330kV	Turn in	T/L	From Omotosho P/S	Additional Incoming Power Source	60.2%	4	4.0	4	4.0	2	2.0	3	3.0	13.0
	2	4x132kV	Turn in/out	T/L	Likosi (Ogijo) S/S ~ Ikorodu	Related to on-going Project	45.6%	3	2.5	3	3.0	4	4.0	4	4.5	14.0
					Likosi (Ogijo) S/S ~ Shagamu Steel	Related to on-going Project	7.9%	1		3		4		5		
					Likosi (Ogijo) S/S ~ Shagmu Industry	Related to on-going Project	6.1%	1		3		4		5		
					Likosi (Ogijo) S/S ~ Shagamu	Related to on-going Project	95.7%	5		3		4		4		
	4	132/33kV	New	S/S	Redeem S/S (2x60MVA)	Load allocation for Developed Area	67.8%	4	4.0	2	2.0	3	3.0	3	3.0	12.0
Lot3	1	330/132/33kV	New	S/S	Ejio (Arigbajo) S/S (2x150MVA)	Diversification of Risk	80.5%	5	3.5	3	3.0	4	4.5	4	4.0	15.0
		2x330kV	Turn in	T/L	Ejio (Arigbajo) S/S ~ Olorunsogo P/S	Incoming Power Source	29.6%	2		3		5		4		
	2	1x330kV	Turn in/out	T/L	Ejio (Arigbajo) S/S ~ Ikeja West	Relief Ikeja West	21.4%	2	2.0	4	3.5	4	4.0	4	3.5	13.0
					Ejio (Arigbajo) S/S ~ Ayede	Relief Ikeja West	36.6%	2		3		4		3		
	drop out	1x330kV	Turn in/out	T/L	Ikeja West~Ayede~Osogbo	Due to overloaded, not to turn-in/out	0.0%	1	1.0	1	1.0	0	1.0	0	0.0	3.0
	3	330/132/33kV	New	S/S	MFM S/S (2x150MVA)	Load allocation for Build-up area	36.9%	2	3.3	2	2.0	3	3.0	4	4.0	12.3
		2x330kV	Turn in/out	T/L	MFM ~ Likosi (Ogijo)	Incoming Power Source	65.1%	4		2		3		4		
					MFM ~ Ikeja West	Incoming Power Source	58.1%	4		2		3		4		
	4	330/132/33kV	Existing	S/S	Olorunsogo PS	Additional Incoming Power Source	Same as TL	2	2.0	4	4.0	2	2.0	2	2.0	10.0
	5	132/33kV	Existing	S/S	New Abeokuta S/S	Could be a Diversion root	Same as TL	3	3.0	2	2.0	2	2.0	2	2.0	9.0
Lot4	1	330/132/33kV	New	S/S	Ajegunle (New Agbara) S/S (3x150MVA)	Load allocation, Future Export	69.9%	4	2.7	3	3.0	4	3.7	4	3.3	12.7
		1x330kV	Turn in/out	T/L	Ajegunle ~ Ikejawest	Relief Ikeja West	9.2%	1		3		4		3		
					Ajegunle ~ Sakete	Export	51.1%	3		3		3		3		
	3	132/33kV	Existing	S/S	Agbara S/S	Load allocation against the Demand	Same as TL	3	3.0	2	2.0	2	2.0	3	3.0	10.0
	2	132/33kV	New	S/S	Badagry S/S (2x60MVA)	Load allocation against the Demand	73.7%	4	4.0	2	2.0	2	4.0	2	2.0	12.0

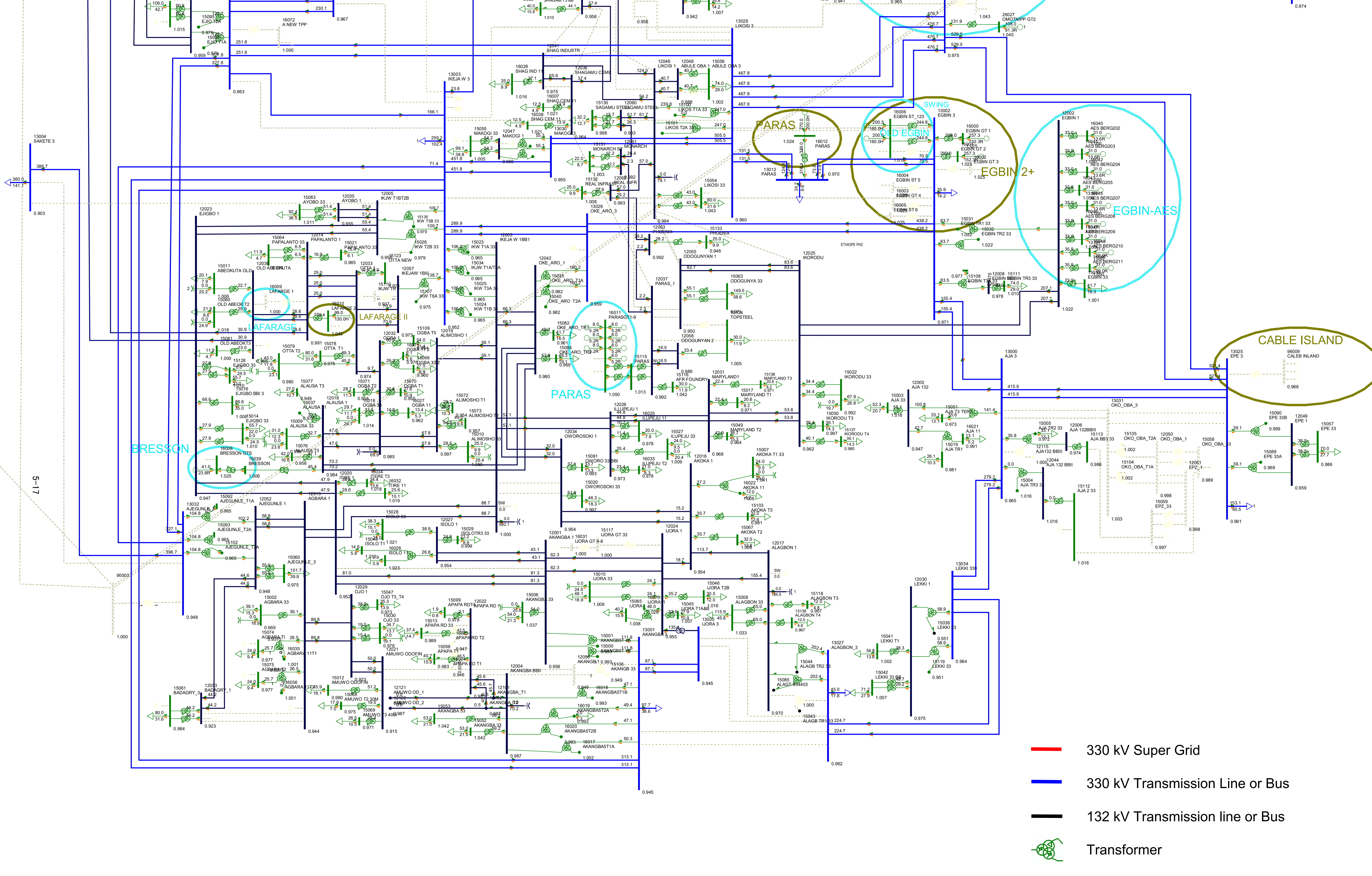
* Prioritization: In case of same score of more than two groups, loading to judge "Effectiveness" is prevailed.

Effectiveness		Improvement of Reliability		Urgency		Countermeasure against Load Demand	
Range	Score	Item	Point	Item	Score	Item	Score
0%~20.0%	1	Source	1	Lowest	1	Lowest	1
20.1%~40.0%	2	Diversion	1	Lower	2	Lower	2
40.1%~60.0%	3	Capacity	1	Average	3	Average	3
60.1%~80.0%	4	Security	1	Higher	4	Higher	4
80.1%~100%	5	Adequacy	1	Highest	5	Highest	5

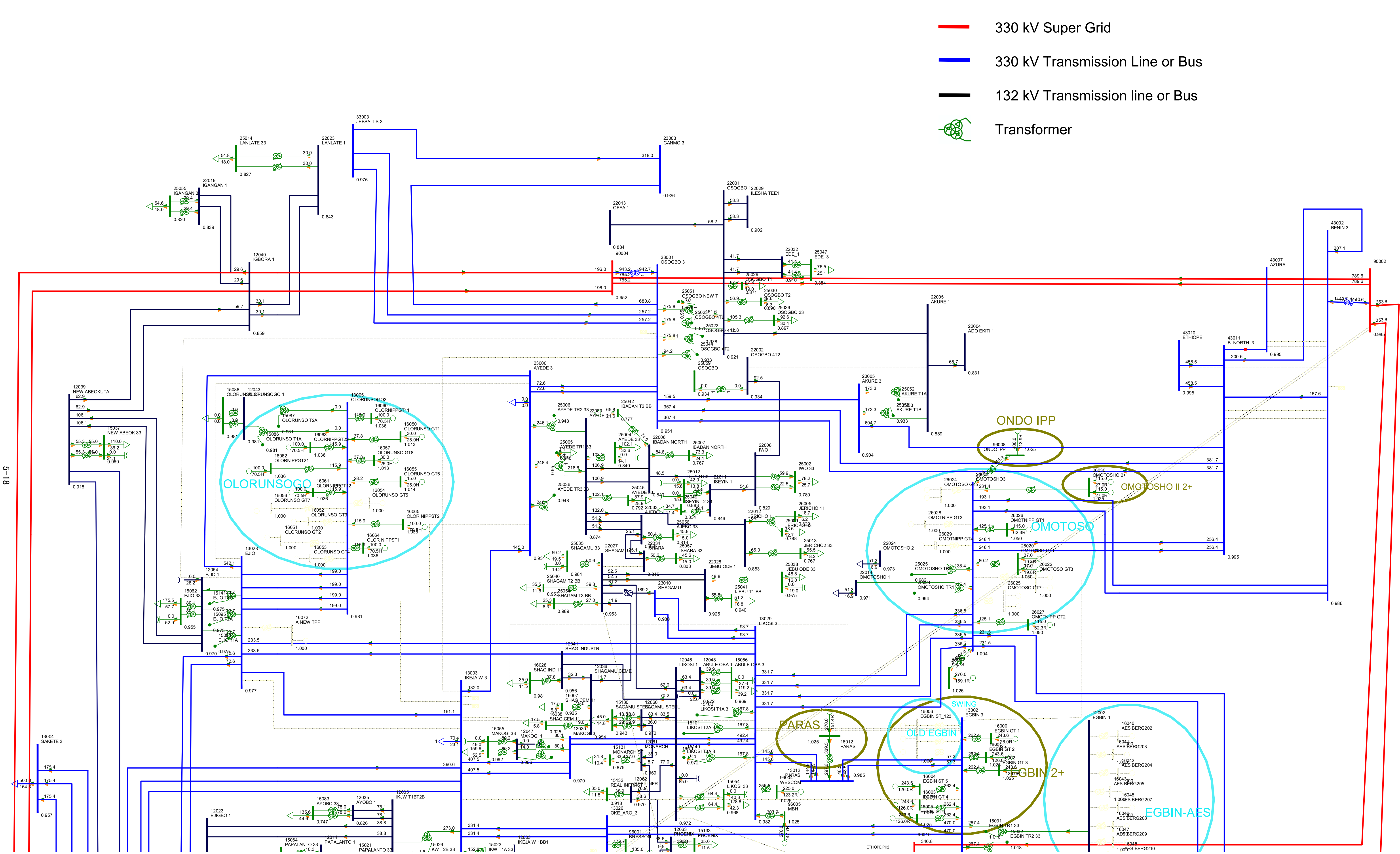
Source: JICA Survey Team



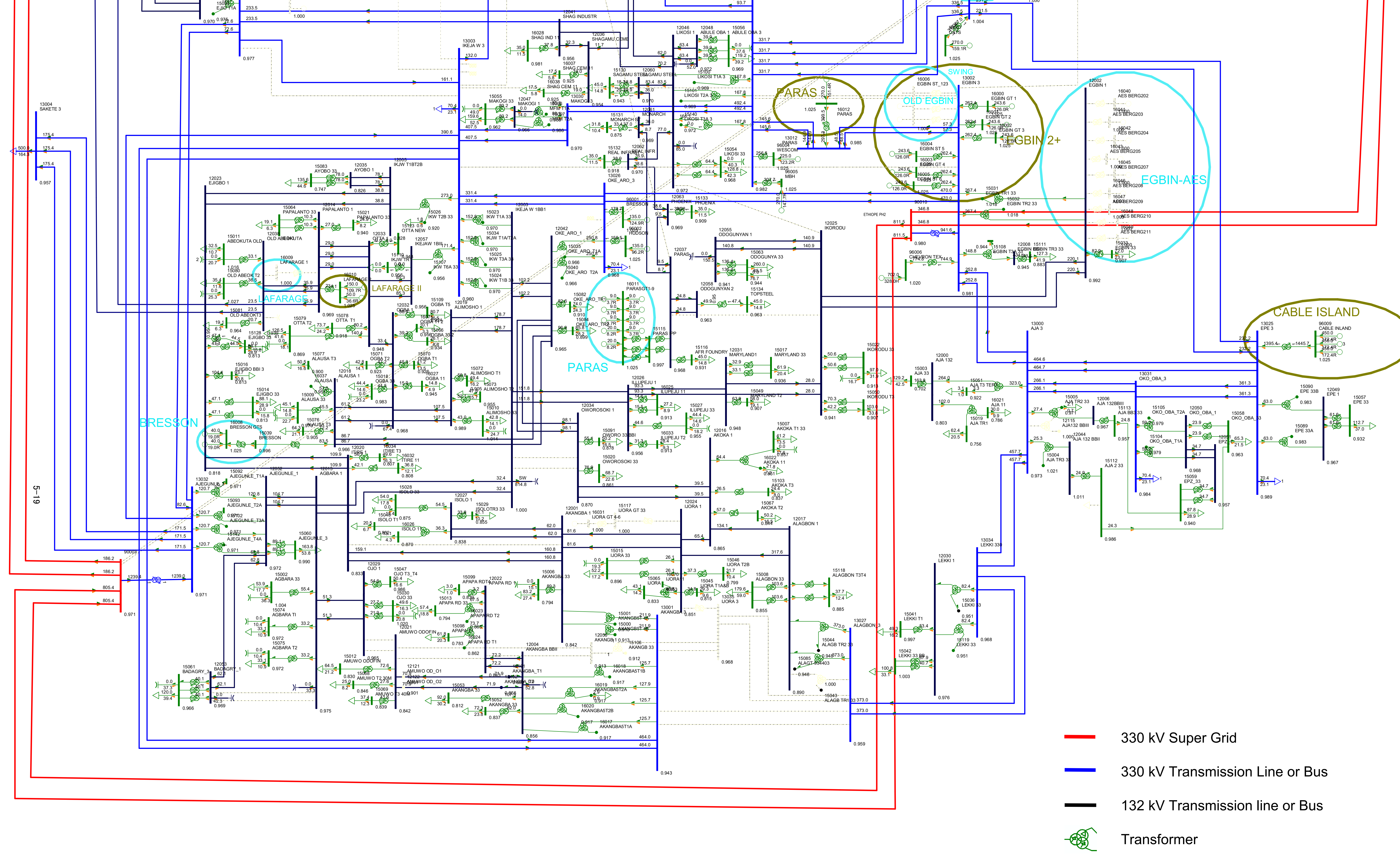
Attachment 1 Case 2: 19 GW 2025 Model (Ogun Area)



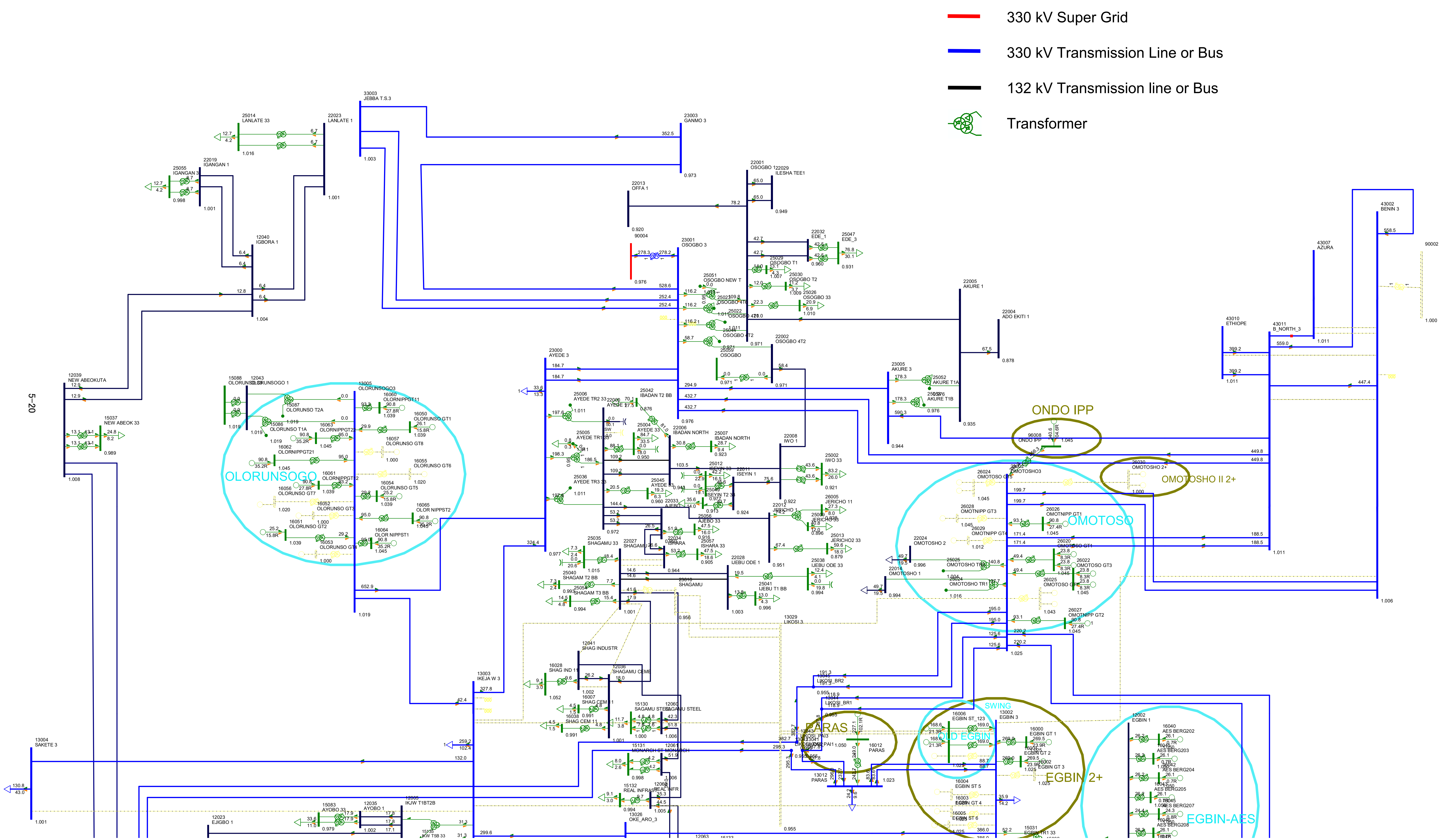
Attachment 2 Case 2: 19 GW 2025 Model (Lagos Area)



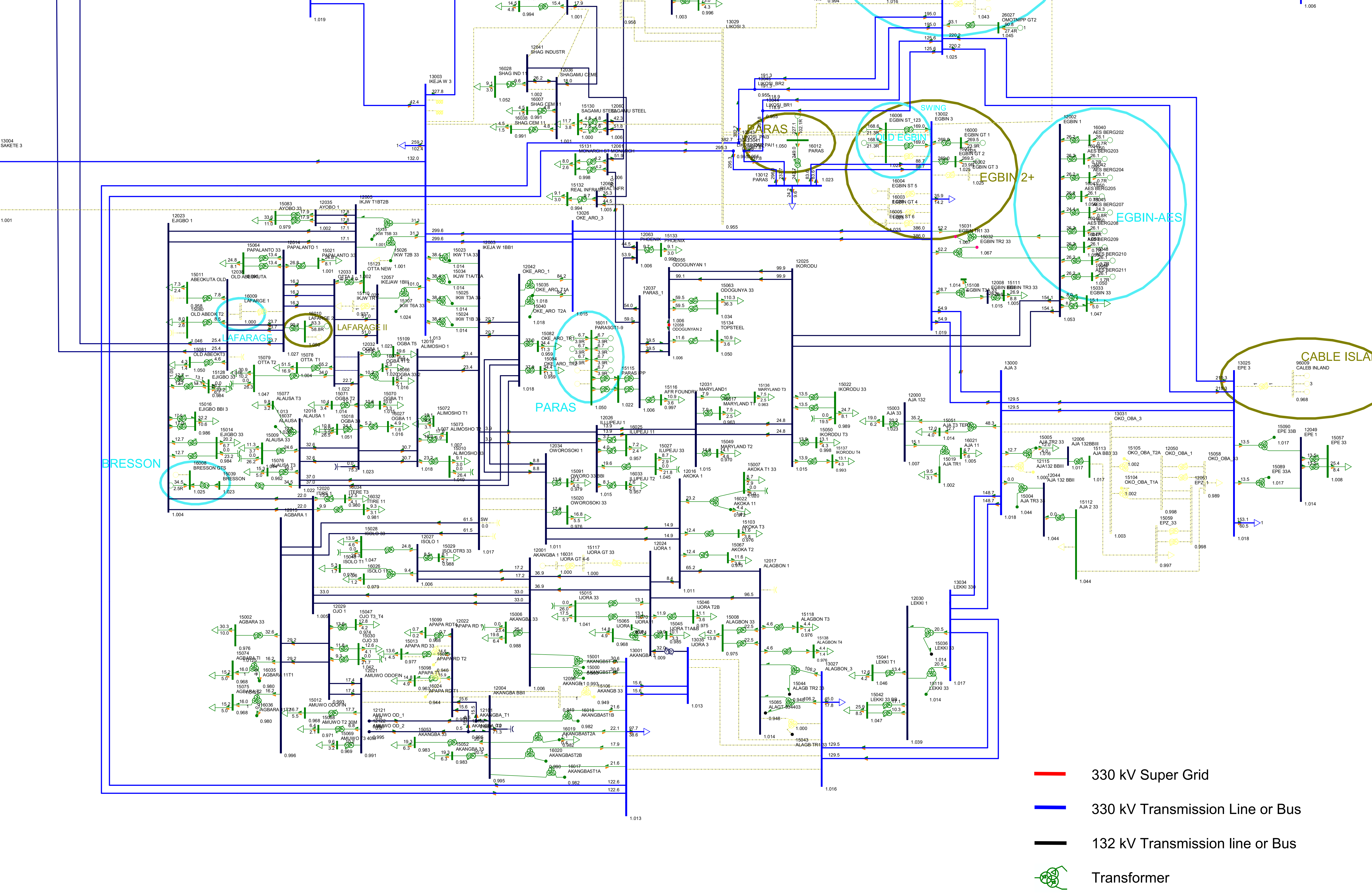
Attachment 3 Case 3: 27 GW 2030 Model (Ogun Area)



Attachment 4 Case 3: 27 GW 2030 Model (Lagos Area)



Attachment 5 Case 1: 16 GW 2025 Model (Ogun Area)



Attachment 6 Case 1: 16 GW 2025 Model (Lagos Area)

Chapter 6 Institutional Framework for Implementation, Operation and Maintenance of the Project

Chapter 6 Institutional Framework for Implementation, Operation and Maintenance of the Project

6-1 Outline of Electric Power Sector Reform in Nigeria

In the past era before the reform in power sector of Nigeria, National Electric Power Authority (hereinafter called as the "NEPA") used to be a sole authority for the development of power supply. However, the capacities of power generation, transmission and distribution facilities were insufficient due to the lack of capital investment. Moreover, the accessibility to power supply for the users was limited with low connection rate.

In order to improve the efficiency and performance of power sector, the power sector reform has been promoted through terminating the monopoly status of the NEPA and inviting private sector participation. The current progress of power sector reform is summarized in Table 6-1.

Table 6-1 Current Progress of Electric Power Sector Reform in Nigeria

Schedule	Description
March, 2005	Promulgation of Electric Power Sector Reform Act
May, 2005	Unbundling NEPA and establishment of Power Holding Company of Nigeria (PHCN)
October, 2005	Establishment of Nigerian Electricity Regulatory Commission (NERC)
November, 2005	Incorporation of TCN
July, 2008	Issuance of Multi-Year Tariff Order (MYTO) by NERC
June, 2010	Establishment of Presidential Action Committee on Power (PACP)
July, 2010	Incorporation of Nigeria Bulk Electricity Trading Company Plc (NBET)
August, 2010	Issuance of Roadmap for Power Sector Reform by PACP
May, 2012	Issuance of Second Multi-Year Tariff Order (MYTO-2) by NERC
August, 2013	Issuance of Roadmap of Power Sector Reform-Revision I by PACP
November, 2013	Official hand-over of PHCN successor companies to private sector
February 2015	Transition to Transitional Electricity Market (TEM) Commencement of Electricity Trading by NBET
March 2015	Issuance of Revised MYTO-2 as MYTO-2.1
April 2015	Enforcement of MYTO-2.1
July 2015	Completion of Management Contract with Manitoba Hydro International (MHI) and Extension of Contract Period until 31 July, 2016
December 2015	Issuance of Revised MYTO-2 as MYTO-2.2
February 2016	Enforcement of MYTO-2.2

Source: Made by JICA Study Team based on various related documents

The electric power sector reform is designed in the following three (3) stages. Besides, the schedule for entry into the following market stage is not fixed since the market transition will be declared after the conditions precedent in each market stage is achieved.

- Interim Market Stage: the preparation stage entering into the Transitional Electric Market stage including the unbundling and privatization of the PHCN, establishment and implementation of proper pricing mechanism and other required rules and orders
- Transitional Electricity Market (hereinafter called as the "TEM") Stage: market to be characterized by entry of new generation companies, contract-based arrangements for electricity trading and the introduction of competition
- Medium Term Market Stage: stage with the introduction of generation competition and a centrally administered balancing mechanism for the market

In February, 2015, it was declared to move into the TEM stage, and the electricity trading through Nigeria Bulk Electricity Trading Company Plc (hereinafter called as the "NBET") commenced. The NBET has concluded Power Purchase Agreements (PPAs) and Vesting Contracts with 15 generation companies (Gencos) and 11 distribution companies (DisCos) respectively. The trading electricity volume is currently at least 14,300 MW/hour at a peak time.

TCN had concluded the management contract with Manitoba hydro International (MHI) up to 31 July 2016. The MHI was responsible to turn TCN into a technically and financially efficient, stable, and sustainable company. The MHI promoted unbundling TCN into TSP and ISO.

6-2 Relevant Legislatives in Power Transmission Sub-Sector

6-2-1 Electric Power Sector Reform Act 2005

The Electric Power Sector Reform Act (hereinafter called as the "EPSRA") was promulgated in March, 2005 as a legal background for electric power sector reform. The EPSRA outlines the framework of the reform as follows:

- To unbundle the state owned power entity (NEPA) into generation, transmission and distribution
- To provide for the transfer of assets, liabilities and staff of NEPA to Power Holding Company of Nigeria (hereinafter called as the "PHCN") and then to successor generation, transmission and distribution companies
- To create a competitive market for electricity services in Nigeria
- To set up an independent regulator

The EPSRA consists of 13 parts with 101 sections in total.

Table 6-2 Composition of Electric Power Sector Reform Act

No.	Part	Major Content	Progress
1.	Formation of Initial and Successor Companies and Transfer of Asset and Liability of NEPA (Sec. 1-24)	Schedule, responsibilities, procedures, constraints and activities for the formulation of initial holding company (PHCN) and successor companies, and for the transfer of assets, liabilities and employees of NEPA to PHCN	• Formulation of PHCN and successor companies • Privatization of Gencos and DisCos
2.	Development of Competitive Electricity Market (Sec. 25-30)	Definitions and requirements of each license (generation, transmission, system operation, distribution and trading) to be issued by NERC, and responsibilities of license holders and related stakeholders	• Issuance of licenses by NERC • Establishment of NBET and commencement of electricity trading
3.	Establishment, Functions and Powers of NERC (Sec. 31-61)	Conditions, functions, authorities and responsibilities for the establishment of NERC, and responsibilities, authorities and obligations of Commissioner	Establishment of NERC
4.	Licenses and Tariffs (Sec. 62-76)	Licensing requirements, duties of licensees, terms and conditions of licenses, review/amendment/cancellation of licenses, etc.	-
5.	Acquisition of Land Access Rights (Sec. 77-79)	Special provisions relating to generation, transmission and distribution companies and notice of construction of railways, roads and telecommunication works and	Implemented depending on works

No.	Part	Major Content	Progress
		control of other works	
6.	Consumer Protection and Licensee Performance Standards (Sec. 80-81)	Consumer protection standards and performance of standards and codes	-
7.	Competition and Market Power (Sec. 82)	Responsibilities of NERC for competitive market and avoidance of abuses of market regulatory power of NERC	-
8.	Power Consumer Assistance Fund (Sec. 83-87)	Establishment of power consumer assistance fund and rules for use of the fund	Not established
9.	Rural Electrification Fund (Sec. 88-92)	Establishment and purpose of rural electrification fund and rules for use of the fund	Not established
10.	Offences (Sec. 93-94)	False declaration and offences	-
11.	General (Sec. 95-97)	Inspectors, regulation and disclosure of confidential information	-
12.	Consequential and Transitional Provisions (Sec. 98-99)	Consequential and transitional provisions	-
13.	Interpretation and Citation (Sec. 100-101)	Interpretation and citation	-

Source: EPSRA (2005)

According to Section 25(b) of the EPSRA, the following two (2) licenses are required for the electricity transmission business: transmission license and system operation license.

The transmission license is the license to carry on grid construction, operation and maintenance of transmission system within Nigeria, or that connect Nigeria with a neighboring jurisdiction. Moreover, the transmission license holder also has obligation to carry out system operation including the procurement of ancillary services[1], pursuant to the terms of a system operation license issued by the Nigerian Electricity Regulatory Commission (hereinafter called as the "NERC") to such licensee (Section 65(1) and (2) of the EPSRA).

The system operation license will authorize the licensee to carry on system operation including the following activities (Section 66(1) of the EPSRA):

- Supply and demand scheduling, commitment and dispatch
- Transmission scheduling and generation outage coordination
- Transmission congestion management
- International transmission coordination
- Procurement and scheduling of ancillary services and system planning for long-term capacity
- Administration of the wholesale electricity market including the activity of administration of settlement payment in accordance with the market rule
- Such other activities as may be required for reliable and efficient system operation

As mentioned below, TCN was incorporated as a successor company of initial holding company (PHCN) with those two (2) required licenses for the power transmission and system operation.

[1] According to Grid Code, the ancillary services include the services regarding the system operation, voltage control, etc.

Moreover, under the EPSRA, it is allowed for the successor company of transmission, namely TCN, to transfer its right, function and obligation of system operation to an independent system operator (Section 25(f)(ii) and 26(7) of the EPSRA). This stipulation indicates that potentially TCN can be fully or partly privatized or TCN can ring fence of system operation section.

6-2-2 Multi-Year Tariff Order

In order to ensure that the prices charged by licensees are fair to consumers and sufficient to allow the licensees to finance their activities and to allow for reasonable earnings for efficient operation, Nigeria Electric Regulatory Commission (NERC) introduced Multi-Year Tariff Order (hereinafter called as the "MYTO") in 2008 as the framework for determining the pricing structure of electricity industries. The MYTO in 2008 was revised in May, 2012 as Second Multi-Year Tariff Order (hereinafter called as the "MYTO-2") and in March, 2015 as MYTO-2.1., then after that MYTO 2-2 was issued in December 2016.

There are three (3) separate tariff orders: one for generation, transmission and distribution/retail sectors. For transmission, NERC established the regulated Transmission Use of System (hereinafter called as the "TUOS") charge to be paid to TCN by the DisCos.

The transmission charges to be paid to TCN are the TUOS charge including the charges for transmission services, system operation and market operation, and separately regulatory and ancillary services charges. Those charges were estimated based on projected volume of power generation. The transmission charges from 2016 to 2024 approved by NERC are shown in Table 6-3.

Table 6-3 Approved Transmission Tariff in MYTO-2

(Unit: N '000/MWh)

料金	2016	2017	2018	2019	2020	2021	2022	2023	2024
TSP	2,975.12	3,202.70	3,624.46	3,708.54	3,921.57	3,873.98	3,657.35	3,520.48	3,384.57
SO	330.08	329.55	211.1	187.92	181.75	172.38	168.4	167.8	167
MO	22.21	20.04	12.46	11.1	10.76	10.23	10.01	10	9.97
NERC Charge	5.28	5.24	3.35	2.99	2.89	2.74	2.68	2.67	2.65
Ancillary Service	50.69	55.94	61.4	67.13	73.19	79.82	86.97	94.7	103.12
Total TUOS Charge	3,383.38	3,613.47	3,912.77	3,977.68	4,190.16	4,139.15	3,925.41	3,795.65	3,667.31

Source: MYTO-for TSN (2015)

The MYTO-2 allows for bi-annual minor reviews in consideration of four (4) variables: inflation rate, gas price, foreign exchange rate and actual daily generation capacity. Moreover, it is also allowed to make a minor review by NERC on less than 5 percent apart so as to keep the tariffs in line with the current realities.

6-3 Related Institution in Power Transmission Sub-Sector

6-3-1 Nigerian Electricity Regulatory Commission (NERC)

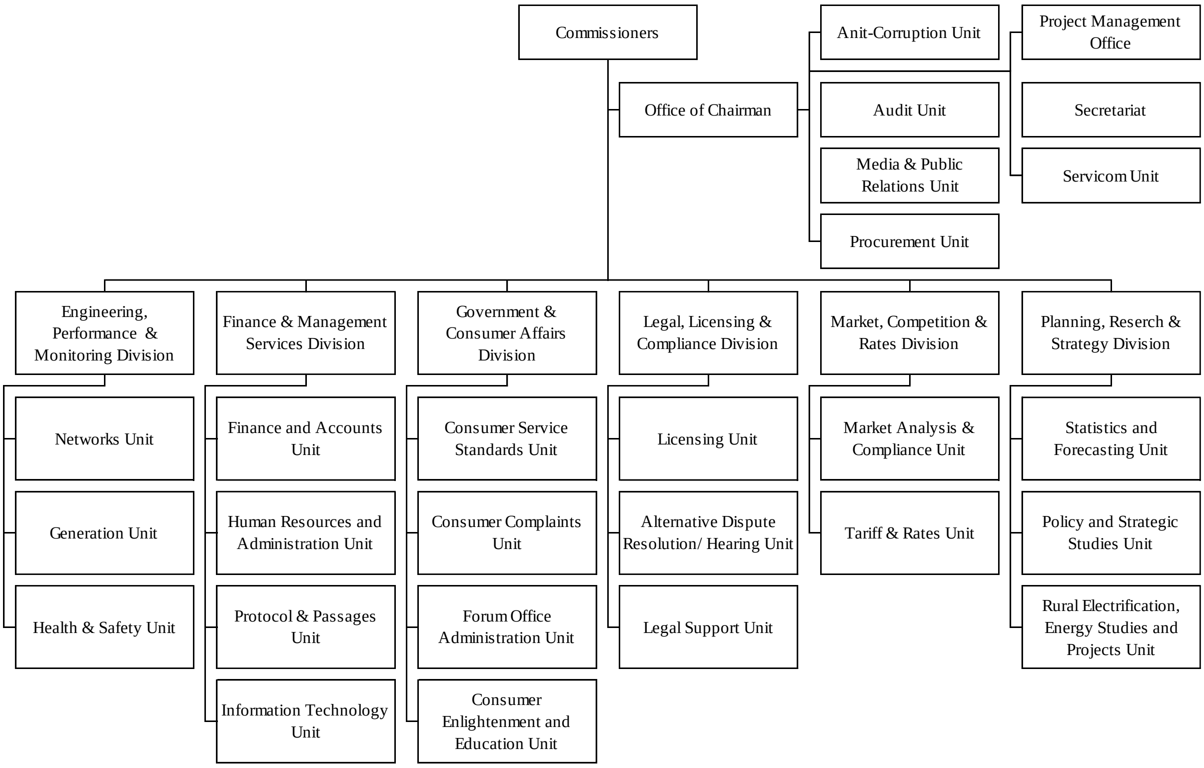
NERC is an independent regulatory body which was inaugurated on 31 October, 2005 as provided in the EPSRA. The principal objectives of NERC are as follows:

- To create, promote and preserve efficient industry and market structures, and to ensure the optimal utilization of resources for the provision of electricity services
- To maximize access to electricity services by promoting and facilitating consumer connections to distribution systems in both rural and urban areas
- To ensure that an adequate supply of electricity is available to consumers
- To ensure that the prices charged by licensees are fair to consumers and are sufficient to allow the licensees to finance their activities and to allow for reasonable earnings for efficient operation
- To ensure the safety, security, reliability and quality of service in the production and delivery of electricity to consumers
- To ensure that regulation is fair and balanced for licensees, consumers, investors and other stakeholders

In order to accelerate the achievement and realization of the above objectives, NERC is required to perform the following functions:

- To promote competition and private sector participation when and where feasible
- To establish or approve appropriate operating codes and safety, security, reliability and quality standards
- To establish appropriate consumer rights and obligations regarding the provision and use of electricity services
- To license and regulate entities engaged in the generation, transmission, system operation, distribution and trading of electricity
- To approve amendments to the market rules
- To monitor the operation of the electricity market

For the implementation of the required function, NERC consists of the seven (7) administrative units and six (6) regulatory divisions as shown in Figure 6-1.



Source: NERC (2018)

Figure 6-1 Organization Chart of Nigerian Electricity Regulatory Commission (NERC)

6-3-2 Federal Ministry of Power, Works and Housing (FMPWH)

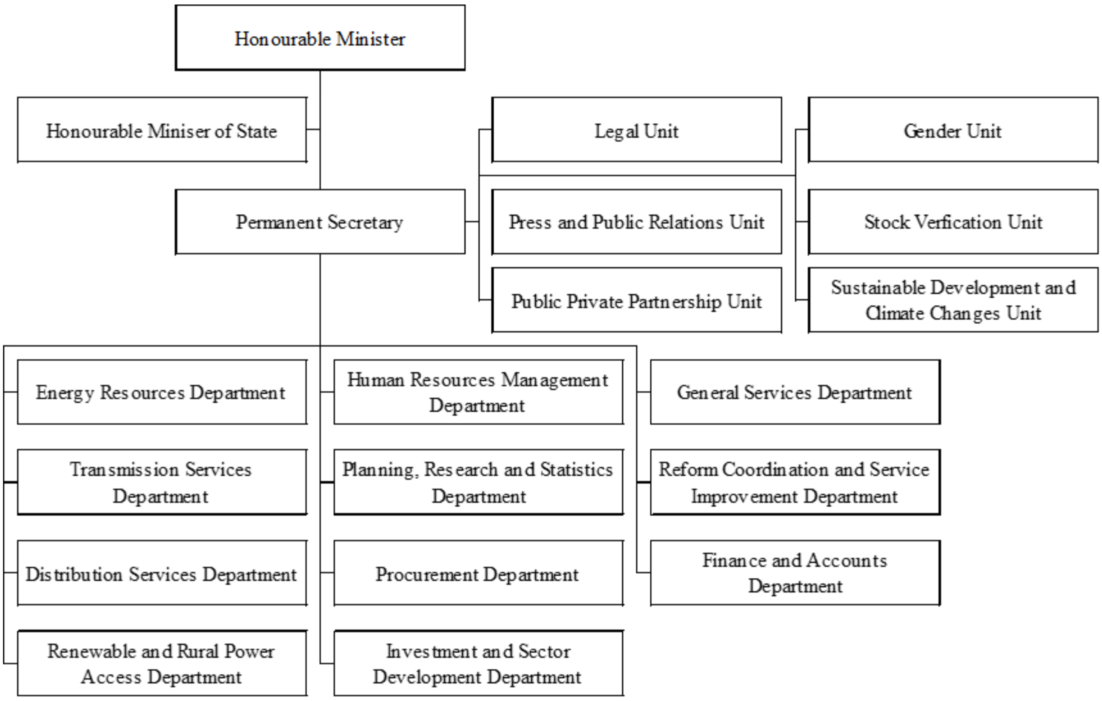
FMPHW is the government institution for policy making and implementation on matters dealing with the provision of electricity in the country. The functions of FMPWH are listed below.

- To initiate and formulate broad policies and programs on the development of the power sector (electricity) in general
- To initiate concessions in the power sector of the economy
- To license electric generating sets of 1MW capacity and below and electrical contractors
- To conduct investigation on electrical accidents and to ensure safety in the electricity industry in Nigeria
- To conduct statutory tests and certification of electric poles (concrete, wooden, steel, etc.) and other major electrical materials before they are used on the grid and networks in Nigeria
- To implement Renewable Energy programs/initiatives (Solar, Wind, Biomass, Small Hydro, etc.)
- To make coordination of activities of power sector
- To handle policy matters relating to research and development in the power sector
- To promote the development of hydro power plants through Public-Private Partnership (PPP)
- To participate in bilateral and multilateral relations affecting the power sector
- To facilitate the overall coordination of the activities of the Parastatals under its supervision

In accordance with the progress of the power sector reform, the organizational structure was restructured in October, 2014. The main change of its structure related to the Project is to divide the former

Department of Power into three (3) departments: Energy Resources Department, Transmission Services Department and Distribution Services Department as shown in Figure 6-2.

FMPWH is composed of 778 officials as of November, 2014.



Source: FMPWH (2014)

Figure 6-2 Organization Chart of Federal Ministry of Power, Works and Housing (FMPWH)

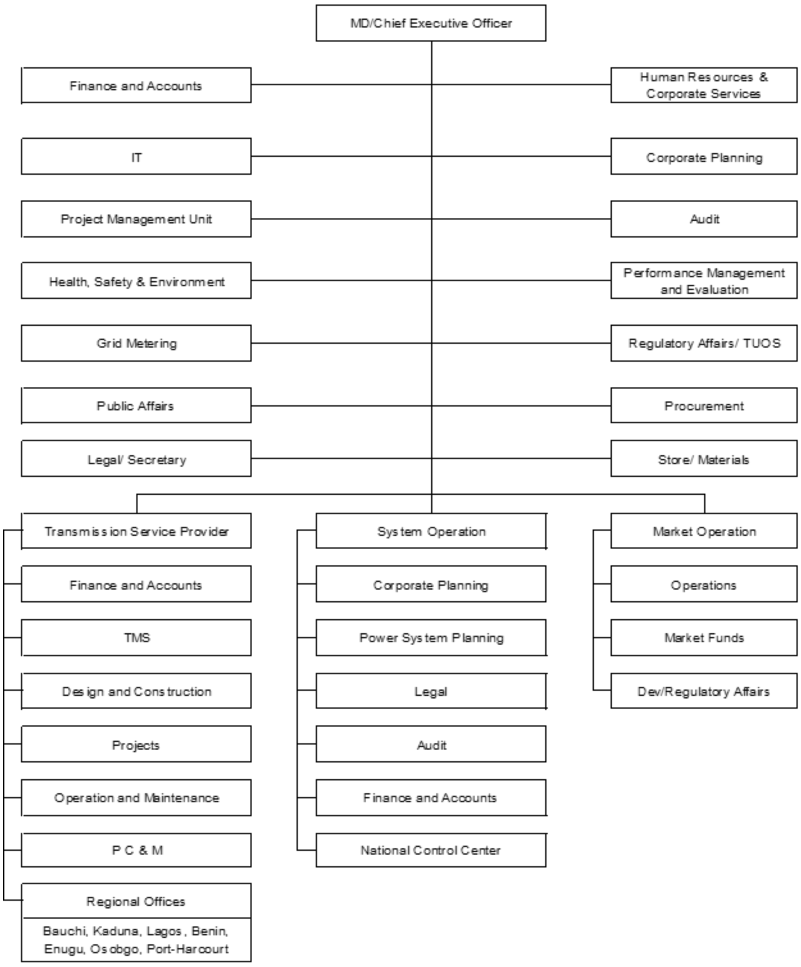
6-3-3 Transmission Company of Nigeria (TCN)

(1) Institutional Outline

TCN was incorporated in November, 2005 as one of the 18 unbundled business units under the PHCN. The Transmission License was issued by NERC on 1st July, 2006 and TCN commenced its operation for the provision of transmission services.

Instead of the privatization under the generation and distribution sub-sectors, TCN entered into its operation under the management contract with Manitoba Hydro International of Canada (MHI) in August, 2012 for three (3) years and its contract is terminated at July 2016. The objectives of this management contract was to assume the full management control of TCN in terms of its day-to-day operations including three (3) principal functions of TCN: Transmission Service Provider (hereinafter called as the “TSP”), System Operator (hereinafter called as the “SO”) and Market Operator (hereinafter called as the “MO”) and to transfer TCN into technically and financially efficient, sustainable, stable, commercially viable and market driven company.

The total number of officials of TCN is counted as 3,592 consisting of 2,273 officials for the TSP, 997 for the SO, 58 for the MO and 264 for other administration units including 589 officials in headquarter (as of December, 2014). The organization chart of TCN is shown in Figure 6-3.



Source: TCN (August 2017)

Figure 6-3 Organization Chart of Transmission Company of Nigeria (TCN)

TCN has performed two (2) broad activities: transmission line services and systems and market operation.

The TSP is the owner of the transmission network to maintain and construct the transmission lines and substations. The TSP is responsible for providing electricity transmission services in cost effective, efficient and reliable way. The TSP carries out maintenance activities in addition to planning, designing, procuring and implementing massive transmission grid expansion program.

The SO ensures the integrated operation of the power system in Nigeria. The main responsibilities of the SO include:

- To monitor the system parameters and security
- To ensure the integrated operation of the power system to deliver the qualified and uninterrupted power
- To facilitate merit order dispatch
- To facilitate the operation of power market through bilateral exchange
- To undertake power system studies and comprehensive system planning
- To augment telemetry, computing and communication facilities

The MO is the electricity market administrator designated for the implementation of the Market Rule (presently applied Market Rule is Interim Rule issued by NERC in April, 2014). The MO is required to operate in a manner that guarantees efficiency, transparency and non-discriminatory market administration services to all market participants, such as Gencos, TSP, SO, MO, DisCos, NBET, NERC and so on. The MO is responsible for the following duties.

- To review the efficiency and adequacy of Market Rules and Market Procedures and to propose such amendments as may be required to ensure their efficiency and adequacy
- To administrate and register the market participants, to organize and maintain the participants' register, to centralize the information required for the market administration, and to organize and maintain the related database
- To verify that each connection point (trading point) where a participant injects or extracts energy has proper commercial metering related to physical exchange (injection and consumption) of energy, to provide ancillary services and other necessary commercial transactions
- To manage the market settlement process including preparation and transmittal of market invoices to the market participants, revenue collection from DisCos, payment to service providers (MO, SO, NBET and NERC), finance and banking, and dispute resolution related to settlements

(2) Financial Condition

The balance sheet of TCN is shown in Table 6-4.

Table 6-4 Balance Sheet of TCN (2014- 2016, Naira '000)

Year	*2016*	*2015*	*2014*
Assets			
Non-current assets			
Property, plant and equipment	534,926,680	518,921,537	514,878,247
Deferred tax assets		2,860,026	
Total non-current assets	534,926,680	521,781,563	514,878,247
Current assets			
Inventories	9,227,103	9,478,343	10,005,304
Trade and other receivables	67,322,139	59,090,107	67,515,727
Cash and cash equivalent	75,949,925	44,783,166	34,358,165
Total current assets	152,499,167	113,351,616	111,879,196
Total assets	687,425,847	635,133,179	626,757,443
Liabilities			
Non-current liabilities			
Borrowings	92,791,098	59,430,014	46,799,326
Deferred tax liabilities	72,285,500		

Year	2016	2015	2014
Total non-current liabilities	165,076,598	59,430,014	46,799,326
Current liabilities			
Trade and other payables	42,937,133	21,793,414	26,128,868
Current tax liabilities	21,684,095	11,624,278	11,624,278
Total current liabilities	64,621,228	33,417,692	37,753,146
Total liabilities	229,697,826	92,847,706	84,552,472
Equity			
Ordinary share capital	5,000	5,000	5,000
Capital contribution	259,652,514	227,436,094	218,165,924
Retained earnings	198,070,507	314,844,379	324,034,047
Total equity	457,728,021	542,285,473	542,204,971
Total equity and liabilities	687,425,847	635,133,179	626,757,443

Source: TCN Annual Financial Statement 2016

Major ratio of Balance Sheet items are stated below.

Table 6-5 TCN Major Ration of Balance Sheet

Year	2016	2015	2014
Non-Current Asset/Total Asset	78%	82%	82%
Current Asset/Total Asset	22%	18%	18%
Borrowing/Assets	13%	9%	7%
Capital Contribution Ratio/	38%	36%	35%
Equity Ratio	67%	85%	87%
Additional Capital Contribution by FGN	20,548,585	9,270,170	17,649,378
(Capital contributing In US Dollar, US$=200Nira)*	102,743	46,351	98,052

Source: Study team *Exchange rate of US$=Nira200 is applied as average rate for the period of 2014~2016.

The equity capital ratio is greatly reduced to 67% in 2016 from 87% in 2014. However, a bigger challenge than the decline in the equity capital ratio is that a large subsidy from the Federal Government is being contributed every year to fill in the business loss. The subsidy for fiscal 2016 is equivalent to $ 102 million in US dollars, accounting for 38% of total assets.

TCN Profit Loss Statements is shown below in Table 6-6.

Table 6-6 TCN Profit Loss Statement（2014~2016, Naira’000）

	Nigerian Nira '000		
Year	2016	2015	2014
Revenue	83,554,144	72,792,084	50,365,852
Cost of sales	26,703,123	15,525,341	16,206,183

Gross Profit	56,851,021	57,266,743	34,159,669
Administrative expense	78,635,446	65,857,877	65,704,663
Other income	1,709,006	1,218,835	2,146,977
Operating Profit (Loss)	(20,075,419)	(7,372,299)	(29,398,017)
Finance Income	16,621	1,072,503	2,529,854
Finance cost	11,405,079	5,749,898	2,069,821
Profit (Loss) before tax	(31,463,877)	(12,049,694)	(28,937,984)
(In US Dollar(1 US$=Nira200)	(157,319)	(60,248)	(160,767)

Source: TCN Annual Financial Statement 2016

Major ratio of P\L items are shown below in Table 6-7.

Table 6-7 TCN Major Ratio of P/L items

Year	*2016*	*2015*	*2014*
Cost/Revenue	32%	21%	32%
Gross Profit Ratio	68%	79%	68%
Adm. Expense/Revenue	94%	90%	130%
Operating Profit/Revenue	-24%	-10%	-58%
Financing Cost/Revenue	14%	8%	4%
Net Profit before tax/Revenue	-38%	-17%	-57%

Source: JICA Study Team

Although sales are increasing every year, expenses are increasing at a rate of more than sales. Especially, the ratio of operation and maintenance expenses to sales accounted for more than 90% that is not possible to cover the operation and management fee by Gross Profit after deducting the cost of sales. As a result, operational losses are recorded annually and the pre-tax loss in 2016 is reached to equivalent of US $ 157 million.

It is desirable that autonomous management be carried out without support from the government as an independent entity. However, government subsidies to fill the losses are continuously being contributed every year and the financial situation as of 2016 has not reached an entity that is required to operate a business as a financially independent private business.

Although TCN has made efforts for policy-based pricing corresponding to costs according to MYTO, the main cause of loss is the lack of revenue due to the low tariff collection rate. At least TCN needs to collect 60% of invoiced amount in order to continue business. However, the collection rate of transmission charges that DisCos needs to pay to TCN was 60% in 2013-2014, but worsened to 42% in 2015 and 35% in 2016.2 As a result, TCN accumulated up to 80 billion Naira (approximately 288 million dollars) accumulated so far in 2016

[2] World bank Project Appraisal Document for Nigeria Electricity Transmission Project (January 2018) による。

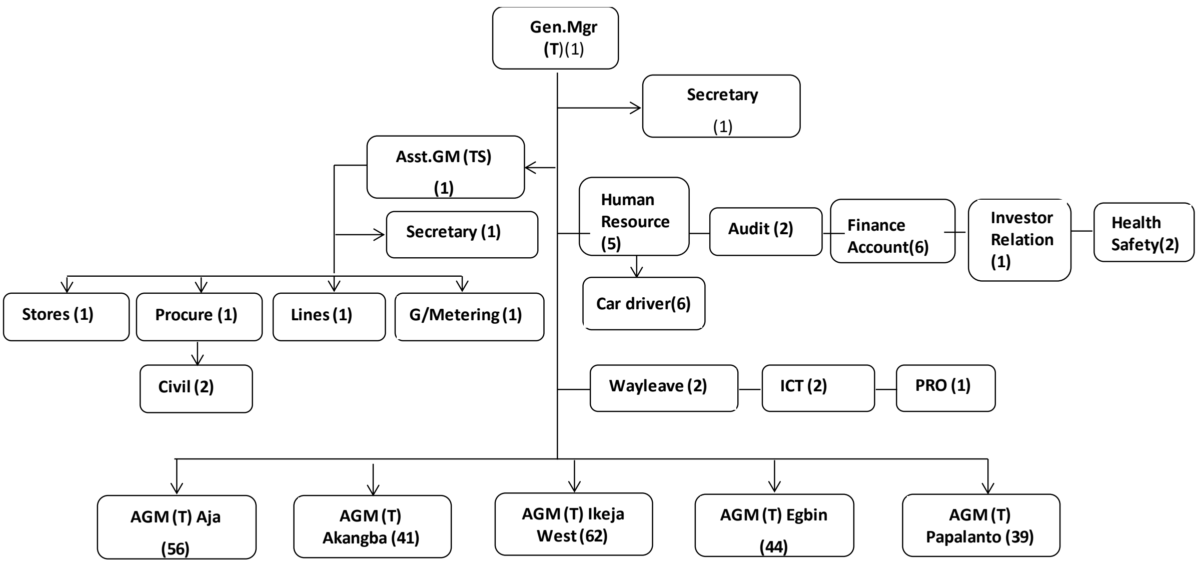
(3) Operation and Maintenance Structure

The operational area of TCN covers the whole country of Nigeria and it is divided into eight (8) regions administratively as shown in Figure 6-4. Since the proposed facilities constructed and installed by the Project will be located in Lagos administrative region, the Lagos Regional Office of TCN will be in charge for the operation and maintenance of those facilities.

Source: TCN (2014)

Figure 6-4 Administrative Area of TCN

The Lagos Regional Office of TCN is one of the regional offices covering whole Lagos state and a part of Ogun state to operate and maintain the transmission facilities in its region. The total number of officials is 43 personnel with the following organization structure as shown in Figure 6-5.



Source: TCN (2018)

Figure 6-5 Organization Chart of TCN Lagos Regional Office

For the operation and maintenance of transmission facilities in its administrative area, Ikeja West Substation plays a role as Regional Control Center (hereinafter called as the "RCC") connecting with and regulating five (5) large-scaled substations designated as Area Control Centers (hereinafter called as the "ACC") with several substations connecting with each ACC. The RCC monitors the operational information on electricity transmission through the ACC, and delivers the information to the National Control Center located in Oshogbo in Osun state. The transmission substations under each ACC are summarized in Table 6-8. According to Lagos Regional Office of TCN, the proposed substations under the Project will be managed by Ikeja West and Egbin ACCs.

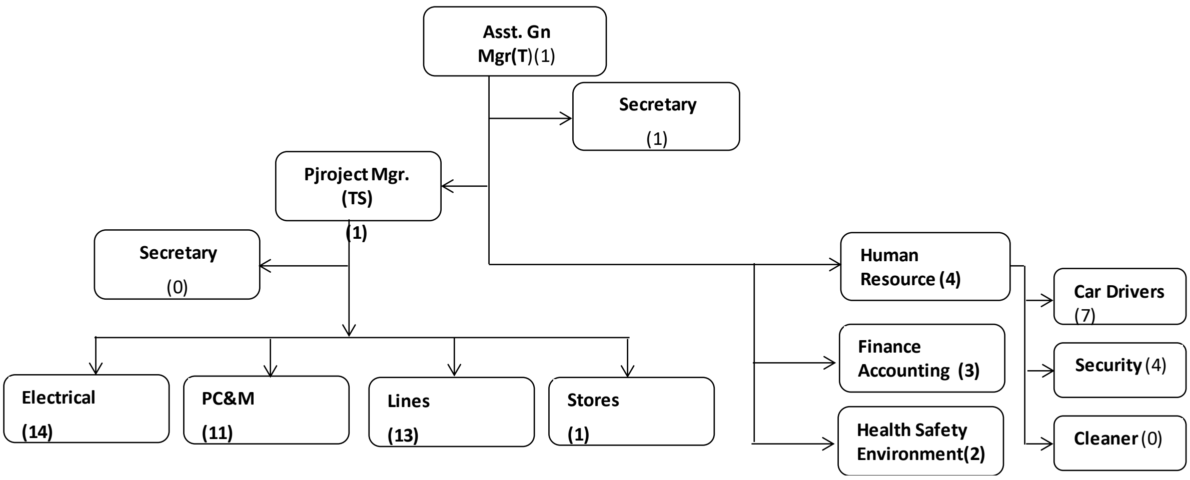
Table 6-8 ACC and Substation in Lagos Region

No.	ACC	Substation	Substation Proposed by JICA Project
1.	Ikeja West	Ikeja West, Ogba, Ejigbo, Alimosho, Agbara, Alausa	Ajegunle(New Agbara), Badagry, MFM
2.	Egbin	Egbin, Ikorodu, Maryland	Likosi(Ogijo), Redeem
3.	Aja	Aja, Alagbon, Amuwo, Apapa RD, Oworo, Akoka, Lekki	-
4.	Papalanto	Papalanto, Abeokuta, Ota, Olorunsogo	-
5.	Akangba	Akangba, Itire, Ojo, Ijoa, Ilupeju, Isolo	-

Source: TCN (2014)

The organizational structures of Ikeja West and Egbin ACCs are shown in

Figure 6-6 and 8 respectively.



Source: TCN (2018)

Figure 6-6 Organization Chart of TCN Ikeja West Area Control Center

Ikeja West Substation

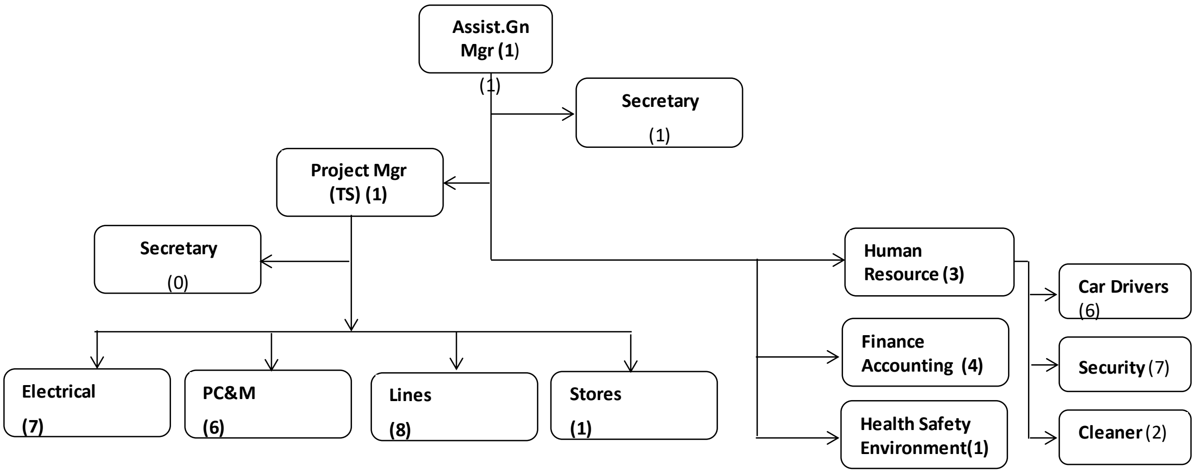
Control Panel
(Manual Operation)

Control Panel
(Automatic Operation)

Operator

Source: JICA Study team

Figure 6-7 Ikeja West Area Control Center



Source: TCN (2018)

Figure 6-8 Organization Chart of TCN Egbin Area Control Center

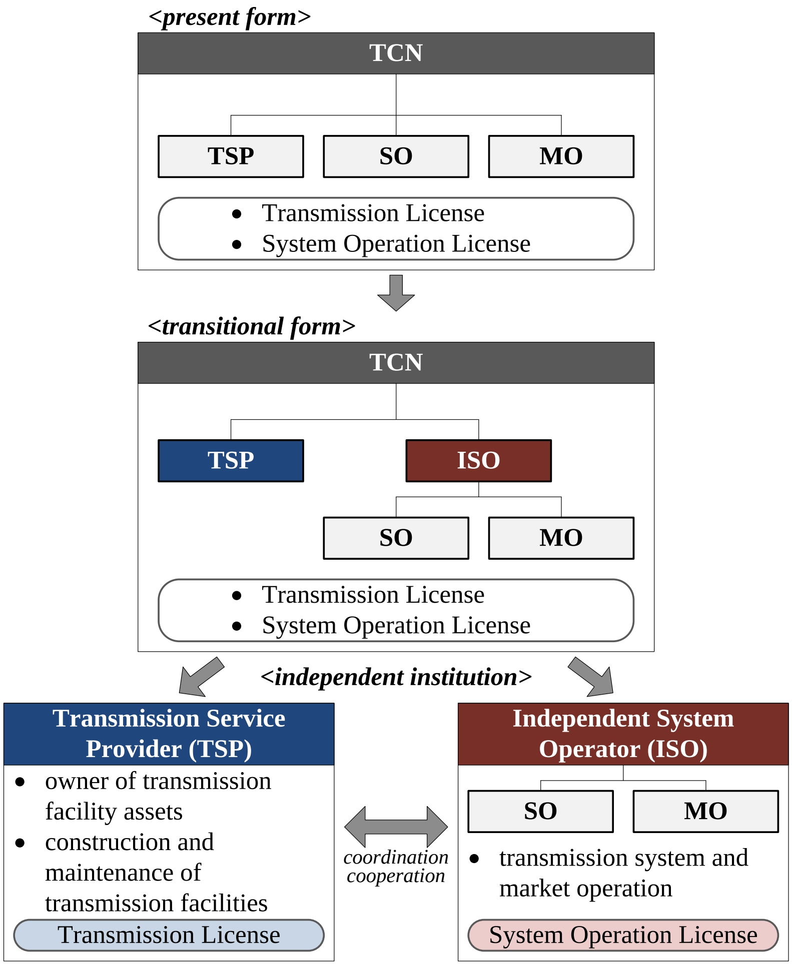
(4) Further Efforts for Enhancement of Market Stability

1) Future Institutional Reform of TCN

As described above, TCN formulates its organization with three (3) business units (T Transmission Service Provider: TSP, System Operator: SO and Market Operator: MO) and several administrative units as a monopoly position of transmission company.

However, during the continuing process of the dynamic electric power sector reform in Nigeria, it is considered to restructure its institution for pursuing further effective and reliable provision of electricity transmission services and operation.

Even though it is still under discussion, the assumed framework for institutional reform provided by TCN is described in Figure 6-9.



Source: Made by JICA Study Team based on interview with TCN

Figure 6-9 Future Direction on Institutional Reform of TCN

In accordance with the Section 25(f)(ii) and 26(7) of the Electric Power Sector Reform Act (EPSRA), the present TCN indicates the direction of company separation into two (2) forms: Transmission Service Provider (TSP) and Independent System Operator (ISO) with each required license. The TSP will be the owner of the electricity transmission facilities currently owned by TCN and be responsible for the construction and maintenance of those facilities. On the other hand, the ISO will focus on the system and market operation for electricity transmission services. The present administrative units will be also allocated to both entities.

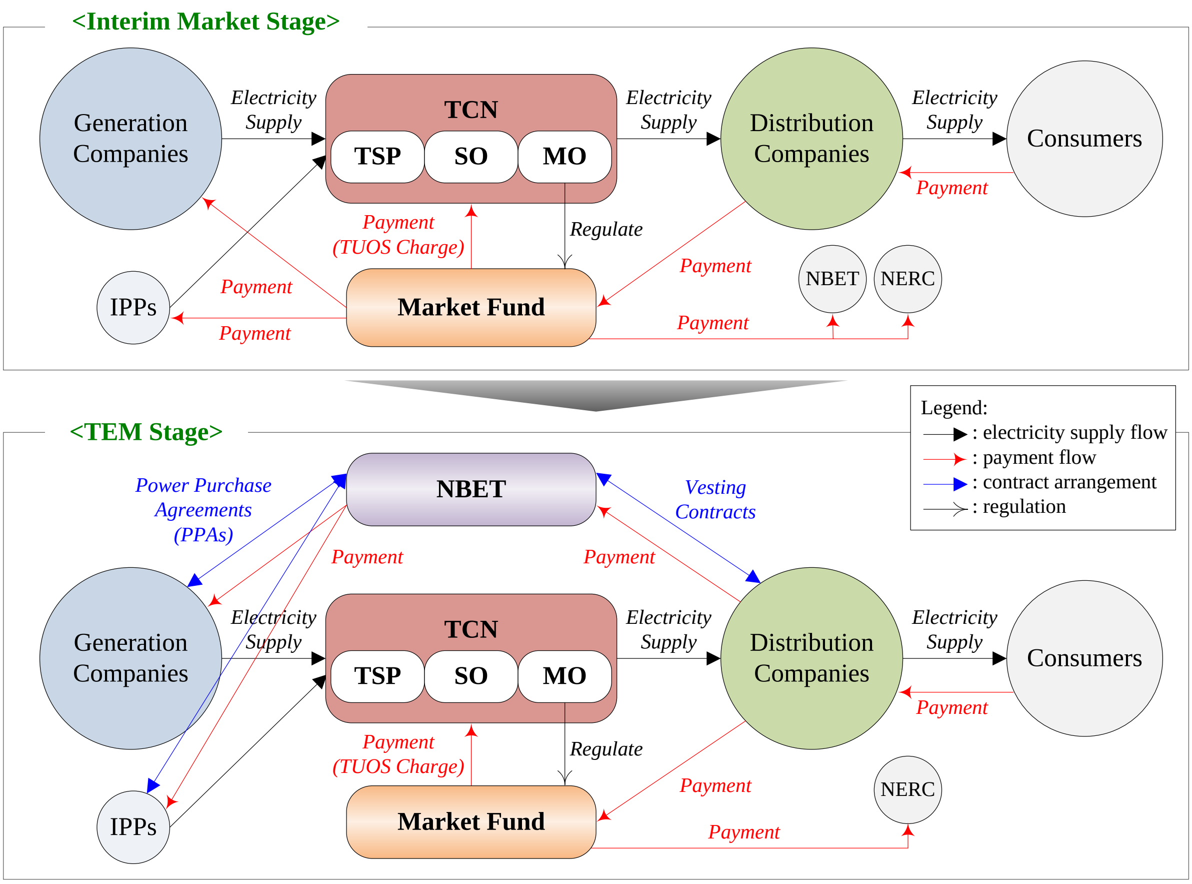
The target year of this reform is not fixed yet, but the reform of the present TCN is currently considered to the above direction.

2) Financial Arrangement in Electricity Power Sector

a) Revision of Payment Mechanism

During the Interim Market stage as stipulated in the Interim Market Rule, the MO prepares the monthly settlement statement based on the meter readings submitted by the Gencos, DisCos and SO and audited by the MO. The MO issues the invoices to the DisCos, and accordingly the DisCos make payments to the MO in the Market Fund which is regulated by the MO. The charges paid by the DisCos in the Market Fund are allocated to each market participants in accordance with the defined proportion in the MYTO-2.

In accordance with the progress of electric power sector reform, however, the Nigeria Bulk Electricity Trading Company Plc (NBET) was incorporated in July, 2010 with 100% of Federal Government of Nigeria shareholding and commenced the electricity trading from February, 2015. The NBET will be responsible to buy electricity power from the Gencos and IPPs based on Power Purchase Agreements and to resell the purchased power to the DisCos with Vesting Contracts. The NBET will moderate the electricity power trading between the Gencos and the DisCos in the private sector by providing the payment security package including the contract, guarantee and insurance to enhance the creditworthiness of the power trading. On the other hand, the payments to the other market participants for the transmission services and regulatory services will be settled through the Market Fund as it is.



Source: Made by JICA Study Team based on interview with TCN

Figure 6-10 Revision of Payment Mechanism

b) Proposal for Revision of TUOS Charge

In order to improve the financial status, TCN submitted the proposal for revised transmission charges to be applied in 2014 and 2015 to NERC in May, 2014.

The Transmission Use of System (TUOS) charge applied in accordance with the MYTO-2 is pre-determined by NERC for the 5-year period from June, 2012 up to May, 2016. Although the revenue requirements of TCN are mostly of a fixed nature, the transmission tariff determined by NERC is based on the volume of bulk supply to DisCos. This indicates that TCN carries an element of generation risks. Therefore, it was proposed to revise the transmission tariff system as fixed charge, rather than volumetric charge as per the MYTO-2 to enable TCN to properly maintain and operate the grid network and to grow the infrastructure in step with rapid expansion of generation and load. If TCN proposal is accepted, it is expected to achieve the surplus of revenue when the future operating profits is not much different from the expected ones and the payment from DisCos is not significantly delayed.

On the other hand, the proposed average transmission charge is to increase the present rate of TUOS Charge from N 1,367/MWh to N 4,824/MWh which is approximately 3.5 times larger than existing tariff rate. Moreover, the increase rate of the tariff applied in MYTO-2.1 was 1.8 times. In order to adjust the required tariff and applicable level, this proposal has been under discussion between NERC and TCN.

c) Establishment of Central Bank of Nigeria-Nigeria Electricity Market Stabilization Facility (CBN-NEMSF)

In November, 2014, the Central Bank of Nigeria (CBN), the Federal Ministry of Petroleum Resources, FMPWH, NERC, and representatives of the Gencos and the DisCos signed the Memorandum of Understanding (MoU) for the establishment of the Central Bank of Nigeria-Nigeria Electricity Market Stabilization Facility (hereinafter called as the "CBN-NEMSF").

The purpose of the CBN-NEMSF is to provide the facility to overcome the shortfalls in power sector revenues caused by necessary adjustments in electricity tariff. Totally more than NGN 200 billion will be distributed to the market participants as a loan in the TEM stage and the DisCos will be obliged to repay within 10 years. In accordance with the transition to the TEM stage, the CBN-NEMSF started the operation.

6-4 Institutional Framework for Implementation, Operation and Maintenance

6-4-1 Institutional Framework for Implementation under On-going Projects

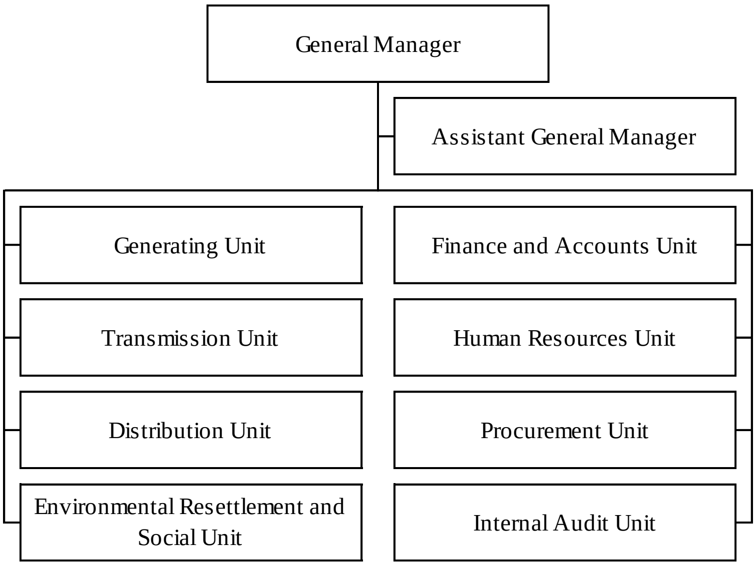
The institutional arrangement for the management and implementation of the Project will be discussed and determined during the appraisal phase between JICA and the government of Federal Republic of Nigeria. Moreover, under the dynamic progress of the electric power sector reform in Nigeria, the future organizational form of TCN is uncertain at present.

On the other hand, by seeing the institutional setup for other donors' project, it is expected to identify the potential form of the project management and implementation framework for the Project. Thus, the following three (3) cases for the power transmission projects in Nigeria are reviewed and analyzed.

(1) World Bank Projects

The Project Management Unit (hereinafter called as the "PMU") was constituted in 2001 for the first credit facility, namely Nigeria Transmission Development Project (NTDP) to address only transmission deficiencies. The distribution and generating units were set up in 2005 and 2007 respectively through the power distribution and hydro power generation projects.

PMU is responsible for implementing and managing all power projects under the World Bank assisted credit of the Federal Government of Nigeria in line with World Bank Procurement Guidelines. The organizational structure of the PMU is shown in Figure 6-8. For the project management funded by the World Bank, the PMU currently employs 70 officials consisting of 47 personnel as regular staff who are assigned in the units and 23 personnel as support staff assigned as the project base.



Source: TCN (2014)

Figure 6-81 Organization Chart of Project Management Unit (World Bank)

Since the PMU was established for the management of World Bank projects and has been continuously engaged in the project management for more than 13 years, the PMU performs the wide range of the functions for all processes of project management from the project finding up to the completion including the procurement. At present, the following five (5) on-going power transmission projects are under the management of the PMU. TCN staff belonging to the PMU receives the salary paid by TCN and field allowance funded by the World Bank.

Table 6-9 On-Going Transmission Project (World Bank)

No.	Project Title	Location	Contract Date	Scope of Works
1.	Rehabilitation and Reinforcement of Transmission Substations (330/132kV & 132/33kV): Lot 1	Afam I, Afam IV, Port Harcourt, Aba Town, Eket	22 June, 2012	• Installation of 60MVA transformer at Afam I 132/33kV S/S • Rehabilitation of Afam IV 330/132kV S/S • Rehabilitation of Port Harcourt 330/132kV S/S • Installation of 60MVA transformer at Aba Town 132/33kV S/S • Installation of 60MVA transformer at Eket 132/33kV S/S
2.	Rehabilitation and Reinforcement of Transmission Substations (330/132kV & 132/33kV): Lot 2	Akangba, Ikeja West, Ikorodu, Akangba	22 June, 2012	• Rehabilitation of Akangba 330/132kV S/S • Rehabilitation of Ikeja West 330/132kV S/S • Installation of 60MVA transformer at Ikorodu 132/33kV S/S • Installation of 60MVA transformer at Akangba 132/33kV S/S
3.	Rehabilitation and Reinforcement of Transmission Substations (330/132kV & 132/33kV): Lot 3	Osogbo, Ayede, Ijebu Ode	22 June, 2012	• Installation of 60MVA transformer at Osogbo 132/33kV S/S • Installation of 60MVA transformer at Ayede 132/33kV S/S • Rehabilitation of Ayede 330/132kV S/S • Installation of 60MVA transformer at Ijebu Ode 132/33kV S/S
4.	Rehabilitation and Reinforcement of Transmission Substations (330/132kV & 132/33kV): Lot 4	Kaduna (Mando), Kano (Dan Agundi)	22 June, 2012	• Installation of 60MVA transformer at Kaduna (Mando) 132/33kV S/S • Installation of 60MVA transformer at Kano (Dan Agundi) 132/33kV S/S
5.	Civil Reconstruction and Flood Control of sinking Alagbon 132kV Substation	Alagbon-Lago	12 April, 2013	• Flood Control of Alagbon 132/33kV Substation

Source: TCN (2014)

According to the PMU, even though it was established to manage the World Bank projects, it is allowed to manage the projects funded by other donors such as African Development Bank and French Agency for Development and the role of PMU is described at the following part of Institutional Framework of Implementation.

(2) African Development Bank Projects

The CEB-PHCN Power Interconnection Project was conducted from 2004 to 2007 funded by African Development Bank (AfDB) for the development of transmission line connecting between Nigeria and Benin. The project component is summarized in Table 6-10.

Table 6-10 Summary of Project Component (African Development Bank)

No.	Country	Project Component
1.	Nigeria	• Construction of 55 km of 330kV single-circuit transmission line from 330kV Ikeja West S/S to Nigeria-Benin border • Extension of 330kV Ikeja West S/S
2.	Benin	• Construction of 15 km of 330kV single-circuit transmission line from Nigeria-Benin border to new 330/161kV Sakete S/S • Construction of new 330/161kV Sakete S/S

Source: TCN (2014)

For the project management, the Project Implementation Unit (hereinafter called as the "PIU") was established on both Nigerian and Benin sides. The PIU on Nigerian side consisted of several engineers and administration staffs: Project Manager, Project Engineer (Substation, Consultancy Services and Civil), Environmentalist, Accountant and Secretary. Project Manager was full-time personnel assigned for the project management; on the other hand, other staffs are part-time assignment. The PIU should manage and supervise the works on Nigerian side so as to ensure that the project execution was in accordance with the contract requirements. Moreover, since this project was joint project between Nigeria and Benin, Join Project Implementation Unit (JPIU) was also set up to oversee and coordinate the activities of the PIU on both countries and the Project Consultant. The JPIU was made up of Executive Director of PHCN, Director of CEB in Benin and Project Managers of both PIUs. TCN deploys the staff to the PIU and pays their salaries. The PIU is engaged in all the project management processes including the procurement.

(3) French Agency for Development Projects

In order to improve the power supply to Abuja, the new transmission lines totaling 270 km and 6 high voltage substations will be constructed under the finance by French Agency for Development (*Agence Française de Développement*) (hereinafter called as the "AFD"). For the management of this project, similar with AfDB project, the PIU is required to be set up. The composition and tasks of the PIU are summarized in Table 6-11. The Project Manager is assigned as full-time personnel and others are part-time officers whose salaries are paid by TCN. PMU manages all the processes of project management including the procurement, but during the procurement process (tendering), the AFD assigns a tender agent and the agent works together with TCN for tendering.

Table 6-11 Composition of PIU (AFD Project)

No.	Position	Main Responsibility
I. General Service		
1.	Project Manager	Fully responsible for project management including the contract management, technical management and financial management
2.	Finance Officer	Responsible for project budget, cost monitoring and control, disbursement application and ensure compliance with the financial requirements and Project Agreements
3.	Environmental/RAP Coordinators	Responsible for the supervision of all environmental activities in compliance with the requirement of the environmental certificates and the implementation of the Environmental Plans in conformity with international acceptable practices
4.	Administrative Officer	Responsible for the management and control of the use of project resources and staff welfare issues
II. Project Management/Contract Administration		
5.	Project Coordinator	Responsible for day-to-day monitoring and administration of the relevant project component and the contract packages
6.	Project Engineers - Lines - Substation - Civil	Shall have functional responsibility for specific contracts under the direction of the Project Coordinator. Shall be responsible for coordination of the review of all designs, drawings, reports and related documents as well as other project management and monitoring activities for the assigned contract including validation and certification of contractor's performance sheets
III. Construction Supervision		
7.	Construction Electrical Engineer	Liaise with the Project Coordinator and Engineer on the electrical construction activities. Supervise all Site Engineers/Technicians and ensure installation is in accordance with approved drawings and the specifications
8.	Construction Civil Engineer	Liaise with the Project Coordinator and Engineer on the civil construction activities. Supervise all Site Engineers/Technicians and ensure civil works are in accordance with approved drawings and the specifications

No.	Position	Main Responsibility
9.	Site Engineers/Technicians	Shall be responsible for ensuring the Quality Control, Site Safety, Site Activities and Site Progress of Work

Source: TCN (2014)

6-4-2 Institutional Framework of Implementation for the existing projects and its issues for Operation and Maintenance

(1) Existing Project Implementation

As described above, there are two (2) institutional forms for transmission project in Nigeria: Project Management Unit (PMU) for WB and Project Implementation Unit (PIU) for AfDB and AFD. Based on the discussion with TCN, the advantages and disadvantages of those bodies for the Project are comparatively analyzed as shown in Table 6-12.

Table 6-12 Comparative Analysis of Institutional Framework for Project Implementation

PMU/PIU	Advantage	Disadvantage
Project Management Unit (PMU) for WB	• It has plenty of experiences on project management and administration procedures for 13 years. • Experienced full-time staffs have been assigned for the management of transmission project.	• It has not been involved in project management funded by other donors. • Even under TCN, PMU is independent entity, so that TCN might not be fully involved in project management and monitoring. • JICA might be required to pay for the facility costs (e.g. office space) for PMU from loan (those costs are included in WB loan).
Project Implementation Unit (PIU) for AfDB and AFD	• TCN has experiences to establish PIU for other donor projects. • Due to new and temporary institution, the staff assignment will be flexibly decided depending on requirements. • Since PIU will be established under TCN, it will enable to make intensive communications with TCN through PIU for successful project implementation.	• Since staffs except for Project Manager will be part-time assignment, there is possibility that project management activities might not be conducted smoothly. • Since PIU will be newly established, PIU needs to understand the required procedures for JICA loan project.

Source: Made by JICA Study Team based on discussion with TCN and PMU

From 2001, the PMU has been in charge for the management of World Bank projects, so it is expected that the assigned staffs have sufficient experiences and knowledge for the proper project management including the administrative and technical aspects. However, since it is familiar with the requirements and procedures for World Bank project under its guidelines, there is concern that the PMU might face difficulties on the different manners of other donor. Moreover, it will be required to include the necessary costs for the facility use of the PMU in a loan, such as the rental cost of PMU office.

Since the PIU is the project-based body for the project management, its form might be flexibly decided depending on the necessity and requirements of donor and TCN. Moreover, it will be established directly under TCN (to be the contracting agency for the Project), which will enable the smooth and intensive communication and coordination among the donor, TCN, the consultant and the contractor for the successful implementation of the Project. However, it is necessary to pay attention that TCN is not familiar with the management of JICA loan project, thus, the relevant guidelines for the JICA project management need to be properly disseminated to the PIU members and TCN including the selection and approval procedures for the procurement of the consultant and contractor, project monitoring during the implementation, disbursement process, and addendum contract.

The project implementation structure shall be discussed between and determined by the government of Federal Republic of Nigeria and JICA. For the successful delivery of the Project, a body for the project management shall be set up. Thus, JICA was required to take the necessary arrangements including the dissemination of JICA guidelines for ODA loan among the PIU members and TCN for the establishment of proper management body of the Project. The guide line seminar for TCN staffs was implemented at November 2017.

In consideration of the above points, it is quite possible enough for TCN to implement the project as TCN has multiple implementation experiences of similar transmission and substation projects (Table 6-9, 6-10) supported by other donors and the similar projects of the same scale as this project.

In addition, in order to improve the monitoring and supervision by TCN management at the time of the project implementation simultaneously, a project monitoring organization was placed between TCN management and PIU for monitoring the status of project implementation in regular basis. Moreover, the business cooperation system and staffs are incorporated between PIU and Lagos office, which is the main project implementation site, into the project implementation process. This structure establishes the system to regularly monitor and manage the project implementation status in Abuja and Lagos. Therefore, it is expected that TCN's capabilities and execution system are considered to be sufficient for implementing the project.

(2) Issues for Operation and Maintenance

Operation and Maintenance (O&M) will be implemented by TCN. After the completion of the Project, it is assumed that the constructed electricity transmission lines and substations will be operated and maintained under the supervision by Ikeja West ACC and Egbin ACCs. Since the specifications of the transmission and substation facilities to be constructed and installed by the Project are the same as the existing ones in principle, it can be said that the personnel presently involved in operation and maintenance are already familiar with those facilities.

For the financial side of O&M, an approximately 2 billion Naira is budgeted for the operation and maintenance of transmission facilities, which is equivalent to around 30 % of total operating budget, it is assumed that the sufficient budget is secured for the operation and maintenance works.

For the human resource side of O&M, the sufficient number of staff needs to be dispatched to the new substations for their operation. According to the Lagos Regional Office of TCN, once a new substation is established, the skilled operators are relocated from the existing stations and newly employed staffs are also assigned. Out of 516 new staffs who were employed in 2013, 82 staffs will be assigned in Lagos Regional Office consisting of 42 staffs for operation and 40 for maintenance. Those new staffs are under training from February, 2014 for two (2) years to obtain the technical knowledge and know-how for their tasks. Moreover, Comprehensive Human Resource plan (including replenishing employees who retire at retirement age, new graduate recruitment, plans for hiring specialized job field, etc.) exist in TCN.

In addition, TCN has provided the several training opportunities to its management and technical staffs in cooperation with National Power Training Institute of Nigeria (herein after called as the "NAPTIN"). The NAPTIN was incorporated in March, 2009 to provide the training for power sector personnel and coordinate the training activities in the power sector. By cooperating with the NAPTIN or as TCN's own programs, the following training courses was provided in 2015, implemented based on Human Resource planning and TCN officers are deployed from the NEPA and PHCN and make continuous trainings supported by other countries. Thus, it is considered that those officials have sufficient level of knowledge and skills to operate and maintain the transmission facilities procured by the Project. On the other hand, even though they have those knowledge and skills, it is observed that some operational activities have not properly conducted, such as the management of operation records and the implementation of the regular inspection. Through the further improvement of TCN's staff, the transmission facilities will be properly operated and maintained, resulting in the provision of high quality of the transmission services.

Table 6-13 Planned Training Program of TCN

Target	Planned Training Program	Number of Target Staff
Transmission Service Provider	Project Planning and Implementation	50
	Project Management	25
	Construction, Design and Linesmen	90
	Basic Protection and Metering	100
	Safety Rules and Standard Protection Code	30
	Lifeline Training	25
System Operator	SCADA Training	10
	Dissemination of NERC Regulations	50
	Safety Training for System Operator	30
	Fiber Optic Engineering (Overseas Training)	2
	Regulation and Market Operations	30
	Grid Code Understanding	50
	Project Management	25
Market Operator	Market Operation Training	5
	Regulatory Affairs	10
	Regulatory Practices and Procedures	10
	Working with Regulator (NERC)	5
	Project Management	10
Others	Financial Planning and Management, ICT, Human Resources Management, etc.	Approx. 450

Source: TCN (2014)

Besides, the substation management shall be appropriately conducted. For example, in order to keep unwanted people out and to secure the safety of the staff working at the station, the security guards shall be dispatched at the gate of the substation. The weeds shall be regularly eradicated and unnecessary water inflow shall be drained to avoid the damages to the transmission facilities. Moreover, the documents and information related to the transmission services shall be properly managed, such as operating records, facility drawings, and technical specifications of the facilities. Those documents and information will be required for the improvement of operational efficiency and quality and the future expansion of facilities, thus, the proper management of documentations, data and information is inevitably required.

6-4-3 Loan Disbursement procedure for the existing projects

The disbursement procedures for the AFD and World Bank is described below. It usually takes two to four weeks for completing disbursement procedures within PIU/TCN. Invoices should be verified by the project consultant for the disbursement that are processed in the procedure for the following donor projects.

(1) Disbursement Procedure for AFD

1) Invoice bigger than USD 1 million for EPC and USD100,000 for consultancy service is paid directly by AFD

- Invoices verified by the project consultant is submitted to the Project Manager who forward this invoices to the Project Coordinator to verify. After this verification, the invoices are then forwarded to the Project Accountant for recording into accounting books and further processing of payment documents.
- Project Accountant then send the Invoices to the Auditors and when they are returned the Accountant will now forward to AFD for final payment.
- Verified invoice will be transferred to AFD for payment to contractor.

2) Invoice less than the above amount for EPC and consultancy service

- Invoice is verified, audited, accounting processed by PIU.
- Verified invoiced is paid by PIU.
- TCN has a project account in foreign currency and local currency in the central bank and US $ 5 million will be deposited from AFD into this account at the start of the project. After that, the account balance is checked by the AFD, and the balance required for payment by PIU is maintained by PIU account department for reporting to AFD periodically through submission of statement of expenditures of the project.

(2) Disbursement Request Procedure by PIU

The TCN as represented by the PIU accounts department is responsible for monitoring the account so that they make request for withdrawal/disbursement as at when due. This request will then be signed by the authorized signatories of TCN/PIU as agreed. The signed request is then forwarded to International Economic Relations department of Ministry of Finance who will then forward it to the AFD.

Once the project is signed, then there is no need for this request to be routed from TCN/PIU through the Ministry of Finance as the responsibility of the project management/implementation has been ceded to TCN/PIU through the subsidiary agreement signed between the TCN and

Ministry of Finance.

(3) Disbursement Procedure for World Bank

- No direct payment is made by World Bank to EPC and consultancy service.
- TCN/PIU makes financial projection for the cost and request to World Bank for disbursement
- After disbursement by World Bank, processing invoice and payment to EPC and consultant is made by PIU.

(4) Offshore Disbursement Procedure by Letter of Credit (L/C)

The following disbursement procedure is applied for the all donor projects.

- L/C is used only for international payment for offshore goods to be bought and supplied by the contractor, not for consultancy service.
- Contractor is required to submit documents to PIU to establish L/C
- PIU asks Central Bank of Nigeria to open L/C in favor of contractor for making offshore payment
- PIU submits L/C to Donor.
- Contractor submits the required documents in L/C to PIU. PIU submits these documents to Donor.
- Donor makes payment to Contractor according to L/C.

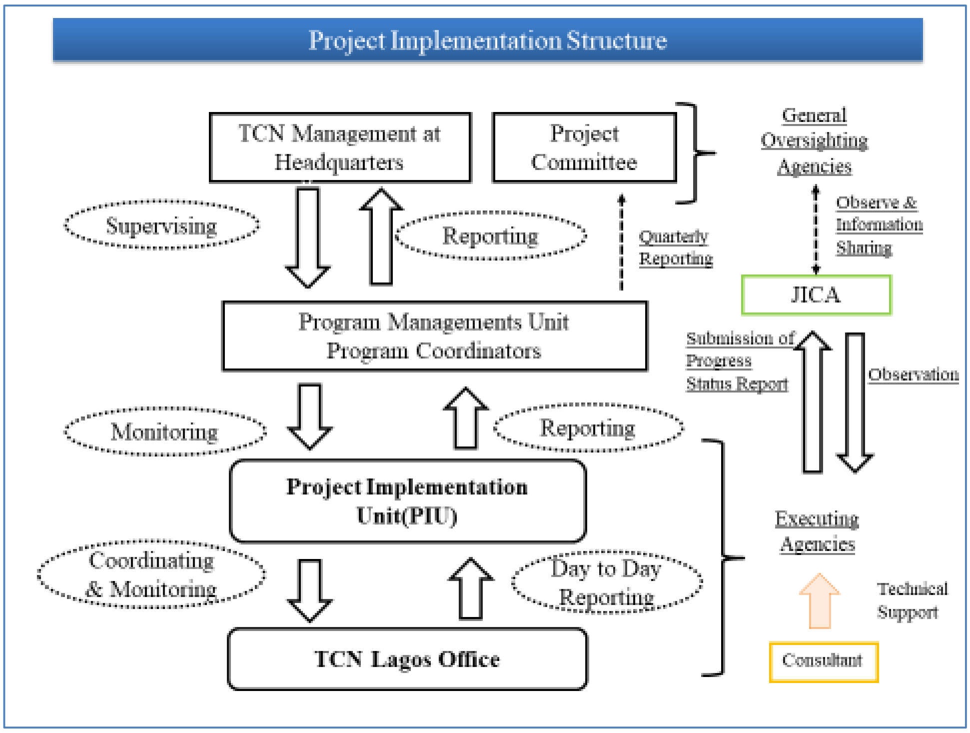
(5) Offshore Direct Disbursement Procedure

Direct disbursement method is used for the payment of services like consultancy, small supplies, when the L/C disbursement for the payment of such service is not convenient. In particular, the payment can be made through the PIU's bank (CBN) directly to the payee's bank after receiving an invoice that includes his full payment details with his bank account information.

6-4-4 Proposed Framework for Implementation of the Projects

(1) Project Implementation

Project implementation is depicted in the Figure 6-12.



Source: JICA Study team

Figure 6-12 Project Implementation Structure

- The project implementation entity shall be the Project Implementation Unit (PIU).
- TCN Lagos office is instructed and monitored by PIU's support management and carries out the project in Lagos.
- PIU makes regular work implementation report to Program Coordinator of TCN Program Management Unit (TCN-PMU).
- TCN-PMU functions as an interface to report on project implementation status by PIU to TCN Managements. Also report the progress of the project quarterly to the Project Committee.
- TCN Management oversees the proper project implementation by PIU through reports from TCN-PMU.

(2) PIU

1) Role of PIU

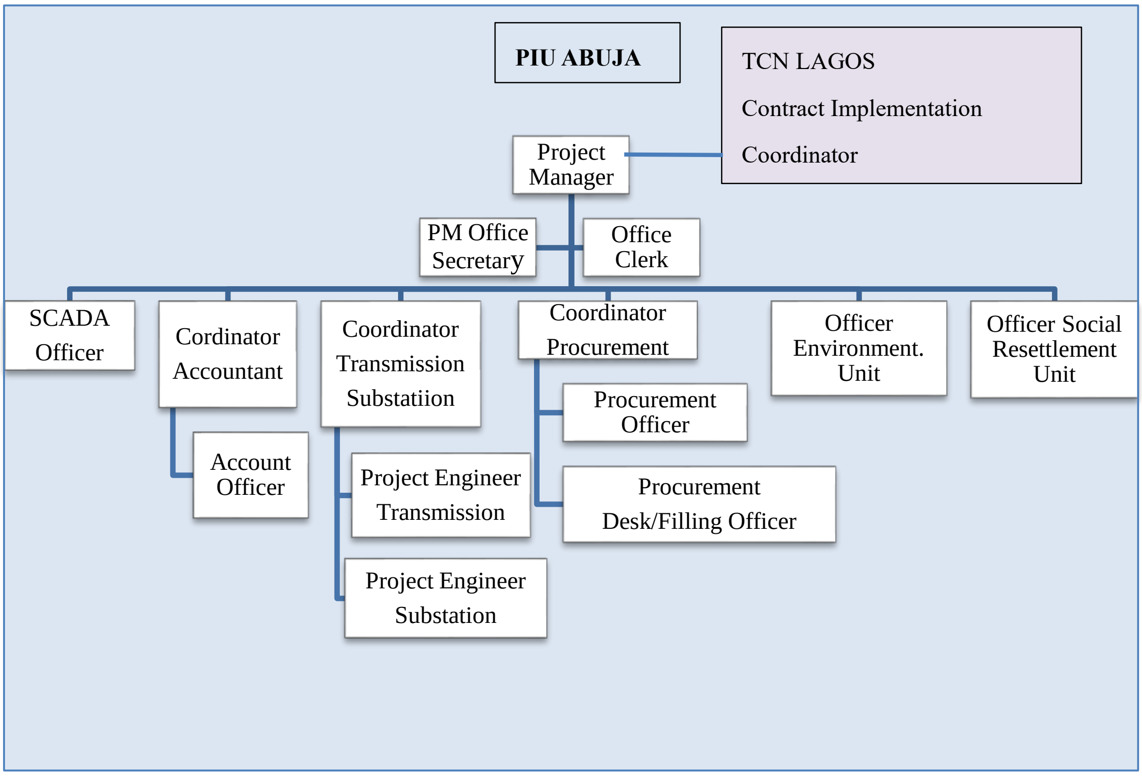
PIU undertakes the procurement of all component of the project. Its role contains;

- ➢ Coordinates the implementation of the project at the Regional Office.
- ➢ Make payment for all project activities and consultants as certified by the Regional Offices.
- ➢ Establish and Monitor L/C.

- ➢ Coordinates the procurement and implementation of specialize activities like SCADA and ERP.
- ➢ Recruits Consultant for the implementation of contracts at the Regional Offices.

2) Organizational Structure of PIU

PIU is located at Abuja. The contract implementation coordinator is deployed in Lagos.



Source: JICA Study team

Figure 6-93 PIU Structure

3) The Assignments of PIU members

The assignments of PIU member is described in the following Table.

Table 6-14 Assignment of PIU members

Position	Before contractor procurement	Construction phase
1. Overall Project Management		
Project Manager (PM) 1 person	PIU general manager Person responsible for business management, including procurement / contract management, technical management, financial management Negotiations with government ministries including reporting authorizations, coordination work with ministries and agencies (forests, roads, water supply etc.) and the state government responsible for reporting authorization	
Secretary for PM 1 person	Operation management for PM	
PIU administrator 1 person	Managing business administration and social benefits of PIU	
2. Project Management for Transmission/Sub Station		
Transmission / Transformation Project Coordinator (Deputy	Review tender documents, implement evaluation,	Manage Power transmission system. Progress monitoring and management of business components

Position	Before contractor procurement	Construction phase
Manager) 1 person	review evaluation report	and contract packages related to substation transformation, and management of transmission and transformation project engineers
Power transmission project engineer 2 person	Implementation of tender related design work Evaluation of consulting procurement, review of outline design, review of tender documents, implementation of evaluation, review of evaluation reports	Review contract management, design, drawings, reports, other related documents in the field of responsibility based on instructions from the project coordinator concerning the power transmission system, manage and monitor change and approval items in each field of responsibility Confirmation that site engineer / engineer's management, approval diagrams and construction based on technical specifications are done Safety management concerning implementation of power transmission project
Sub Station project engineer 2 person	Implementation of tender related design work Evaluation of consulting procurement, review of outline design, review of bid books, implementation of evaluation, review of evaluation reports	Review contract management, design, drawings, reports, other related documents in the field of responsibility based on the instructions of the project coordinator concerning electric substation, manage / monitor change and approval matters in each field of responsibility Confirmation that site engineer / engineer's management, approval diagrams and construction based on technical specifications are done Safety management pertaining to implementation of substation project.
3. Procurement Management		
Procurement coordinator 1 person	Progress monitoring and management of procurement based on Nigeria Public Procurement Act 2007 for necessary materials / equipment and consultant contracts / bidding related for the entire project	
Procurement officer 2 person	Implementation of consulting procurement process, implementation of main procurement process, review of PQ, tender documents, implementation of evaluation, review of evaluation reports	Procurement operation management based on instructions of procurement coordinator
Procurement bookkeeper 1person		Bookkeeping management of procured materials / equipment
4. Social Environment Management		
Environment officer 1 person	Support for EMP and EMoP review and update	Confirmation of compliance with environmental permits, EMP and EMoP Audit of regular construction work and supervision of contractors Organizing the results of environmental monitoring Periodically report compliance status of EMP and EMoP and monitoring results to environmental / resident relocation plan coordinator
Social Management Officer 1 person	Support for RAP update Implementation of additional stakeholder consultations (explanation of compensation etc.) Implementation of land acquisition process	Monitoring land acquisition process and livelihood recovery plan Periodically report the implementation status of the land acquisition process and livelihood recovery plan to the Environment / Resident relocation plan coordinator
5. Accounting Management		
Accounting Coordinator 1person	Business budget and expenditure management, payment management, compliance, etc.	
Accounting officer 3 person	Cooperation with accounting coordinator, accounting practice	
6. SCADA Management		
SCADA officer 1 person	Adjust the SCADA bidding document and preparation for the bidding process.	Adjust the process leading to the validity of the SCADA contract. Match the coordinate axes on map with the implementation SCADA.
7. Lagos Contract Implementation Coordinator		
Contract Implementation	Coordinate the daily implementation of contracts, coordinates progress meetings and	

Position	Before contractor procurement	Construction phase
Coordinator 1 person	submit regular meeting and progress reports to the PIU and Regional General Managers. Supervise the daily performance of consultancy service recruited to support implementation of projects/contract. Coordinate with Lagos Office that is in charge of the day to day implementation of contracts.	

Source: JICA Study team

(3) TCN-PMU

1) Role of TCN-PMU

The PMU functions as an interface for reviewing the progress of international donor projects and reporting its implementation performance to TCN Management.

2) The assignments of TCN-PMU members

The assignments of TCN-PMU member are described in the following Table 6-15.

Table 6-15 Assignment of PMU members

Position	Assignments
Program Coordinator 1person	The Program Coordinator is responsible for operation and coordination of the whole project in Nigeria. Reports directly to the TCN CEO and Program Committee on implementation status. Review and resolve required specialized needs per personnel allocation and implementation of each PIU in project implementation. Evaluate the performance of PIU's Project Manager. Resolve issues that go beyond PIU administrative authority. Monitoring and evaluation, manage coordinators, audit coordinators, and environmental social coordinators. Reporting and negotiating about project implementation with government ministries including the Ministry of Electric Power and Ministry of Finance.
Coordinator Monitoring and Evaluation（M&E） 1 person	The M & E Coordinator is responsible for ensuring the design and implementation of M & E Frame work. Submit monthly and quarterly M & E report while contacting PIU's Project Manager.
Coordinator Audit 1 person	The audit coordinator shall be responsible for the design and implementation of the project audit scheme. Complete the system of internal control and ensure that compliance with all regulations and guidelines of donors and countries is always observed in project implementation.
Coordinator Environmental and Social Management 1 person	Review and update EMP and EMoP RAP update based on the latest drawing Reflecting environmental and social requirements for Contractor's instruction sheet Confirmation of compliance with environmental permits, EMP and EMoP Creation of monitoring report (environment and resettlement) (once in quarter)

Source: JICA Study team

(4) TCN Management

1) Role of TCN Management

TCN Management is expected to provide general oversight over the implementation of the Projects. TCN Management shall ensure the proper Monitoring and Evaluation of the project are carried out by PIU. TCN Management shall coordinate relationship between the projects and

Ministries of Power, Finance and other relevant Ministries. TCN Management shall ensure audit of the projects, ensure environmental and social management of the projects.

(5) Project Committee

1) Role of Project Committee

Project Committee consists of TCN, Ministry of Electric Power, Ministry of Finance, and other related ministries and agencies. Project Committee does not give instructions to the implementation of the project, but receives a progress report of the project from the TCN-PMU.

(6) Lagos Office

1) Role of Lagos Office

Lagos Office is in charge of the day to day implementation of contracts with PIU Lagos contract implementation coordinator.

(7) Features of the proposed framework for the Project Implementation

The proposed framework reflects the following issues for the project implementation.

- Project implementation is aimed to utilize entire the capacity of TCN.
- TCN Management exercises necessary supervisory and control over donor financed projects.
- PIU will be set up at Abuja for the purpose of practical reporting and monitoring with TCN Management.
- To reflect the regional structure and role of TCN Lagos office to enable contract administration in order to fast track the implementation at Lagos office in Lagos (Lagos office have contract implementation/administration coordinator who will report to the regional general managers and PIU. Also send monthly progress report to the program coordinator at Abuja).

Chapter 7　Environmental and Social Consideration

Chapter 7 Environmental and Social Considerations

7-1 Legal and Regulatory Requirements

7-1-1 Environmental Component

7-1-1-1 Relevant Policies

(1) National Environment Policy

Launched by Government in November 1989, this document prescribed guidelines for achieving sustainable development in fourteen vital sectors of the nation's economy, namely: Human Population; Land Use and Soil Conservation; Water Resources Management; Forestry, Wildlife and Protected Natural Areas; Marine and Coastal Area Resources; Sanitation and Waste Management; Toxic and Hazardous Substances; Mining and Mineral Resources; Agricultural Chemicals; Energy Production; Air Pollution; Noise in the Working Environment; Settlements; Recreational Spaces, Green Belts, Monuments, and Cultural Property.

The project will have effects on biophysical and human environment; as a result it shall comply with the relevant provisions of this policy.

7-1-1-2 Major Laws and regulations

Major laws and regulations relating environment issues are as shown in Table 7-1.

Table 7-1 Major Laws and Regulations relating environment issues

Name of Laws and Regulations	Year
The Environmental Impact Assessment (EIA) Act 2004	2004
The Nigerian Urban and regional Planning Act	1992
Harmful Waste（Special Criminal Provisions）Act	1988
Forest Act	1958
Labour Act	2004
Endangered Species Act	1985

Although under the Constitution of the Federal Republic of Nigeria it is recognized the importance of improving and protecting the environment, comprehensive law for conservation, protection and management of environment was not established and regulations are mostly set up for specific issue in Nigeria.

Among the laws and regulations mentioned above, Forestry Act, 1958 provides for the preservation of forest and the setting up Forest Reserves. In order to cope with this, in addition of acts prohibited in the Forest Reserves, Ministry of Forestry gave caveat that even in the Free Area such as community/natural forests, watersheds or areas close to it, private/individual plantations, roadside trees, home stead trees, felling any tree is required proper permission from the State Government.

Federal Ministry of Environment (FMEnv) is wholly responsible to all the environmental management and planning environmental policy.

7-1-1-3 Environmental Regulation and Management

The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established as para-state organization from the FMEnv in 2007 and is the institution responsible in Nigeria for the elaboration of Environmental Standards and Regulations and its enforcement at country level. Besides, NESREA is to enforce compliance with provisions of international agreements, protocols, conventions and treaties on the environment.

More than 20 kinds of regulations were enacted and among them those related to the project are as follows:

- National Environmental (Permitting and Licensing Systems) Regulations, 2009
- National Environmental (Sanitation and Waste Control) Regulations, 2009
- National Environmental (Surface and Groundwater Quality Control) Regulations, 2011
- National Environmental (Noise Standards and Control) Regulations, 2009
- National Environmental (Wetlands, River Banks and Lake Shores Protection) Regulations, 2009
- National Environmental (Coastal and Marine Area Protection) Regulations, 2011
- National Environmental (Watershed, Hilly, Mountainous and Catchment Areas) Regulations, 2009

7-1-1-4 Environmental Impact Assessment in Nigeria

(1) Outline of EIA regulations

Laws and regulations related to Environmental Impact Assessment in Nigeria are as follows:

Environment Impact Assessment Decree 86, 1992 (EIA Decree)

According to the EIA Decree EIA is mandatory for any major development project likely to have adverse impacts on the environment.

EIA Procedural Guidelines, 1992

It indicates the steps to be followed in the EIA process from the project conception to commissioning. It assists to project proponents in conforming to the requirements of Decree 86, 1992 and to obtain certification from the Federal Government of Nigeria through the FMEnv.

EIA Sectoral Guidelines for Transmission Lines

For major sectors EIA guidelines specific to the sector is established including grid development. According to the sectoral guidelines for transmission line development, in general expected negative impacts are indicated to environmental items such as land acquisition /resettlement and way-leave, landscape, ecological impact including vegetation removal, noise and vibration.

(2) Categorization of the Projects

According to the Decree 86 of 1992 that governs EIA, exists three categories of projects as follows:

Category I for which EIA is mandatory;
Category II for which a partial EIA will be required and,
Category III for which EIA is not required.

Regarding electric power development, following projects are as mandatory activities required EIA study in the EIA Decree (Schedule 13. Power Generation and Transmission):

(a) Construction of steam generated power stations burning fossil fuels and having a capacity of more than 10MW.
(b) Dams and hydroelectric power schemes with either or both of the following.
- dams over 15 meters high and ancillary structures covering a total area in excess of 40 hectares;
- reservoirs with a surface area in excess of 400 hectares;

(c) Construction of combined cycle power stations.
(d) Construction of nuclear-fueled power stations.

However, as for transmission line development there is no clear description of the project, which is required EIA study. Categorization of the project will be determined through screening by FMEnv after submission of the project plan to FMEnv. The proposed project was classified as Category I which require EIA based on the screening by FMEnv.

In addition, according to EIA Procedural Guidelines 1995, the project in the following environmentally sensitive areas is mandatory to obtain EIA approval, but the project area is considered not being the sensitive areas listed below :

S-1 Coral reefs
S-2 Mangrove swamps
S-3 Small islands, S-4 Tropical rainforest
S-5 Areas with erosion prone soils
S-6 Mountain slopes
S-7 Areas prone to desertification (and semi arid zones)
S-8 Natural conservation areas
S-9 Wetland of national or international importance
S-10 Areas with harbor protected and or endangered species
S-11 Areas of unique scenery
S-12 Areas of particular scientific interest
S-13 Areas of history or archeological interest
S-14 Areas of importance to threatened ethnic groups

In case of 58 km 330 kV Qit – Ikot Abasi Transmission Line Project financed by World Bank in 2012, the EIA study report[1] was prepared.

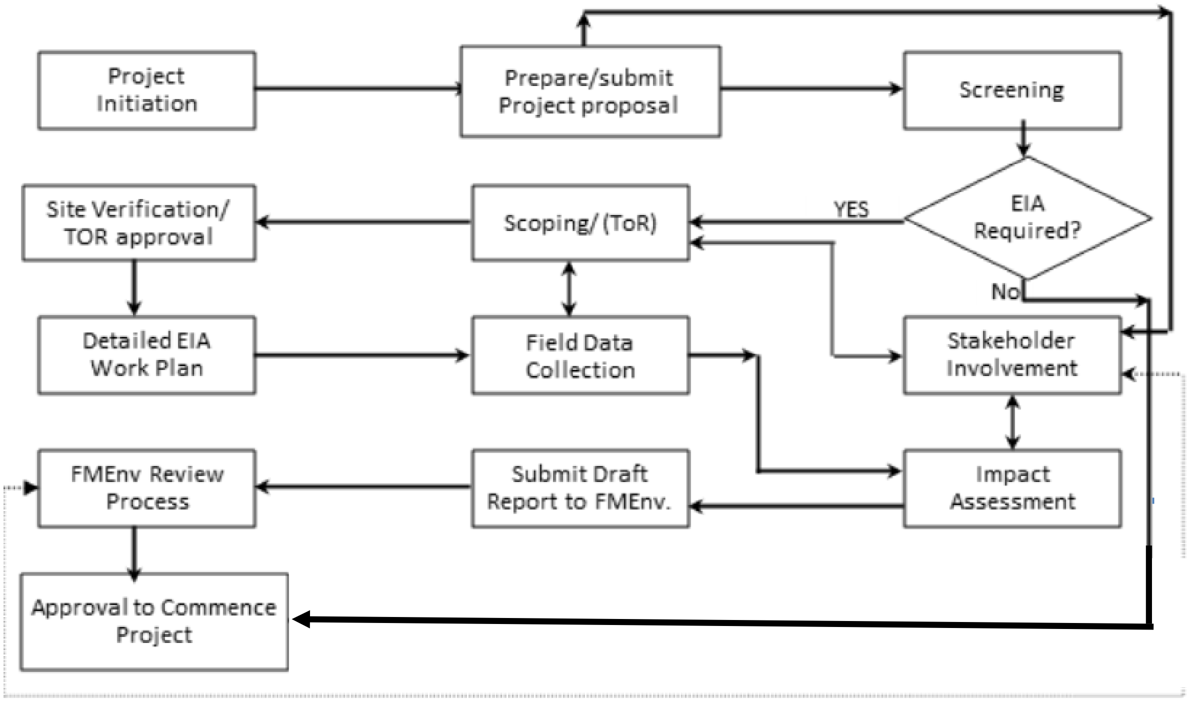
(3) Procedures of EIA Approval

According to the EIA Procedural Guideline (1995) procedures of EIA in Nigeria are shown in Table 7-2 and Figure 7-1

Table 7-2 Procedures of EIA Approval in Nigeria

Procedures		Concerned Organization		
		Proponent//EIA Consultant	Federal ministry of Environment (FMEnv)	Local Government
1	The proponent makes registration to FMEnv by submission of the project plan (brief) and payment of 50,000 Naira.	X		
2	Environmental Assessment Department of FMEnv after the site verification conducts screening by Initial Environmental Examination (IEE) and determines categorization of the project as follows: (a) Category I for which EIA is mandatory; (b) Category II for which a partial EIA will be required and, (c) Category III for which EIA is not required.		X	
3	As a result of the screening, if EIA study is required, the proponent submits provisional environmental scoping and TOR for EIA study to FMEnv.	X		
4	FMEnv gives approval to the proponent after reviewing the scoping and TOR.		X	
5	The proponent selects EIA consultants certified by FMEnv, who can conduct EIA study to meet requirement with TOR.	X		
6	The proponent pays 500,000 Naira to FMEnv and contracts out EIA study to selected EIA consultant.	X		
7	The EIA consultant conducts EIA study.	X		
8	Proponent submits draft EIA report prepared by the EIA consultant to FMEnv.	X		
9	FMEnv reviews draft EIA report.		X	
	(1) In-house Review (Environmental Assessment Department)		X	
	(2) Public Review (21 days display)		X	
	(3) Panel Review (Panelists include experts, local government council, FMEnv)		X	
10	FMEnv furnish the Review Report with some conditions and a Approval to the proponent.		X	
11	The proponent prepares final EIA report.	X		
12	FME provides EIA approval to the proponent.		X	

Source: JICA （2014） “The Project for Review and Update of Nigeria National Water Resources Master Plan”, EIA Procedural Guidelines 1995 and hearing from TCN.



Source: FMEnv

Figure 7-1 The EIA Process of FMEnv.

(4) Information disclosure and stakeholder meetings

In Term of "stakeholder" or "public participation" is not found in the EIA Decree. However, subjects relating public involvement are described from screening process to reviewing draft final report of EIA study for EIA approval in the EIA Decree as follows:.

(a) In general: Article 7 - The Agency (FMEnv) shall give opportunity to government agencies, members of the public, experts in any relevant discipline and interested groups to make comment.

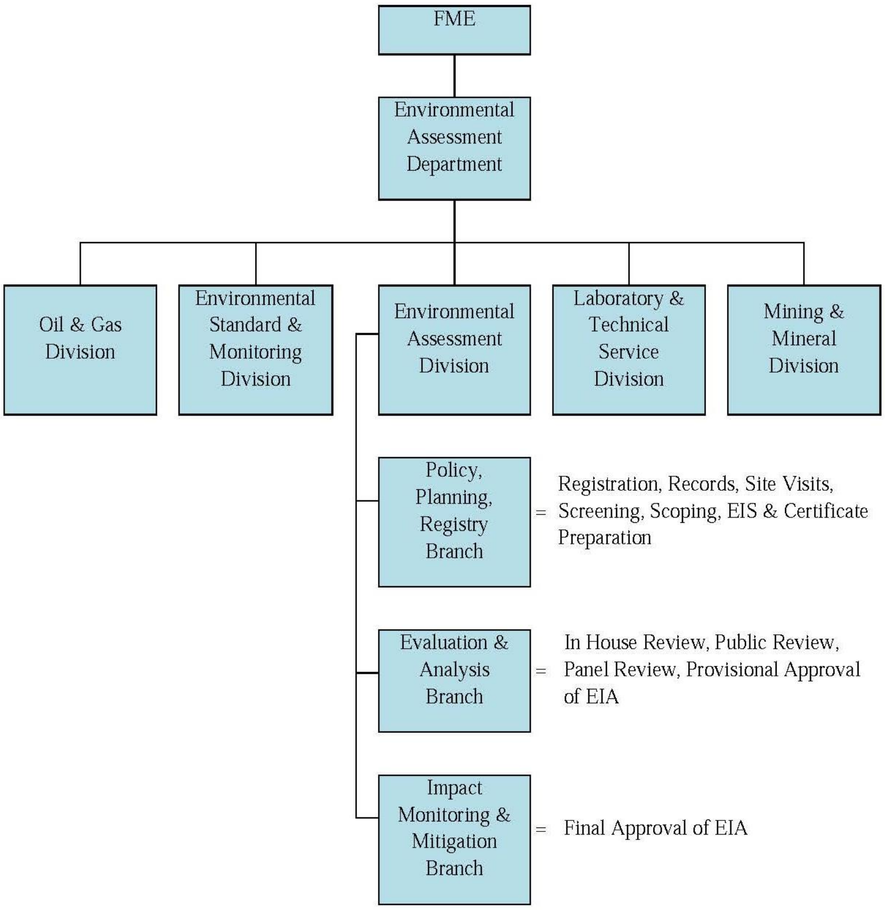
(b) Screening process: Article 17 - Every screening shall include a consideration of comments concerning environmental effects received from the public.

(c) Public hearing: Article 37 - A review panel the review panel shall hold hearing in a manner that offers the public an opportunity to participate in the assessment.

(d) Public comments: Article 25 - After receiving an EIA study report FMEnv shall publish in a notice for filing comments on the conclusions and recommendations of the report. Any person may file comments with the FMEnv relating to the conclusions and recommendations of the EIA study report.

(5) Organization in Charge of EIA

In FMEnv Environmental Assessment Division of Environmental Assessment Department is in charge of EIA issues.



Source: JICA (2014) "The Project for Review and Update of Nigeria National Water Resources Master Plan"

Figure 7-2 Organization Chart of FMEnv

7-1-2 Social Component

7-1-2-1 Relevant Policies

(1) National Land Policy

The legal basis for land acquisition and resettlement in Nigeria is the Land Use Act of 1978, modified in 1990. The act was revised as Cap L5 Laws of the Federation of Nigeria 2004 in 2004. According to the act, all land in Nigeria is vested in the Governor of each State, to be held in trust for the use and common benefit of all people.

The Land Act gives State government (and local government) the right to revoke statutory and customary rights to land for the overriding public interest.

In doing so, the act specifies that the state or local government should pay compensation to the current holder or occupier with equal value.

The need for an integrated approach towards land use planning is highlighted. The coordination of activities of all stakeholders in land use planning is emphasized. In particular, the involvement of land owners, community groups, women, youth and the less privileged in making land use related decisions that affect them is regarded as being critical in the successful implementation of the policy.

The project will involve land take for the line route and the new substation sites. Hence, the process for the land acquisition shall comply with the national land policy.

7-1-2-2 Relevant Laws

(1) Land Use Act

The Land Use Act is the key legislation that has direct relevance to this project. The Land Use Act is the applicable law regarding ownership, transfer, acquisition and all such dealings on Land. As mentioned above, the provisions of the Act vest every parcel of Land in every State of the Federation. At any rate, all land irrespective of the category belongs to the State while individuals only enjoy a right of occupancy as contained in the Certificate of Occupancy (C of O), or where the grants are “deemed”.

The concept of ownership of land as known in the western context is varied by the Act. The Governor administers the land for the common good and benefits of all Nigerians. The law makes it lawful for the Governor to grant statutory rights of occupancy for all purposes; grant easements appurtenant to statutory rights of occupancy and to demand rent. The Statutory Rights of Occupancy are for a definite time (the limit is 99 years) and may be granted subject to the terms of any contract made between the state Governor and the Holder.

The Act may grant customary rights of Occupancy for agricultural (including grazing and ancillary activities), residential and other purposes.

The State is required to establish an administrative system for the revocation of the rights of occupancy, and payment of compensation for the affected parties. So, the Land Use Act provides for the establishment of a Land Use and Allocation Committee in each State that determines disputes as to compensation payable for improvements on the land (Section 2 (2) (c)).

In addition, each Local Government is required to set up a Land Allocation Advisory Committee, to advise the Local Government on matters related to the management of land. Where land subject to customary rights of Occupancy and used for agricultural purposes is revoked under the Land Use Act, the local government can allocate alternative land for the same purposes (section 6) (6). It is noted that a Land Allocation Advisory Committee is not established for a land acquisition of any specific project, but exist in each State as part of internal mechanism for land management and allocation.

Where a right of occupancy is revoked on the ground either that the land is required by the Local, State or Federal Government for public purpose or for the extraction of building materials, the holder and the occupier shall be entitled to compensation for the value at the date of revocation of their unexhausted improvements. Unexhausted improvement has been defined by the Act as:

- Anything of any quality permanently attached to the land directly resulting from the expenditure of capital or labour by any occupier or any person acting on his behalf, and increasing the productive capacity the utility or the amenity thereof and includes buildings plantations of long-lived crops or trees, fencing walls, roads and irrigation or reclamation works, but does not include the result of ordinary cultivation other than growing produce.

Where a right of occupancy is revoked for public purposes within the state of the Federation; or on the ground of requirement of the land for the extraction of building materials, the quantum of compensation shall be as follows:

- In respect of the land, an amount equal to the rent, if any, paid by the occupier during the year in which the right of occupancy was revoked.

- In respect of the building, installation, or improvements therein, for the amount of the replacement cost of the building, installation or improvements to be assessed on the basis of prescribed method of assessment as determined by the appropriate officer less any depreciation, together with interest at the bank rate for delayed payment of compensation. With regards to reclamation works, the quantum of compensation is such cost as may be substantiated by documentary evidence and proof to the satisfaction of the appropriate officer.

- In respect of crops on land, the quantum of compensation is an amount equal to the value as prescribed and determined by the appropriate officer.

This project will require acquisitions of land for the substation sites and ROW for the transmission lines. Hence, will comply with the requirements of this law.

In accordance with the Act, once state government confirm the completion of proper compensation to all PAPs and the result is gazetted to the public, the lands will be entitled to the project owner such as the TCN this time.

7-1-3 JICA Guidelines for Environmental and Social Consideration

The objectives of "JICA Guidelines for Environmental and Social Consideration" (April, 2010) (hereinafter referred as "JICA Guidelines") are to encourage Project proponents etc. to have appropriate consideration for environmental and social impacts, as well as to ensure that JICA's support for and examination of environmental and social considerations are conducted accordingly.

7-1-4 Gap Analysis between JICA Guidelines and Nigerian Laws

7-1-4-1 Gap on Environmental Impact Assessment

Regarding legislative and institutional arrangement for EIA, in general there is no difference in categorization, details of EIA study and EIA report, public participation, and information disclosure between the JICA Guidelines and Nigerian laws and regulations as shown in Table 7-3.

Table 7-3 Gap Analysis between the JICA Guidelines and EIA Legislation in Nigeria

Item	JICA Guidelines	Outline of EIA Legislation in Nigeria	Differences/ Measures
Category	According to the JICA Guidelines, JICA classifies projects into four categories, (A, B, C FI) according to the extent of environmental and social impacts, taking into account an outline of project, scale, site condition, etc (a) Category A: The Projets are likely to have significant adverse impacts on the environment and society. These impacts may affect an area broader than the sites or facilities subject to physical construction. Category A, in principle, includes projects in sensitive sectors, projects that have characteristics that are liable to cause adverse environmental impacts, and projects located in or near sensitive areas. Project Proponents must submit EIA reports for Category A projects to JICA, which will be disclosed prior to JICA's environmental review. And JICA conducts environmental and social surveys at the EIA level for Category A projects and prepares drafts of mitigation measures—including avoidance, minimization, and compensation—as well as drafts of monitoring plans and of institutional arrangements for environmental and social considerations. (b) Category B: The potential adverse impacts of the Projects on the environment and society are less adverse than those of Category A projects. Generally, they are site-specific; few if any are irreversible; and in most cases, normal mitigation measures can be designed more readily. When an EIA procedure has been conducted, the EIA report may be referred to, but this is not a mandatory requirement. JICA undertakes its environmental reviews based on information provided by project proponents etc. and others. Environmental reviews for Category B, at the IEE level. (c) Category C: The Projects are likely to have minimal or little adverse impact on the environment and society. Environmental review will not proceed after categorization. (d) Category FI: JICA's funding of projects is provided to a financial intermediary or executing agency; the selection and appraisal of the sub-projects is substantially undertaken by such an institution only after JICA's approval of the funding, so that the sub-projects cannot be specified prior to JICA's approval of funding (or project appraisal); and those sub-projects are	According to the EIA Decree and EIA Procedural Guidelines 1995, all the proposed projects are classified into three categories considering extent, nature and location of the projects. (a) Category I for which EIA is mandatory; the project is likely to significantly affect the environment (almost same as the category A of JICA Guidelines) (b) Category II for which a partial EIA will be required; the project is likely to not significantly but somewhat affect the environment (almost same as the category B of the JICA Guidelines).and (c) Category III for which EIA is not required; the project is unlikely to affect the environment (almost same as the category C of the JICA Guidelines) In addition, the proposed projects in Sensitive Areas as shown in 3.1.1.3 2) are also classified as category I.	No difference in general

Item	JICA Guidelines	Outline of EIA Legislation in Nigeria	Differences/ Measures
	expected to have a potential impact on the environment. JICA examines the related financial intermediary or executing agency to see whether appropriate environmental and social considerations as stated in the guidelines are ensured for projects in this category. JICA also examines institutional capacity. (2.2 Categorization, JICA GL)		
Screening	JICA conducts screening by classifying proposed projects into four categories: A, B, C, and FI. (2.2 Categorization, JICA GL)	Screening should be conducted by FMEnv. after site survey.	No difference in general
Scoping and preparation of TOR	JICA Guidelines define scoping as choosing alternatives for analysis, a range of significant and potentially significant impacts, and study methods. Items to be addressed in the specific project are narrowed down to the needed ones through the scoping process. (2.3 Impacts to be Assessed, JICA GL)	Proponent should make environmental scoping and TOR for EIA study and submit to FMEnv.	No difference in general
Environmental Items	The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. (3. Scope of Impacts to Be Assessed, Appendix 1 of the JICA GL)	Environmental items, on which impacts due to the project to be identified and evaluated are not described in the EIA Decree. However, items of major negative impacts due to power transmission line project are indicated to such items as land acquisition/resettlement and way-leave, landscape, ecological system, noise and vibration are indicated as major negative impacts due to power transmission line project according to EIA Sectoral Guidelines for Transmission Line.	No difference in general
Contents of EIA report	Illustrative EIA Report for Category A projects are explained in the JICA Guidelines's Appendix 2. (a) Executive summary (b) Policy, legal, and administrative framework (c) Project description (d) Baseline data (e) Environmental impacts	Mentioned in Article 4 of the EIA Decree - An Environmental Impact Assessment shall include at least the following minimum matters: (a) Proposed activities (b)Potential affected environment including specific information necessary to identify	No difference in general

Item	JICA Guidelines	Outline of EIA Legislation in Nigeria	Differences/ Measures
	(f) Analysis of alternatives (g) Environmental Management Plan (h) Consultation (Illustrative EIA Report, Appendix 2 of the JICA GL)	and assess the environmental effects of the proposed activities (c) Practical activities, as appropriate (d)An assessment of the likely or potential environmental impacts on the proposed activity and the alternatives, including the direct or indirect cumulative, short-term and long-term effects (e) An identification and description of measures available to mitigate adverse environmental impacts of proposed activity and assessment of those measures (f)An indication of gaps in knowledge and uncertainly which may be encountered in computing the required information (g)An indication of whether the environment of any other State, Local Government Area or areas outside Nigeria is likely to be affected by the proposed activity or its alternatives (h)A brief and non-technical summary of the information provided under paragraph (a) to (g).	
Environmental Management Plan (EMP) and Environmental Monitoring Plan	(a) Appropriate follow-up plans and systems, such as monitoring plans and environmental management plans, must be prepared; the costs of implementing such plans and systems, and the financial methods to fund such costs, must be determined. Plans for projects with particularly large potential adverse impacts must be accompanied by detailed environmental management plans. (2. Examination of Measures, Appendix 1 of the JICA GL) (b) In cases where sufficient monitoring is deemed essential for appropriate environmental and social considerations, such as projects for which mitigation measures should be implemented while monitoring their effectiveness, project proponents etc. must ensure that project plans include feasible monitoring plans (8. Monitoring, Appendix 1 of the JICA GL) (c) Environmental Management Plan describes mitigation, monitoring, and institutional measures to be taken during construction and operation in order to eliminate adverse impacts, offset them, or reduce them to acceptable levels. (Illustrative EIA Report, Appendix 2 of the JICA GL)	Although the term of "environmental management plan" is not found in the EIA Decree, it is used in the EIA Sectoral Guidelines (Transmission Line). Although the term of "environmental monitoring" is not found in the EIA Decree, the term of "follow-up program" is used as follows: (a) Article 16 - the design and implementation of a follow-up program, (b) Article 17 –mandatory study must include a discussion of the need for and the requirements of any follow-up program.	No difference in general

Item	JICA Guidelines	Outline of EIA Legislation in Nigeria	Differences/ Measures
Information disclosure and public participation	Information disclosure (a) EIA reports (which may be referred to differently in different systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them; (b) EIA reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA reports are required to be available at all times for perusal by project stakeholders such as local residents and copying must be permitted; (Preambles, Appendix 2 of the JICA GL) Public participation (a) Projects must be adequately coordinated so that they are accepted in a manner that is socially appropriate to the country and locality in which they are planned. For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plans. (5. Social Acceptability (1), Appendix 1 of the JICA GL) (b) In preparing EIA reports, consultations with stakeholders, such as local residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared; (c) Consultations with relevant stakeholders, such as local residents, should take place if necessary throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared (Preambles, Appendix 2 of the JICA GL)	Term of “stakeholder” or “public participation” is not found in the EIA Decree. However, subjects relating to public involvement are described from screening process to reviewing draft final report of EIA study for EIA approval in the EIA Decree. In general: Article 7 - FMEnv shall give opportunity to government agencies, members of the public, experts in any relevant discipline and interested groups to make comment. (b) Screening process. (c) Public hearing. (d) Public comments.	No difference in general

Item	JICA Guidelines	Outline of EIA Legislation in Nigeria	Differences/ Measures
Comparison of alternatives	Analysis of alternatives systematically compares feasible alternatives to the proposed project site, technology, design, and operation including the “without project” situation in terms of the following: the potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. For each of the alternatives, it quantifies the environmental impacts to the extent possible, and attaches economic values where feasible. It also states the basis for selecting the particular proposed project design, and offers justification for recommended emission levels and approaches to pollution prevention and abatement. (Illustrative EIA Report, Appendix 2 of the JICA GL)	Mentioned in the EIA Decree. For example: (a) Article 4 - an EIA shall include an assessment of the likely or potential environmental impacts on the proposed activity and the alternatives, including the direct or indirect cumulative, short-term and tong-term effects. (b) Article 17 - every mandatory study of a project by review panel shall include a consideration of alternative means of carrying out the project.	No difference in general But, there is no clear description about the comparison against “Do Nothing Option”, therefore, this comparison shall be carried out in this study

Source: EIA Decree、EIA Procedural Guidelines 1995、e-Law Environmental Law Alliance Worldwide, "EIA Country Report for Nigeria"（URL:http://eialaws.elaw.org/eialaw/nigeria）

7-1-4-2 Gap on Land Acquisition

Table 7-4 Gap Analysis between the JICA Guidelines/WB OP 4.12 and Land Use Act

Item	JICA Guidelines/WB OP4.12	Land Use Act	Gaps	Recommended Policies
Avoidance or minimization of involuntary resettlement.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible effective measures to minimize impact and to compensate for losses must be agreed upon with people who will be affected. (JICA Guidelines)	Not mentioned	The local law does not have policy to avoid or minimize land acquisition and involuntary resettlement.	During implementation EIA, all alternatives will be explored, impacts of land acquisition and resettlement will be avoided, or if avoidance is not feasible, will be minimized.
Level of livelihood restoration of PAPs	Project owning countries must make efforts to enable PAPs and to improve their standard of living, income opportunities, and production levels, or at least to restore these to pre-project levels. (JICA Guidelines)	Not mentioned	The local law does not indicate target level of livelihood restoration of PAPs.	Abiding the WB policies and JICA Guidelines, livelihood levels of PAPs will be monitored before and after resettlement in order to confirm their restoration or improvement. Also PAPs will be financially/technically supported to recover livelihood levels.
Calculation of compensation	PAPs must be compensated at full replacement cost as much as possible. (JICA Guidelines)	Compensation is at market price. Normally, depreciation will be deducted.	Market price with deduction of depreciation will be less than full replacement cost.	There is no article prohibiting not deducting depreciation, nor adding necessary costs (e.g. administrative fees), hence compensation should be calculated at full replacement cost.
Commencement of relocation	Physical resettlement should not take place before providing land and monetary compensation and other supports. (JICA Guidelines)	The timing is not clearly mentioned (Article 6 (7) "within a reasonable time")	There is no clear description to indicate the timing of payment of compensation and commencement of resettlement.	Abiding the WB policies and JICA Guidelines, payment of compensation should be completed and any other assistances should be provided prior to the commencement of physical resettlement
Preparation and disclosure of RAP	In case of large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA Guidelines)	Not mentioned	The local law does not provide disclosure of documents corresponding to RAPs.	Abiding the WB policies and JICA Guidelines, a RAP will be prepared. It will be disclosed in an appropriate language and placed where accessible by PAPs and local NGOs (e.g. Local Government Offices, etc.).

Item	JICA Guidelines/WB OP4.12	Land Use Act	Gaps	Recommended Policies
Stakeholder meeting	Consultations must be held with the PAPs and their communities. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the PAPs. (JICA Guidelines)	Not mentioned	The local law does not provide consultation with PAPs for land acquisition and resettlement.	The land acquisition process practiced by TCN includes stakeholder consultation. The methods will be confirmed to abide the WB policies and JICA Guidelines.
Participation of PAPs	Appropriate participation by PAPs and their communities must be prompted in the planning, implementation, and monitoring of RAPs. (JICA Guidelines)	Not mentioned	The local law does not provide participation of PAPs in the process of land acquisition and resettlement.	Abiding the WB policies and JICA Guidelines, during the preparation of a RAP, participation of PAPs will be promoted through consultations and socioeconomic survey, and appropriate methods of their participation during implementation and monitoring will be examined.
Grievance redress	Appropriate and accessible grievance mechanisms must be established for PAPs and their communities. (JICA Guidelines)	Grievance redress is not mentioned, but State Land Use and Allocation Committee will accept dispute and if not settled, the matter may be taken to courts.	The local law does not provide establishment of grievance mechanism regarding land acquisition and resettlement.	Abiding the WB policies and JICA Guidelines, grievance committee will be established and informed to PAPs.
PAPs without legal titles	By WB OP4.12, the definition of eligible DPs for resettlement entitlements includes: "those who do not have formal legal rights to land at the time the census begins but have a claim to such land or assets…;and Those who have no recognizable legal right or claim to the land they are occupying."(WB OP4.12)	Not mentioned	The local law does not provide policies for PAPs without legal entitlement.	Since there is no provision to prohibit assisting or compensating nontitle holders, abiding the WB policies and JICA Guidelines, the nontitle holders are also eligible to be supported or compensated.
Vulnerable groups	Particular attention is paid to the needs of vulnerable groups among those displaced, especially those below the poverty line, the landless, the elderly, women and children, etc.. (WB OP4.12)	Not mentioned	The local law does not provide considerations for vulnerable groups among PAPs.	Abiding the WB policies and JICA Guidelines, if there are vulnerable groups among PAPs, considerations appropriate for each group will be made.

7-2 Analysis of Alternatives

7-2-1 Study area

The project area is located in Lagos and Ogun State. The entire project consists of about 203km high voltage transmission lines and 6 high voltage substations. For the purpose of Environmental and Social Consideration and preparation of Resettlement Action Plan, the entire project is divided into 3 sections, Lot 1, Lot 2 and Lot3 as shown in below Figure 7-3 and Figure 7-4. It should be noted that these 3 Lots are different from 4 Lots of the project component mentioned in previous chapters.

(1) Lot 1 :

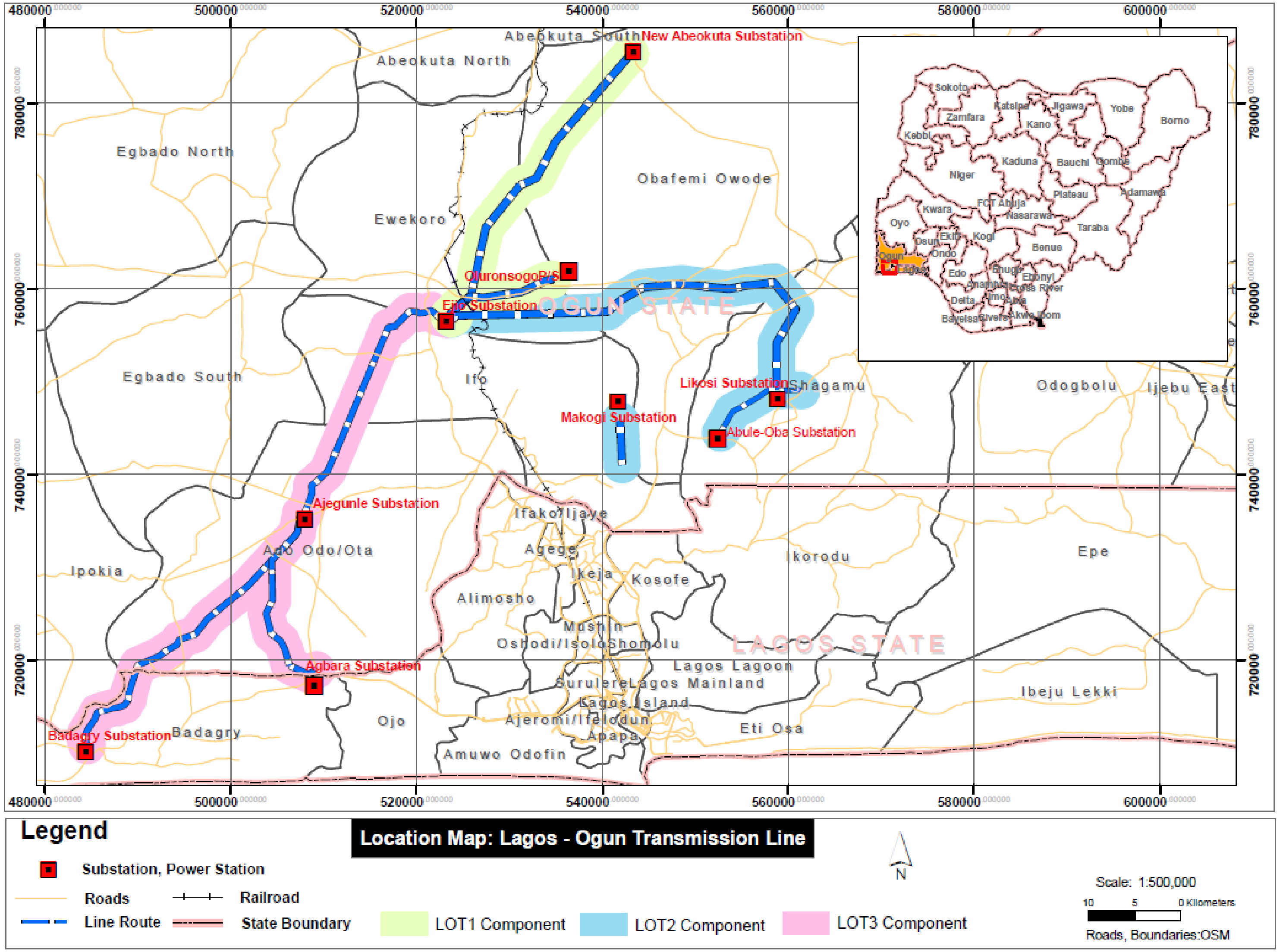
- Ejio (Arigbajo) – New Abeokuta 132kV D/C Transmission Line (AJ-BA) (35.5km).
- Olorunsogo – Ejio (Arigbajo) 330kV D/C Transmission Line (EJ-OL) (12.5km).
- Ejio (Arigbajo) – Ikeja West /Osogbo 330kV D/C Turn in-out (EJ-NA) (7.34km) at Sojuolu.

(2) Lot 2 :

- Likosi (Ogijo) Substation
- Abule Oba (Redeem) Substation
- Makogi (MFM) Substation
- Likosi (Ogijo) – Ejio (Arigbajo) D/C Transmission Line (EJ-LI) (48.8 km)
- Likosi (Ogijo) – Existing Ikorodu/Shagamu 132 kV 2x D/C Transmission Line (LI-(IK-SH)) (132kV Quad Line)(2.41 km)
- 132kV D/C Transmission Line from Likosi (Ogijo) – Makogi (MFM) (MA-(IK-LI)) (7.78 km)
- Makogi (MFM) – Egbin/Ikeja West 330kV 2 x D/C Transmission Line(MA-(IK-LI)) (4.2 km)

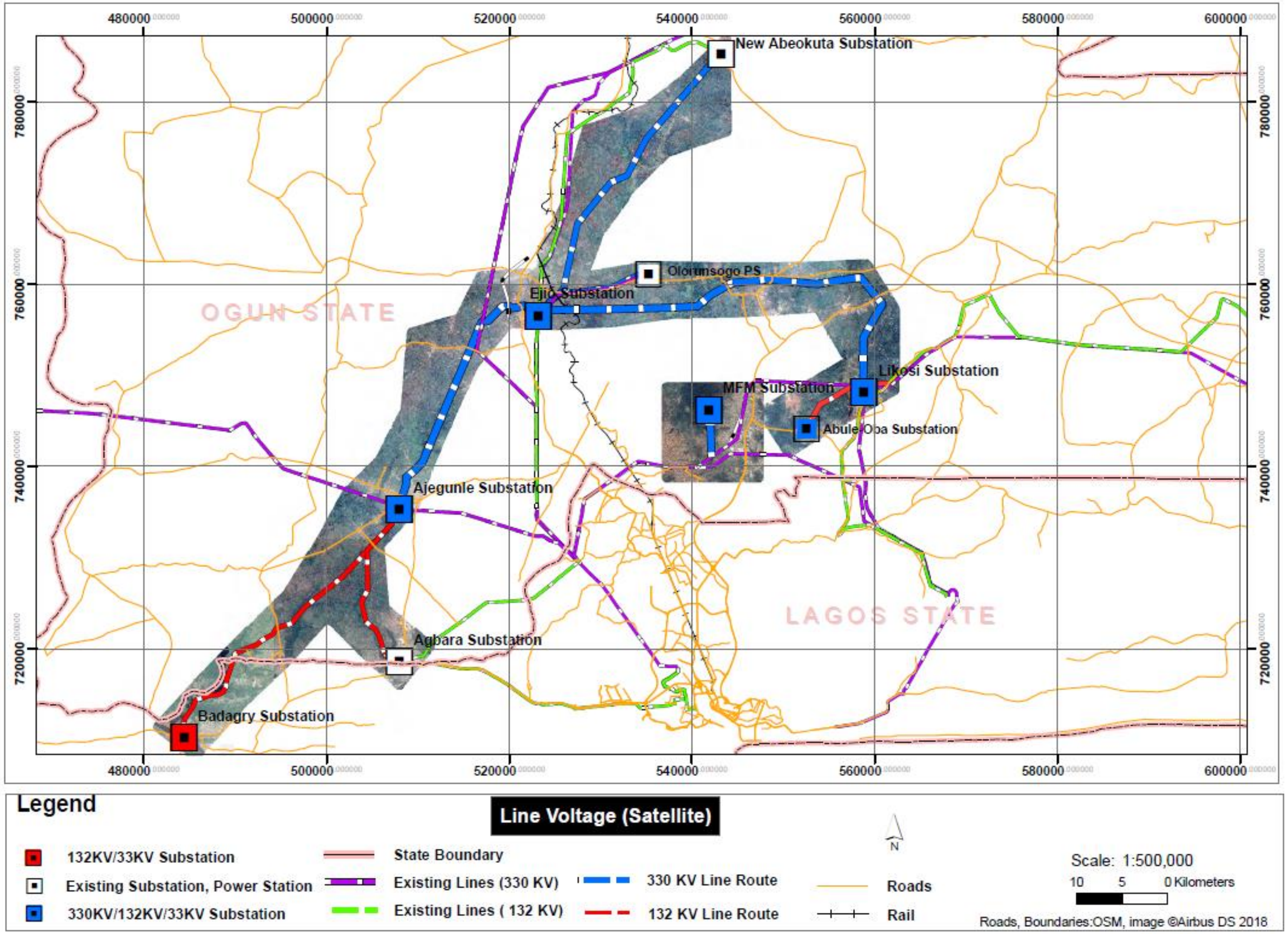
(3) Lot 3:

- Ejio (Arigbajo) to Ajegunle (New Agbara) 330kV D/C Transmission (EJ-NA)(29.6 km)
- Ajegunle (New Agbara) to Agbara 132kV D/C Transmission Line (AJ-AG) (21.7 km)
- Ajegunle (New Agbara) to Badagry 132kV D/C Transmission Line (AJ-BA) (36.2 km)
- New substation at Ejio (Arigbajo) (2x150MVA, 330/132kV + 2x60MVA 132/33kV)
- New substation at Ajegunle (New Agbara) (2x150MVA, 330/132kV + 2x60MVA 132/33kV)
- New substation at Badagry (2x60MVA, 132/33kV).
- Temporary Access road around Badagry area (approximately 16km)



Source: JICA study team

Figure 7-3 Project Area and Project Component



Source: JICA study team

Figure 7-4 Project Area and Project Component

7-2-2 Project Options

7-2-2-1 Do-Nothing' Option

The first project option considered was the 'do-nothing' option. This option will not require land acquisitions, physical resettlement and forest cutting, but would result in the continuation of shortage of electricity supply, which has also been inefficient, inadequate, and unreliable. In case that transmission line won't be constructed in this project, the use of domestic and industrial generators to power homes, offices and industries will escalate. This will result in increased air emissions, which have corresponding health impacts and may exacerbate global warming due to increased greenhouse gas emissions. Furthermore, economic growth will be stifled. Therefore, this option was not recommended.

7-2-2-2 Project Implementation Option

The second option considered was the execution of the proposed project as planned. This option was accepted because it will de-bottleneck the grid around the largest demand centre along Lagos- Ibadan Expressway. The project will provide a more secure and reliable energy supply with all the benefits listed as below;

- Improved and more reliable electric power supply;
- Enhances productivity and efficiency in both public and private organizations;
- It helps to develop and promote small, medium, and large-scale enterprises thereby creating direct and indirect employment opportunities;
- It helps to improve the security of lives and properties;
- General contribution to climate change through overall reduction of the used of personal power generating sets; and
- General improvement of the standard of living for the populace.

7-2-3 Site & Line Route Alternatives

The general characteristics of the line route considered are:

- length, to minimize cost and the impact on the environment,
- rectilinear, to minimize the angles and the footprint,
- accessible, near roads, to facilitate maintenance,
- surrounding towns and villages, to facilitate electrification, and
- bypassing towns and villages, to minimize the demolition of built structures and relocation of populations.

The factors to avoid are:

- exclusion zones of airports and airfields
- soils with low load-bearing capacity, thus, far from wetlands and floodplains
- hills and ridges
- protected areas, forest reserves, classified forests, Ramsar sites and other sites, which aim to protect natural areas and species
- physical cultural resources (PCR), archaeological, paleontological, historical, architectural, religious (including graveyards and burial sites) and aesthetic or other cultural significance.

7-2-3-1 Analysis of line route alternatives

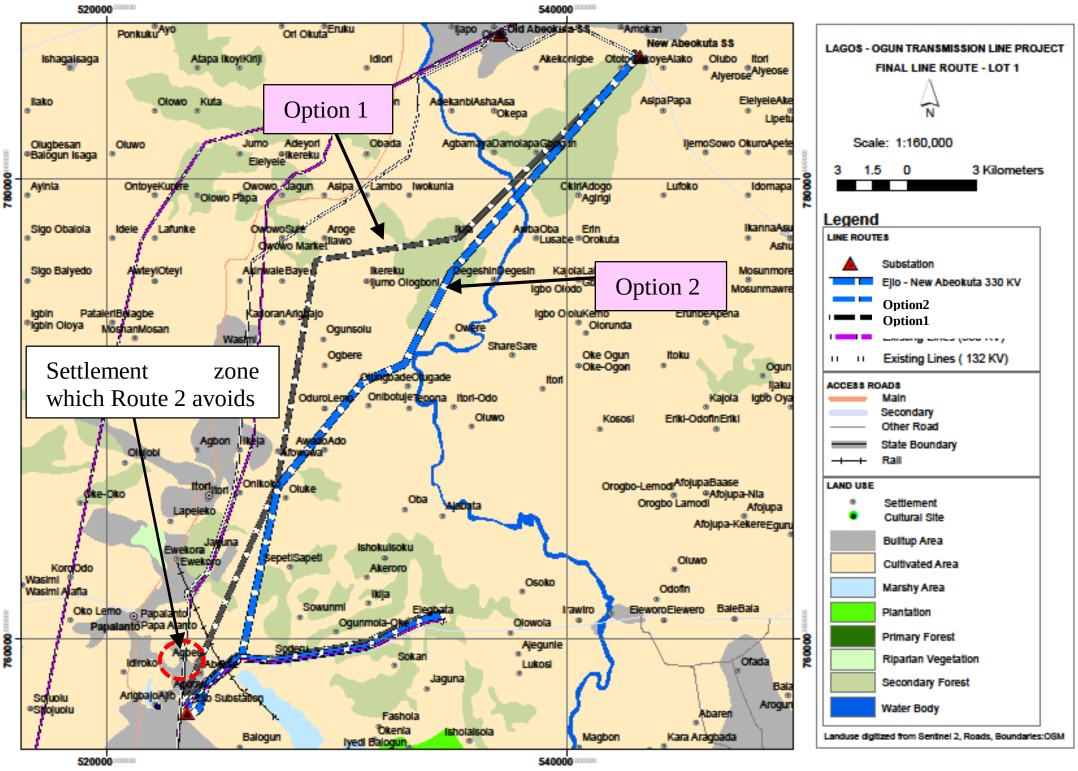
Route alternative analysis was carried out for each section and summary of the result is shown as below.

A. Lot 1 Section

Section of route analysis	
Starting Point	Ejio Substation
Ending Point	New Abeokuta Substation

Table 7-5 Line route alternative analysis: Ejio S/S – New Abeokuta S/S

The route		Option 1	Option 2
Description		The route avoids the river and runs along the existing road.	The route is shorter than JICA options because it maintained a straight line towards Abeokuta, it bypassed all built up areas.
Distance (km)		37.5	35.15
Social Aspect	Number of Buildings in Way Leave (Estimated)	50	4
Natural Aspect	Access Road	Some existing roads, including the main road, are present by substations, but construction of access roads may be necessary in some areas.	Require construction of access roads in some areas, Existing road are present but less than proposed JICA option
	Land Use	Farmlands, vegetation, small settlements	Farmlands, vegetation, small settlements
	Impacts on Natural Environment	Some vegetation needs to be cleared	Some vegetation needs to be cleared but reduced environmental impact compared to JICA proposed route
Geographical Conditions (Topography, ground stability, etc.)		None in particular	Few Marshy areas along the line. Foundation design and access road strengthening in this areas.
Natural Disaster Risk		None	None
Technical Aspect		No difference	Easier due to few Marshy areas.
Cost		More expensive due to longer distance	Cheaper due to shorter distance
Recommended Route		△	○ Recommended since the social impact is less and cost is cheaper



Source: JICA study team

Figure 7-5 Line route alternative analysis: Ejio S/S – New Abeokuta S/S

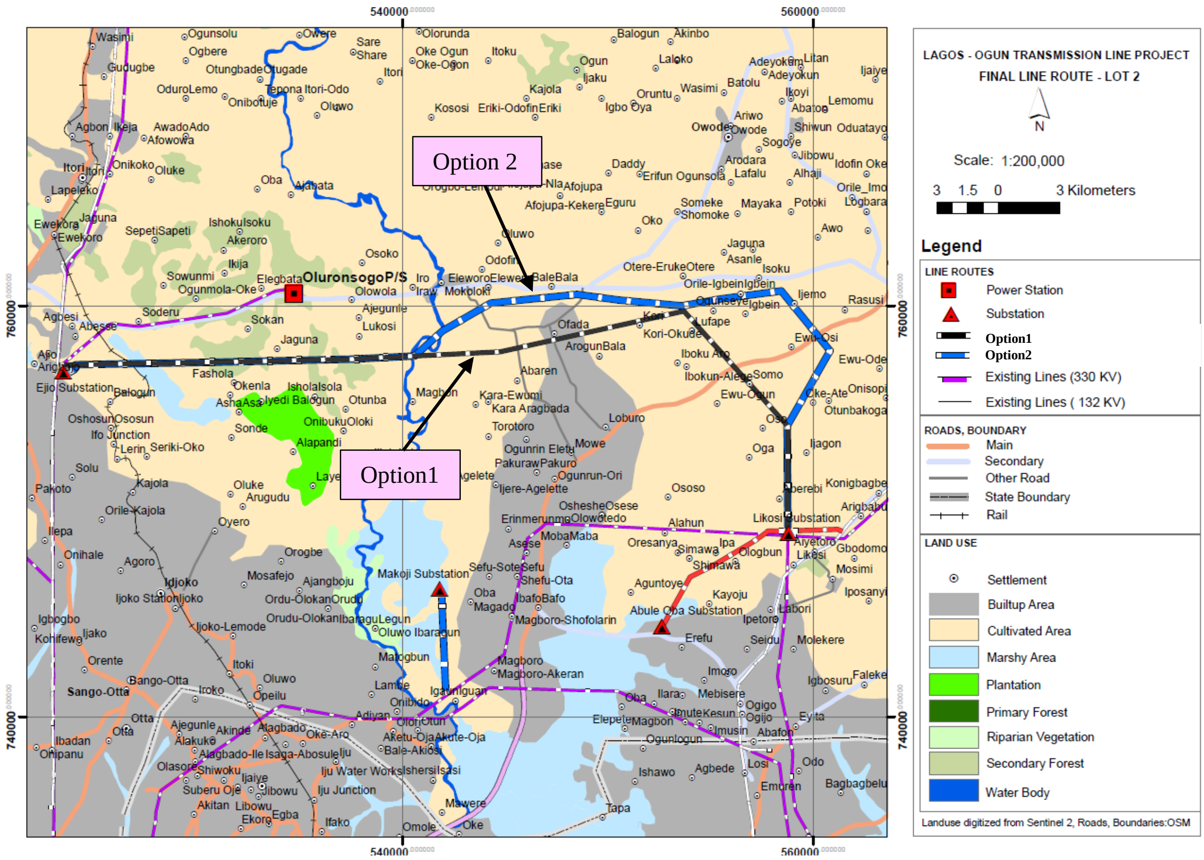
B. Lot 2 Section

Section of route analysis	
Starting Point	Ejio Substation
Ending Point	Likosi Substation

Table 7-6 Line route alternative analysis: Ejio S/S – Likosi S/S

The route		Option 1	Option 2
Description		To reduce and avoid impact by land acquisition, it avoids settlements and built-up areas	It avoids crossing an existing Ejio-Olorunsogo 330KV line. It avoids build-up areas and settlement to minimize land acquisition. It avoids Ofada town, OPIC residential/ industrial estate and crosses Lagos-Ibadan expressway into Likosi/Dejuwogbo substation where there are minimal built-up areas.
Distance (km)		43.7	48.74
Social Aspect	Number of Buildings in Way Leave (Estimated)	>400	355 This routes avoids build-up areas and settlement to minimize land acquisition.
Natural Aspect	Access Road	Some existing roads are present but upgrading of existing access roads may be necessary in some areas.	Some existing roads are present but upgrading of existing access roads may be necessary in some areas.

The route		Option 1	Option 2
	Land Use	Farmlands, vegetation, settlements, river, swampy forest	Farmlands, vegetation, settlements, river, swampy forest
	Impacts on Natural Environment	Some vegetation needs to be cleared. No difference from the other route.	Some vegetation needs to be cleared. No difference from the other route.
Geographical Conditions (Topography, ground stability, etc.)		None in particular	None in particular
Natural Disaster Risk		None	None
Technical Aspect		No difference	No difference
Cost		Cheaper due to shorter distance	More expensive due to longer distance
Recommended Route		△	○ Recommended since this route avoids build-up areas and settlement to minimize land acquisition.



Source: JICA study team

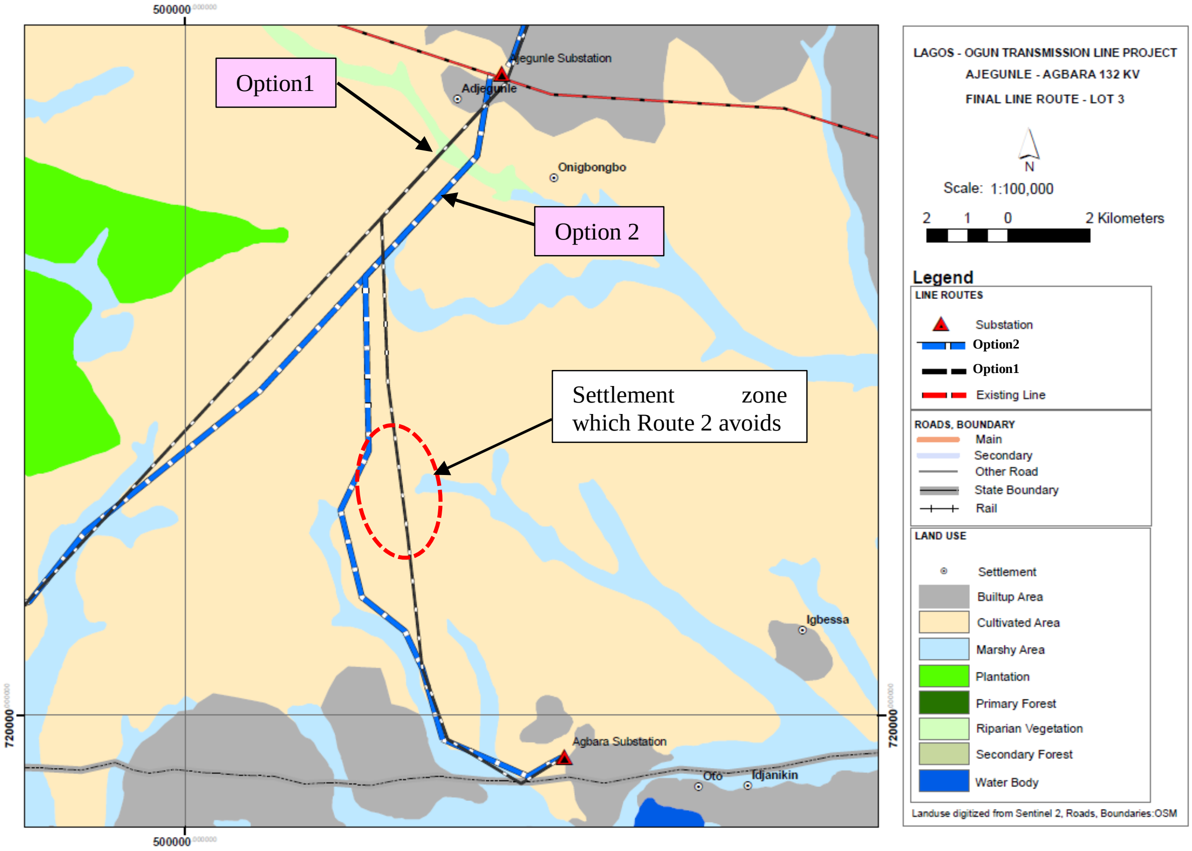
Figure 7-6 Line route alternative analysis: Ejio S/S – Likosi S/S

C. Lot 3 Section

Section of route analysis	
Starting Point	Ajegunle Substation
Ending Point	Agbara Substation

Table 7-7 Line route alternative analysis: Ajegunle S/S – Agbara S/S

		Option 1	Option 2
Description		Most straight route with the lowest construction cost	It avoids build-up areas and settlement to minimize land acquisition.
Distance (km)		20.8	21.6
Social Aspect	Number of Buildings in Way Leave (Estimated)	400	300 (Out of which, 80 is within the shared Way Leave)
Natural Aspect	Access Road	No difference	No difference
	Land Use	Built-up areas along the expressway, farmlands, vegetation	Less built-up areas, farmlands, and vegetation.
	Impacts on Natural Environment	Some vegetation needs to be cleared. No difference from the other routes.	Some vegetation needs to be cleared. No difference from the other routes.
Geographical Conditions (Topography, ground stability, etc.)		No difference	No difference
Natural Disaster Risk		No difference	No difference
Technical Aspect		No difference	No difference
Cost		Cheaper due to shorter distance	More expensive due to longer distance
Recommended Route		△	○ Recommended since this route avoids build-up areas and settlement to minimize land acquisition.



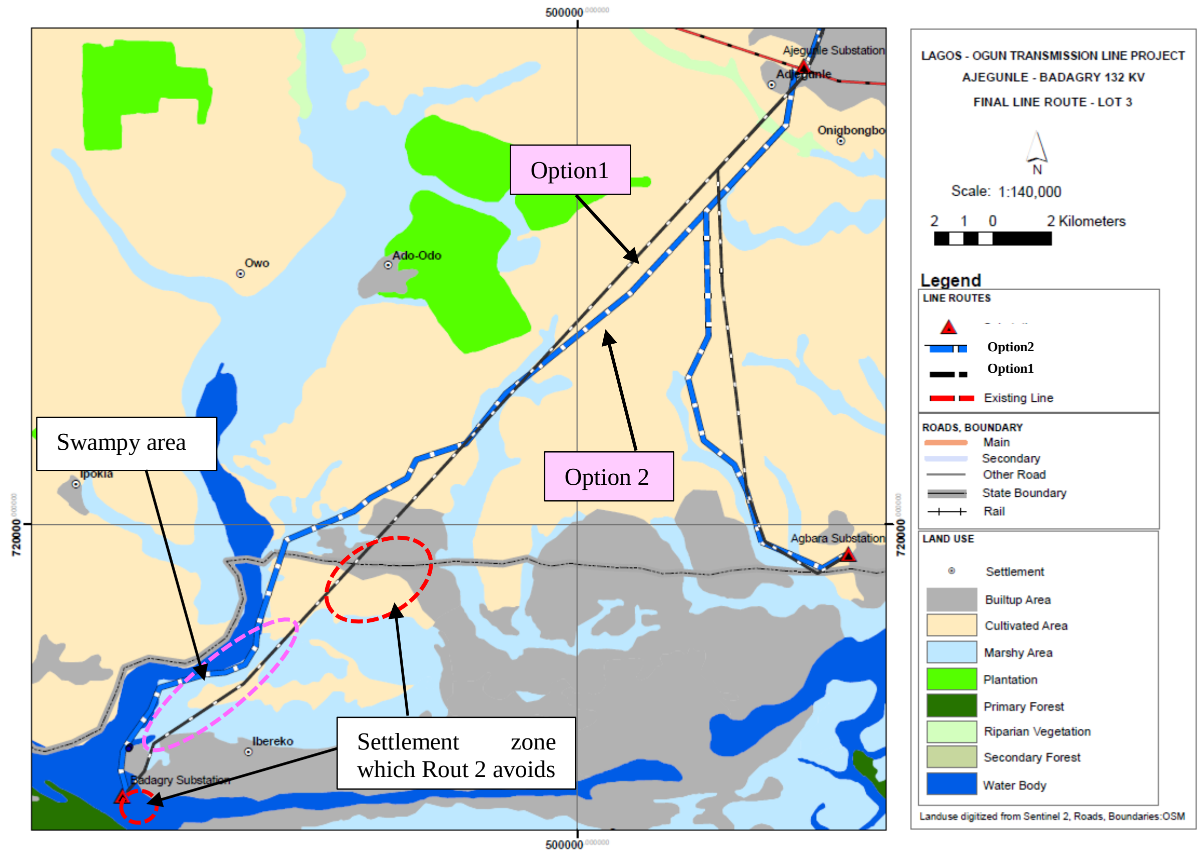
Source: JICA study team

Figure 7-7 Line route alternative analysis: Ajegunle S/S – Agbara S/S

Section of route analysis	
Starting Point	Ajegunle Substation
Ending Point	Badagry Substation

Table 7-8 Line route alternative analysis: Ajegunle S/S – Badagry S/S

		Option 1	Option 2
Description		Most straight route with the lowest construction cost	It avoids build-up areas and settlement to minimize land acquisition. In addition, it avoids forest area.
Distance (km)		34.2	36
Social Aspect	Number of Buildings in Way Leave (Estimated)	250	120
Natural Aspect	Access Road	Many existing roads are present along the route and Construction of access roads is unnecessary most likely.	Although existing roads are present along the route, construction of access roads may be necessary in few areas, mostly towards the Badagry substation
	Land Use	Built-up areas along the expressway, farmlands, vegetation	Few builtup areas, farmlands, and vegetation.
	Impacts on Natural Environment	Some vegetation needs to be cleared.	Some vegetation needs to be cleared. Less forest area is impacted.
Geographical Conditions (Topography, ground stability, etc.)		None in particular	The route cross more swampy area
Natural Disaster Risk		There is a risk for flood impact but less than route 2.	There is more risk for flood impact compare to route 1 since the route is closer to the river
Technical Aspect		Pile foundation may be necessary for few towers on swampy area.	Pile foundation may be necessary for few towers on swampy area. More pile foundations may be required compared to route1.
Cost		Cheaper	The construction cost is higher since the route is longer as well as the more pile foundations (which is more expensive than standard one) would be required.
Recommended Route		△	○ Recommended since this route avoids build-up areas and settlement to minimize land acquisition although the construction cost would be higher.



Source: JICA study team

Figure 7-8 Line route alternative analysis: Ajegunle S/S – Badagry S/S

7-2-3-2 Analysis of location of substation

A. Ajegunle (New Agbara) Substation

The location of Ajegunle (New Agbara) Substation had been decided by TCN and survey was conducted in 2013. The location was selected because a new substation was needed to be constructed along the existing transmission line. TCN conducted preliminary site selection study and selected the area where less residential structures are located to minimize social impact.

B. Badagry Substation

Badagry Substation was planned to be constructed around the current location in order to supply stable electricity to the western Lagos area. TCN requested Lagos State to provide a land for the Substation. At the beginning of the planning stage, Lagos State allocated the land from state owned land at the location shown in Figure 7-9, however through verification process by Lagos state, a community land was identified within the land. To minimize social impacts to the community land, another alternative land was proposed.

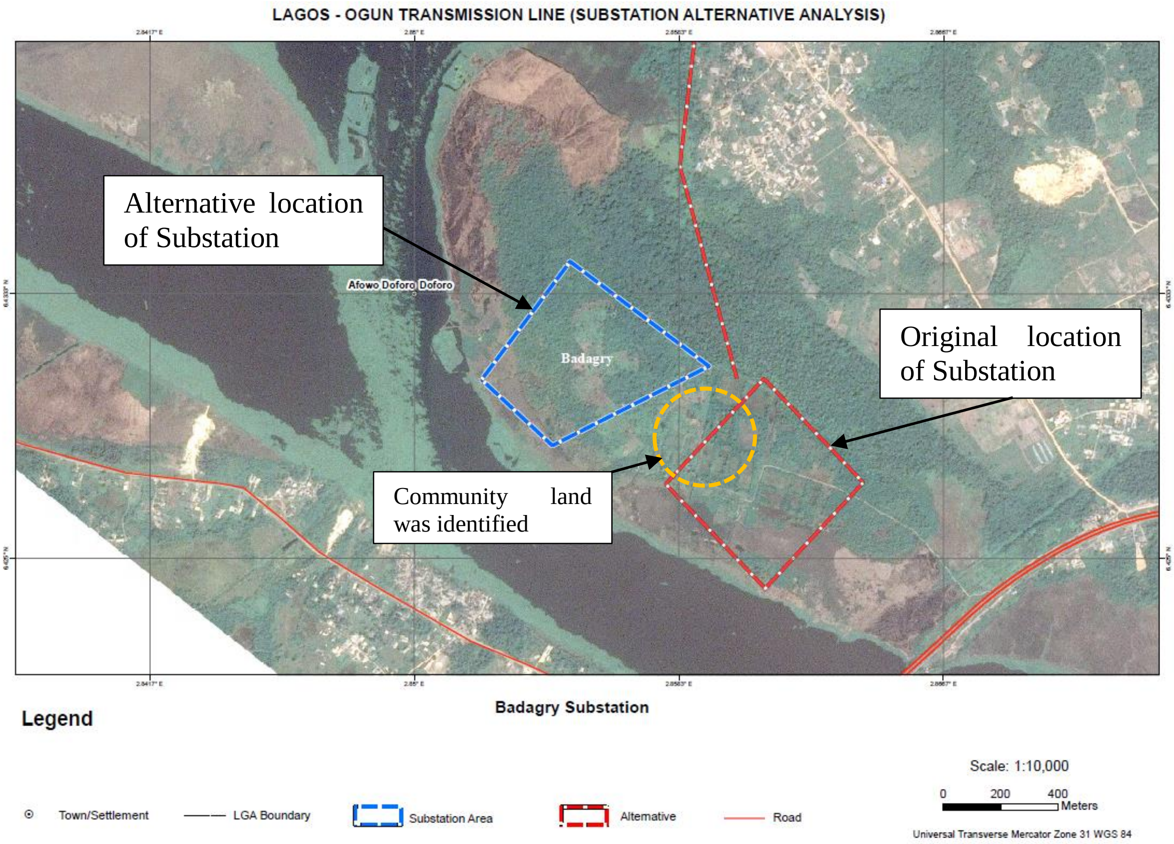


Figure 7-9 Substation alternative analysis: Badagry Substation

C. Ejio (Arigbajo) Substation

The location of Ejio (Arigbajo) Substation had been decided by TCN by 2013. The location was selected because a new substation was needed to be constructed at the crossing point of two existing transmission lines. Around the two transmission line crossing point, TCN selected the area where less residential structures are located to minimize social impact.

D. Likosi (Ogijo) Substation

The location of Likosi (Ogijo) Substation was acquired by TCN in 2008 and obtained Certificate of Occupancy of the land. The location was selected because a new substation was needed to be constructed at the crossing point of two existing transmission lines.

E. Abule Oba (Redeem) Substation

Abule Oba (Redeem) Substation was planned to construct around the current area in order to supply stable electricity to the area including the religious society (Redeem) approximately 10 years ago. Originally the substation was planned to be constructed at the south-western portion of the land owned by the Redeem. Through the consultation meetings with the Redeem in 2017, TCN was informed that a new auditorium construction was planned at the centre of the Redeem's land. To avoid impacts by transmission line including tower construction over the auditorium, alternative substation land was selected at South-eastern portion of Redeem's land as shown in Figure 7-10.

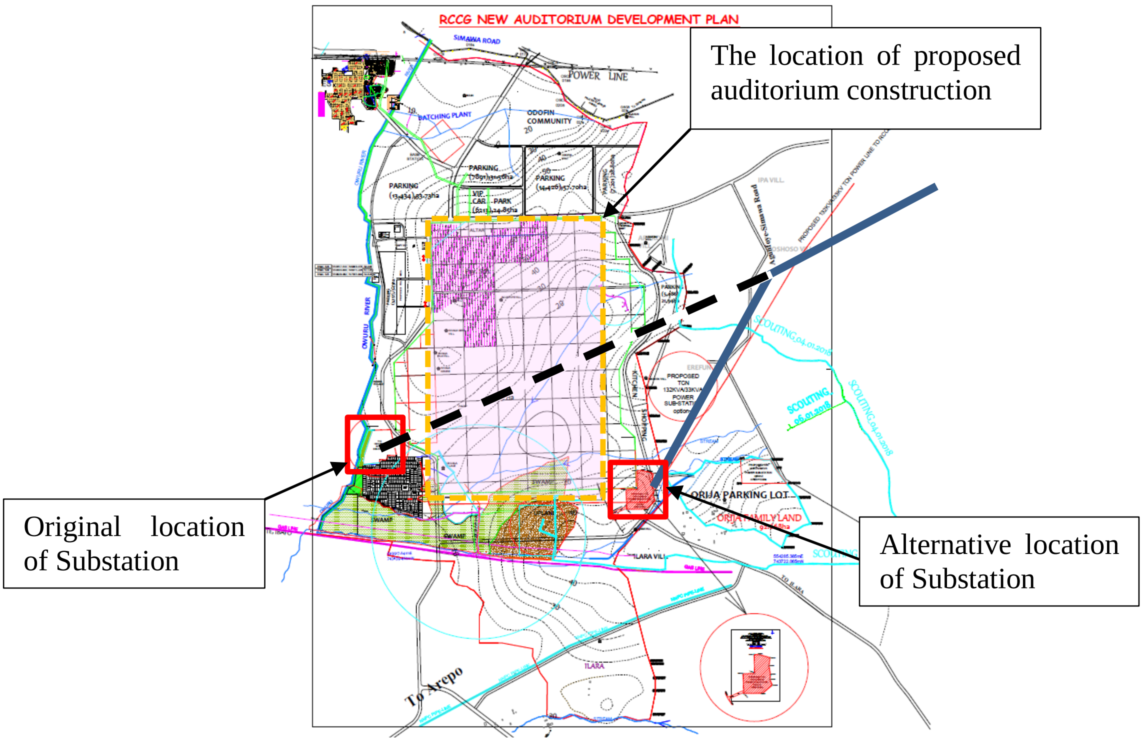


Figure 7-10 Substation alternative analysis: Abule Oba (Redeem) Substation

F. Makogi (MFM) Substation

Makogi (MFM) Substation was planned to construct around the current area in 2013 in order to supply stable electricity to the area including the religious group. Originally the substation was planned to be constructed near residential area as shown in Figure 7-11. Through the consultation meetings with the religious group, miracle fire mountain (MFM), in 2017, TCN was informed that a new university construction was planned around the originally proposed location. To avoid impacts by the new substation construction to university and residential area, TCN selected the alternative location far enough from residential area. During the alternative analysis, flood risk was also assessed. The elevation of the area between original location and alternative location is lower than the surrounding area, and the land is tend to be wet. The alternative location located at comparatively higher elevation, which is dry land, was selected to avoid the flood risk.

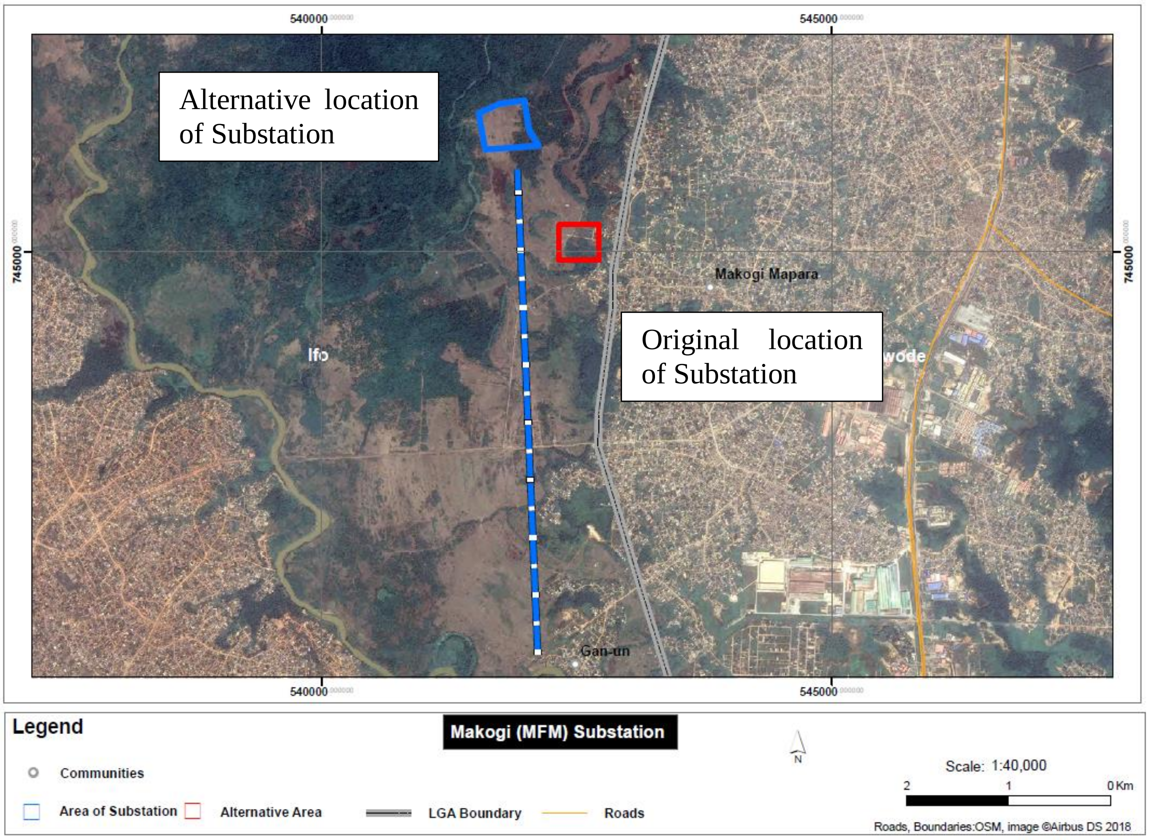


Figure 7-11 Line route alternative analysis: Makogi (MFM) Substation

7-3 Scoping

7-3-1 Expected Activities due to Grid Strengthening Project

Expected activities due to the project implementation are shown for three stages, namely, Planning Stage (Pre-Construction Stage), Construction Stage and Operation Stage in Table 7-9.

Table 7-9 Activities due to Grid Strengthening Project

Stage	Activities
I Planning Stage (Pre-construction Stage)	Securing land for grid related facilities (transmission line and sub-station)
	Securing construction yard including storage of construction materials
	Change in land use and utilization of local resources
II Construction Stage	Procurement of construction materials and securing water supply
	Earth moving work such as excavation, cutting and mounting
	Construction work for grid related facilities and approach roads
	Operation of construction machines, vehicles and plants and installation of workers' camp
	Residence of construction workers and their working activities
III Operation Stage	Operation of grid related facilities
	Spatial occupancy of grid related facilities

7-3-2 Preparation of Impact Matrix

By taking into consideration the JICA Guidelines, and relevant laws and regulations of Nigerian Government, together with characteristics of the proposed project and project area, following items are selected as indicators expressing existing environmental and social conditions and affected impacts.

Possible impacts are identified and the extent of the impacts is also evaluated one by one with rating against the above mentioned 37 environmental items.

As for the rating following criteria were adopted with respect to the extent of impacts:

- A (+/-) - Significant positive/negative impact is expected,
- B (+/-) - Positive/negative impact is expected to some extent,
- C - Extent of positive/negative impact is unknown or not clear (Further examination is needed. It should be taken into consideration that impacts may become clear as study progresses),
- D - Negligible or No impact is expected.

Results of rating and details of expected impacts due to the project in each stage are shown in Table 7-10.

Table 7-10 Ratings and Reasons of expected impacts due to the Project

Environmental Item		Planning Stage	Construction Stage	Operation Stage	Reasons
Social Environment	1) Land acquisition/Involuntary Resettlement	A-	D	D	**Planning Stage:** For the propose project it is necessary to secure land for transmission tower and sub-station and to get easement (way-leave) of land under new construction and rehabilitation of transmission line. This may result in a large scale involuntary resettlement. In addition, temporary resettlement of structures and peoples is expected in order to construct and use access roads to the project site during Construction Stage. **Construction and Operation Stage:** No negative impact is expected.
	2) Local economy such as employment and livelihood etc.	D	B-/B+	B+	**Planning Stage:** No negative impact is expected. **Construction Stage:** Negative impacts such as restriction of land use for agriculture and shops are expected. On the other hand, positive impacts such as creation of new employment are also expected. **Operation Stage:** Positive impacts such as stabilization of electric power supply to the project area and surrounding area may enhance local economy. In addition, temporary road for construction work and new road construction for maintenance of transmission line may give rise to positive impact on employment and livelihood.
	3) Utilization of land and local resources	B-	B-	C	**Planning Stage:** There is some possibility that existing residential and agricultural land use may be changed for land under transmission line and sub-station. **Construction Stage:** To secure water use for construction work including workers' camp, local water resources (surface water and groundwater) is required. **Operation Stage:** Enhancement of local economy as a result of stabilization of electric power supply may change land use in the project area. In addition, temporary road for construction work and new road construction for maintenance of transmission line may give rise to change in land use and local resources, although feature of the impact is not clear.
	4) Social institutions such as social infrastructure and local decision-making institutions	C	C	C	**All Stages:** At scoping stage it is unknown. However, it should be considered that there are co-existing two types of administrative system, i.e., administrative division (State and Local government level etc.) and traditional community and (kingdom and chiefdom) and their roles. **Construction Stage:** If information disclosure about procedures and schedules for operation of construction vehicles and machines and staying of construction workers at the project site to local residents and social institutions is not sufficient, it may generate their anxiety and discontent to the project. Thus, it is necessary to make them in advance.
	5) Existing social infrastructures and services	B-	B-	B+	**Planning Stage:** There is some possibility for relocation of existing social infrastructures and services. **Construction Stage:** Construction work may cause inconvenience to access to existing social infrastructures and services. **Operation Stage:** Positive impacts such as maintaining stability of electric power supply is expected. In addition, construction of new road and improvement of road condition for road construction work and operation and maintenance may cause positive impacts.
	6) Vulnerable group such as the poor, women, children, elderly, disabled etc.	C	C	C	**All Stages:** At scoping stage it is unknown but there is a possibility for existence of the poor.
	7) Ethnic minority	D	D	D	There is no ethnic minority that is benchmarked by the JICA Guidelines and defined by World Bank Safeguard Policies.

Environmental Item		Planning Stage	Construction Stage	Operation Stage	Reasons
	8) Misdistribution of benefit and damage	C	C	C	**All Stages:** There is, however, some possibility of misdistribution of benefit and damage, if TCN as the proponent do not make information disclosure appropriately to concerned peoples and other stakeholders about project plan including land acquisition/resettlement matters, procedures and schedules of construction work such as operation of construction machines and vehicles, and staying of construction workers, and benefits after operation.
	9) Local conflict of interests	C	C	C	**All Stage:** There is, however, some possibility of local conflict of interests, if TCN as the proponent do not make information disclosure appropriately to concerned peoples and other stakeholders about project plan including land acquisition/resettlement matters, procedures and schedules of construction work such as operation of construction machines and vehicles, and staying of construction workers, and benefits after operation.
	10) Gender	B-	B-	C	**Planning Stage:** There is a possibility that householder of PAUs is women or household is composed of women only may affected adversely. There is also a possibility that male householders do not share compensation fee with female living together. **Construction Stage:** There is a possibility that employment chance would not be shared equally to women. **Operation Stage:** Expected impact is unknown.
	11) Children's rights	D	B-	D	**Planning Stage:** No negative impact is expected. **Construction Stage:** There is a possibility that children may engage in labor of construction work. **Operation Stage:** No negative impact is expected.
	12) Cultural and historical, heritage site	C	C	C	**Planning and Construction Stage:** At present, distribution data of cemeteries, churches, mosques etc. in the affected area is not clear. Thus, expected impacts are unknown. In addition, UNESCO Cultural or Heritage sites are not distributed. **Operation Stage:** If proper considerations are not taken at the Planning Stage, there is a possibility of some negative impact.
	13) Water rights, fishing rights and rights of common	D	C	C	**Planning Stage:** No negative impact is expected. **Construction Stage:** At present fishery activities are found in lagoons and rivers of the project area. However, expected impact is unknown. **Operation Stage:** If proper considerations are not taken at the Planning Stage, there is a possibility of some negative impact.
	14) Public health and Sanitation	D	B-	D	**Construction Stage:** Air pollutants emitted from construction vehicles, machines and plants may cause some adverse effect to respiratory organs of local residents and construction workers, although temporarily. **Planning and Operation Stage:** No negative impact is expected.
	15) Infectious diseases such as HIV/AIDS	D	B-	D	**Construction Stage:** Influx of construction workers may cause outbreak of infectious deceases such as HIV/AIDS. **Planning and Operation Stage:** No negative impact is expected.
	16) Working condition (including occupational health)	D	B-	B-	**Planning:** No negative impact is expected. **Construction Stage:** There is a possibility that outside construction workers may lose their health and safe condition depending upon details of construction work and working environment. **Operation Stage:** There is a risk of H&S issue.

Environmental Item		Planning Stage	Construction Stage	Operation Stage	Reasons
	17）Hazards/security risks	D	B-	B-	**Planning Stage:** No negative impact is expected. **Construction Stage:** Although the project activities will not enhance hazard and risks, migration of outside workers from other areas may increase in number of crimes in the project area. **Operation Stage:** There is a risk of a fire from transmission line and tower, and sub-station facilities.
	18）Accidents (Construction work and traffic)	D	B-	B-	**Planning Stage:** No negative impact is expected. **Construction Stage:** Occurrence of accidents may increase due to construction work deploying machines and plants as well as occurrence of traffic accidents due to construction vehicles. **Operation Stage:** Operation and maintenance work for transmission line and sub-station in the height or with high voltage is likely to occur accidents such as falling down and electrocution.
Natural environment	1）Topography and Geology	D	B-	D	**Construction Stage:** Topographical change, a large scale excavation, cutting soil and/or improvement of foundation is not required. However, there is a possibility of negative impact on topographical features due to installation of transmission line and sub-station in a definite scale. **Planning and Operation Stage:** No negative impact is expected.
Natural environment	2）Soil erosion	D	B-	B-	**Planning Stage:** No negative impact is expected. **Construction Stage:** Soil run-off from filling and cutting of soil surface with earth moving work, dump site and borrow pits may cause soil erosion. Although large scale reclamation is not expected, soil erosion is one of nationwide concerns in Nigeria. **Construction and Operation Stage:** If neither measures against soil run-off from filling/cutting soil surface nor recovering vegetation after tree cutting is carried out, there is a possibility of soil erosion.
Natural environment	3）Groundwater	D	B-	C	**Planning Stage:** No negative impact is expected. **Construction Stage:** To secure water supply for construction work, there is a possibility of pumping up of groundwater. In addition, some topographical change, cutting and filling work etc. may cause negative impacts on functions about subsurface infiltration and water circulation. **Operation Stage:** In order to keep subsurface infiltration and water circulation function of groundwater, proper measures should be taken to shape of foundation with reflecting the results of geological survey to be conducted at Planning Stage.
Natural environment	4）Hydrological situation	D	C	C	**Planning Stage:** No negative impact is expected. **Construction Stage:** Although along transmission line and sub-station rivers, wetland and lagoons are distributed, expected impact is unknown at present. In addition, some topographical change, cutting and filling work etc. may cause negative impacts on functions about subsurface infiltration and water circulation. **Operation Stage:** Impact is unknown at present. But in order to keep subsurface infiltration and water circulation function of groundwater, proper measures should be taken to shape of foundation with reflecting the results of geological survey to be conducted at Planning Stage.
Natural environment	5）Protected Area	C	C	D	**Planning and Construction Stage:** A Protected Area is distributed around proposed Badagry sub-station. Although at present it is not clear whether the proposed sub-station may cause impact on the protected area or not, it is avoidable by proper selection of the site. **Operation Stage:** No negative impact is expected.

Environmental Item		Planning Stage	Construction Stage	Operation Stage	Reasons
	6) Flora, Fauna, Biodiversity and Ecosystem	D	B-	B-	**Planning Stage:** No negative impact is expected. **Construction Stage:** Negative impacts on change of vegetation due to felling, rare animal and plant species, fishes living in rivers, wetlands and lagoons, and animals and plants necessary to life of peoples **Operation Stage:** There is some possibility of accidental striking and electrocution of birds to transmission line and tower.
	7) Landscape	D	C	C	**Planning Stage:** No specific negative impact is expected. **Construction Stage:** Transmission tower and line under construction may cause some change of existing landscape. **Operation Stage:** Existing transmission tower and line in the project area are fitted into present scenery. However, appearance of new transmission tower and line may cause some change of the land scape.
	8) Local climate	D	D	D	**All Stages:** No specific negative impact is expected.
	9) Global warming/climate change	D	B-	D	**Planning Stage:** No negative impact is expected. **Construction Stage:** Greenhouse gas emissions such as CO_2 is somewhat expected due to operation of construction vehicles, machines and plants. However, it can be solved by applying measures such as stopping idling mode and use of vehicles with lower pollutants emission. On the other hand, CO2 absorption function of forest is expected to reduce due to deforestation and tree cutting. **Operation Stage:** Emission of greenhouse -gas such asCO_2 is not expected from operation of sub-station.
Environmental Pollution	1) Air pollution	D	B-	D	**Planning Stage:** No negative impact is expected. **Construction Stage:** Emission of air pollutants is expected temporarily from construction vehicles, machines and plants. **Operation Stage:** In general, sub-station and transmission facility are not the source of air pollutants emission source sub-station and transmission facility.
	2) Water pollution	D	B-	B-	**Planning Stage:** No negative impact is expected. **Construction Stage:** Water pollution is expected due to following pollutant generation from construction work, although temporarily: (i) Run-off of dirty water including soils from cutting, filling and excavation of earthmoving work. (ii) Wastewater from worker' camps and construction office. (iii) Spilling over of toxic materials such as oil and lubricants. **Operation Stage:** If appropriate measures against run-off of soil are not made in the construction work, water pollution is expected due to spillage of soil. Generation of water pollutants is not expected from sub-station and transmission facilities.
	3) Soil contamination	D	B-	C	**Planning:** No negative impact is expected. **Construction Stage:** Possibility of soil contamination due to leakage of toxic materials from earthmoving work and construction materials. **Operation Stage:** Potential contamination of soil from inadvertent release of hazardous or contaminating material.
	4) Bottom sediment contamination	D	B-	D	**Construction Stage:** There is a possibility of bottom sediment contamination due to discharge of construction materials containing toxic materials and turbulence of bottom muds of river and swamp by excavation and dredging work. **Planning and Operation Stage:** No negative impact is expected.

Environmental Item		Planning Stage	Construction Stage	Operation Stage	Reasons
	5） Solid waste	D	B-	D	**Construction Stage:** Generation of solid waste from construction work, tree cutting and workers' camp is expected. **Planning and Operation Stage:** No negative impact is expected.
	6） Noise and vibration	D	B-	B-	**Planning Stage:** No negative impact is expected. **Construction Stage:** Generation of noise and vibration is expected from construction machines and vehicles temporarily. **Operation Stage:** Generation of noise is expected from operation of sub-station.
	7） Ground subsidence	D	D	D	**At all Stages:** no negative impact is expected.
	8） Odor	D	D	D	**At all Stages:** no negative impact is expected.
	9） Radio disturbance	D	D	D	**At all Stages:** no negative impact is expected.
	10) Electromagnetic field	D	D	D	**At all Stages:** International Commission on Non-Ionizing Radiation Protection (ICNIRP) prepared the guideline of occupational exposure for EMF and has set 200 micro tesla as reference level for general public exposure. In general, the level of EMF around the transmission line is 4~6 micro tesla which is well below compared with the ICNIRP's reference level. Since this project will comply with the applicable regulations in Japan as well as ICNIRP, health impact is not expected due to EMF. Therefore, no negative impact is expected at all stages.

7-3-3 TOR for EIA study

7-3-3-1 Scope of the Study Areas

Study areas correspond to those to be affected by to the project. The areas are mostly located around the area of project implementation but have some difference depending on environmental item.

Since the project area covers a wide range, it is necessary to divide the area to sub-areas by their locations and environmental conditions. Accordingly, the EIA report should be prepared for each sub-area by evaluating the results of the EIA study and describing mitigation measures with considering characteristics of sub-area.

7-3-3-2 Survey Items and Methodology

(1) Collection of Existing Data and Reconnaissance Survey

Collection of existing data and field survey including actual measurements should be carried out for environmental items as shown in Table 7-11.

Table 7-11 Environmental Items to be surveyed

Environmental Item		
Social Environment	1)	Land acquisition/involuntary resettlement
	2)	Local economy such as employment and livelihood etc.
	3)	Utilization of land and local resources
	4)	Social institutions such as social infrastructure and local decision-making institutions
	5)	Existing social infrastructures and services
	6)	Vulnerable group such as the poor, women, children, elderly, disabled etc.
	7)	Misdistribution of benefit and damage
	8)	Local conflict of interests
	9)	Gender
	10)	Children's rights
	11)	Cultural and historical heritage site
	12)	Water rights, fishing rights and rights of common
	13)	Public health and Sanitation
	14)	Infectious diseases such as HIV/AIDS
	15)	Working condition (including occupational health)
	16)	Hazards/security risks
	17)	Accidents (Construction work and traffic)
Natural Environment	1)	Topography and Geology
	2)	Soil erosion
	3)	Groundwater
	4)	Hydrological situation
	5)	Coastal zone
	6)	Protected Areas
	7)	Fauna, Flora, Biodiversity and Ecosystem
	8)	Landscape
	9)	Global warming/climate change
Environmental Pollution	1)	Air pollution
	2)	Water pollution
	3)	Soil contamination
	4)	Bottom sediment contamination
	5)	Solid waste
	6)	Noise and Vibration

(2) Field Survey

To obtain existing baseline data of environmental conditions field surveys should be carried out for items shown in Table 7-12 referring to the above results of the above scoping.

Regarding the survey on natural environment the survey time and methods should be considered in order to be able to evaluate seasonal changes with taking climate condition of the project area into considerations.

Table 7-12 Contents and details of the Field survey

Environmental Item	Survey Item	Method for Survey
Comparison of Alternatives		
Comparison of Alternatives	(1) Options for transmission route and location sub-station (2) Methods and procedures of construction work	(1) Selection of the route and location to avoid, minimize the occurrence of involuntary resettlement, tree cutting and impacts on reserved areas and ecosystem (2) Measures to minimize or reduce adverse impacts by construction work
Baseline Data Survey		
（1） Social Environment		
1）Land acquisition/involuntary resettlement	(1) Census survey on land under the planned transmission route (30m to 50m width) and sub-station. (2) Census survey on affected land and assets. (3) Household survey on livelihood and living condition (4) For leasehold land survey on reason and details of leasehold and resettlement	(1) Conduct inventory survey on land and all the structures and occupants (including landowner, illegal occupant, leaseholder, businessman, employee of shop etc.) in the project area by interview and hearing and identify the number of Project Affected Persons (PAPs) (2) Inventory of assets with amount and recognizable legal rights of PAPs in the project area by actual measurement and hearing (3) Interview survey on socio-economic baseline data of affected households (livelihood, occupation, household size, household income, standard of living, socio-cultural characteristics etc.) (4) Hearing of past experiences of land acquisition an resettlement and complaints from residents
2）Local economy such as employment and livelihood etc.	Survey on livelihood and employment in the project area	(1) Collection of existing data of livelihood and employment condition (2) Interview survey on socio-economic baseline data of affected households (livelihood, occupation, household size, household income, standard of living, socio-cultural characteristics etc.)
3）Utilization of land and local resources	In and around the project sites: (1) land use and utilization of natural resources (residential, industrial, agricultural commercial, pasture use) (2) Water resources (surface water and groundwater)	(1) Inventory of assets with amount and recognizable legal rights of PAPs in the project area by actual measurement and hearing (2) Collection of qualitative data on land use and utilization of natural resources (existing and planned) (3) Interview survey on utilization of water resources

Environmental Item	Survey Item	Method for Survey
4) Social institutions such as social infrastructure and local decision-making institutions	Social institutions such as social infrastructure and local decision-making their roles in the project area	Collection of information about Sate, Administrative Division, Traditional leaders, religious associations, cooperatives etc, through stakeholder engagement
5) Existing social infrastructures and services	(1) Public facilities such as schools, hospitals (2) Means of transportation and communication	(1) Collect information through desktop review and site visit about public facilities, means of transportation and communication. Partly same as the 1) – (1)
6) Vulnerable group such as the poor, women, children, elderly, disabled etc.	Living condition and livelihood of the poor, and vulnerable groups in the project area	Interview survey on socio-economic baseline data of affected households (livelihood, occupation, household size, household income, standard of living, socio-cultural characteristics etc.) Same as the item 1) –(3)
7) Misdistribution of benefit and damage	Existing social institutions and means of mutual communication and obtaining consensus	(1) Survey on features of local stakeholders State, Local Government (2) Collection of information about State and local government level administration, traditional community leaders, religious associations, cooperatives etc. (3)Survey on good practices of making consensus and mutual communication
8) Local conflict of interests	Existing social institutions and means of mutual communication and obtaining consensus	(1) Survey on features of local stakeholders State, Local Government (2) Collection of information about State and local government level administration, traditional community leaders, religious associations, cooperatives etc. (3) Survey on good practices of making consensus and mutual communication
9) Gender	(1) Ownership of land and assets by women (2) Share of compensation fee to female by male householder (3) Condition at work of women	(1) Collect laws and regulations about ownership of women on land and assets through desktop study (2) Survey on traditional custom by hearing from local stakeholders such as residents and NGOs (3) Past experiences of TCN for gender issues (4) Survey on labor condition of women by hearing from local stakeholders such as residents and NGOs
10) Children's rights	Existing condition of children's labor	(1) Collection of laws and regulations of children's labor in Nigeria through desktop study (2) Collection of existing data about children's labor (3) Hearing from residents, local stakeholders, NGOs etc.
11) Cultural and historical heritage site	Distribution of cemetery, churches, mosques, heritage sites in the project area	(1) Collection of information about distribution cemetery, churches, mosques, heritage sites in the project area through site visit and stakeholder engagement (2) Hearing about condition of relocation and temporary agreement, if possible

Environmental Item	Survey Item	Method for Survey
12) Water rights, fishing rights and rights of common	(1)Utilization of water resources (2) Fishery activities	(1) Interview survey on utilization of water resources to local government and residents (2) Hearing from fishery associations
13) Public health and Sanitation	Public health condition of local residents in the project area	(1) Collection and analysis of public health and diseases in the project area through desktop study and stakeholder engagement (2) Hearing from local medical facilities
14) Infectious diseases such as HIV/AIDS	Existing health condition of local residents, especially suffering from infectious diseases in the project area	(1) Collection and analysis of infectious diseases in the project area through desktop study and stakeholder engagement (2) Hearing from local medical facilities
15) Working condition (including occupational health)	Safety condition during construction work	(1) Confirm labor related laws and regulations such as Labor Law in Nigeria (2) Collect information about safety measures during construction work
16) Hazards/security/ risks	(1) Existing situation of crime and security in the project area (2) Fire prevention plan from transmission line and tower and sub-station	(1) Hearing from local police and other concerned organizations (2) Collection and analysis existing data
17) Accidents (construction work and traffic accidents)	(1) Accidents during construction work (2) Accidents during operation and maintenance	(1) Collection of information about safety measures of TCN during construction work through interview to TCN (2) Collection of information about safety measures of TCN for operation and maintenance of transmission line and sub-station through interview to TCN
(2) Natural Environment		
1) Topography and Geology	(1) Existing situation of fragile land and accidental collapse soil erosion in the project area (2) Installation plan of transmission line and sub-station	(1) Collection of existing data (2) Field survey and hearing of cases of collapse
2) Soil erosion	Existing situation of soil erosion in the project area	(1) Collection of existing data (2) Field survey and hearing on cases of soil erosion
3) Groundwater	(1) Existing use of groundwater and surface water (rainy season and dry season) (2) Plan for topographical change, cutting and filling at the earthmoving work	(1) Collection of existing data (2) Hearing of groundwater use
4) Hydrological situation	(1) Stream regime of rivers, wetlands and lagoons (2) Floodplain and area of flooding risk (rainy and dry season) (3) Plan for topographical change, cutting and filling at the earthmoving work	(1) Collection of secondary data (2) Field survey and hearing on conservation and use of rivers, wetlands, lagoons etc.
5) Protected Areas	Distribution of Protected Areas in the project area	To confirm location of the existing and candidate Protected Area around proposed Badagry sub-station

Environmental Item	Survey Item	Method for Survey
6) Fauna, Flora, Biodiversity and Ecosystem	(1) Existing situation of animal and plant species that may be affected by the project (2) Existing situation of felling plant species and area of deforestation in order to secure land for grid related facilities (3) Fishes and aquatic organisms in rivers, wetlands and lagoons (4) Existing utilizing condition of wild animals and plants by local residents	By cooperation with Local governments, NGOs, research organizations etc. to conduct following survey: (1) Inventory survey on endangered species, endemic species, protected species by Nigerian Government, plant and animal species affected by deforestation and bird species. Collection of secondary data and hearing from experts regarding conservation situation and ecological features. Collection of information about avoidance of bird striking. (2) Survey on felling tree species, vegetation and area of deforestation by the project. Survey on laws and regulations of felling and deforestation as well as procedures of obtaining necessary approval from concerned authorities. (3)Collection of secondary data and hearing
7) Landscape	(1) Existing landscape (2) Installation schedule of transmission line and tower at the construction work	(1) Collection of existing data (2) Field survey and hearing
8) Global warming/climate change	(1) Present situation of global warming and climate change in the project area (2) Operation plan of construction vehicles and machines (3) Tree cutting plan	(1) Collection of existing data (2) Hearing to relevant organizations (3) Collection of data about national policy for global warming and climate change of Nigeria (4) Estimation greenhouse gas emission by using data about number of construction vehicles, machines and time of operation etc. (5) Collection of existing measures for reduction of greenhouse gas emission from construction work
(3) Environmental Pollution		
1) Air pollution	(1) Air quality standard (2) Existing Air quality (3) Major air pollution sources (4) Operation plan of construction vehicle s and machines	(1) Collection of existing data (2) Field survey and hearing on existing air pollution (3) Collection of baseline data by field measurement of air quality such as SO_2, NO_2, TSP, PM_{10}. (measuring point: near sub-station site, urban area, road area, forest area etc.) (4) Estimation air pollutants emission by using data about number of construction vehicles, machines and time of operation etc. (5) Collection of existing measures for reduction of air pollutants emission from construction work

Environmental Item	Survey Item	Method for Survey
2) Water pollution	(1) Water quality standards (2) Existing situation of water pollution (3) Major water pollution sources and water use	(1) Collection of existing data (2) Field survey and hearing on existing water pollution (3) Collection of baseline data by field measurement and analysis water samples such as water temperature, pH, turbidity, DO, SS, BOD, COD, oil and grease, salinity, anions, heavy metals, Coliform etc. (Measurement point: river, wetlands, and lagoons etc.)
3) Soil contamination	(1) Soil contamination standards (2) Existing situation of soil contamination	(1) Collection of secondary data (2) Field survey and hearing of existing pollution (3) Baseline data survey by sampling and analysis of heavy metals and other hazardous compounds for soil in and surrounding areas Items should be determined by consideration with environmental standards capability of local consultants.
4) Bottom sediment contamination	(1) Existing situation of bottom sediment contamination	(1) Collection of secondary data (2) Field survey and hearing of existing pollution (3) Baseline data survey by sampling and analysis of organic compounds, sulfide, heavy metals, oil and grease and other hazardous compounds for rivers, wetlands and lagoons. The survey item should be determined by consideration with environmental standards capability of local consultants.
5) Solid waste	(1) Regulation of solid waste treatment and disposal (2) Existing situation of solid waste generation, collection, treatment and disposal	(1) Collection of secondary data (2) Field survey and hearing of solid waste treatment and disposal in the project area
6) Noise	(1) Environmental standards for noise pollution (2) Existing ambient noise level (3) Major noise sources	(1) Collection of secondary data (2) Actual field survey and hearing of noise level (3) Measurement of daytime and night-time ambient noise level of sub-station, urban area, roadside, forest area etc. as baseline data

7-4 ESIA study

7-4-1 Schedule of ESIA study

The schedule of EIA process to be carried out up to today is shown in below.

Table 7-13 Schedule of EIA Study for each LOT

Item	Lot1	Lot2	Lot3
Kick Off Meeting (Lagos and Ogun state, TCN, consultans)	May 3 2017		
TOR approval from FMEnv	July 17, 2017	July 11, 2017	July 11, 2017
ESIA study	Aug 2017-Mar2018		
Draft ESIA report submitted to FMEnv	Apr 2018	Apr 2018	Apr2018
Public Disclosure (30 days)	May 1 – 31 2018		
Panel Review	Oct 19, 2018		
EIA approval	May 3, 2019	July 3, 2019	February 5, 2019

7-5 Description of Existing Environment

7-5-1 Physical Environment

7-5-1-1 Climate

Nigeria located in the tropics, is wide country and has four climate types depending on geographical and topographical condition, namely, tropical rainforest climate for coastal area faced to the Gulf of Guinea, tropical savanna climate for central and western area of the country, tropical dry climate for northern area and highland climate for mountain area with higher than 1,500 m above sea level.

Both Lagos State and Ogun State, where the proposed project area is included, belong to tropical rainforest climate and tropical savanna climate. Both States have rainy and dry seasons and humid and hot. However, Ogun State located in inland area is less humid than Lagos Sate.

Annual rainfall is 1,500mm to 2,500mm in Lagos State and 1,000mm to 2, 000 mm in Ogun State. In Lagos State in general there are two rainy seasons, namely, first rainy season (from April to July) and second rainy season (from September to December), and other time is in dry condition. In Ogun State there is one rainy season (from March to November) and one dry season (from December to February).

Regarding annual average temperature minimum low temperature is 20~24°C and maximum high temperature is 28~34°C for both States with little change in a year.

7-5-1-2 Topography and geology

Lagos State is located in coastal region of Western Niger Delta and estuaries of Ogun and Oshun River. About 40% of the area is occupied with water bodies such as tidal area, wetland, coast, river and bay area. On the other hand, inland area spread coastal plain, river mouth and island and 10% of land area prone to inundation by high wave and flooding.

In Ogun State lowland plain with fertile soil suitable to agriculture and hilly area fitted to grazing spread around inland area from northern boundary of Lagos State.

Topographical condition of the project area changes from hilly area of inland to lowland plain, swamp and lagoons of coastal area.

7-5-1-3 Air Quality

Air quality measurement were carried out at 74 locations along the proposed project routes. Parameters measured during the study includes, PM, SO_2, NO_2 and CO. The result shows that all measured parameters shows the compliance with the national air quality standard. The detail of result is shown in Appendix 4.

7-5-1-4 Ambient Noise

Noise measurement were carried out at 74 locations along the proposed project routes. Noise level along the proposed route were varied depend on the land use of sampling location. The undeveloped area (away from residential area or road network) shows the low noise level (~approximately 50dB) while the area within developed area including along the heavy traffic road indicate the high noise level. For example, maximum noise level along the main road in Lot 1 was 81.2 dB, which was above WHO standard (55 dB). The detail of result is shown in Appendix 4.

7-5-1-5 Electromagnetic Field Strength

Electromagnetic Field Strength (EFS) measurement were carried out along the proposed project route. The result of the measurement was varied the area by area. The obtained highest values were measured at a sampling point closer to a power generation station fence line, but below 0.4μT. The obtained values were far below the ICNIRP guidelines for both occupational (1000μT) and general public exposure (200μT). The detail of result is shown in Appendix 4.

7-5-1-6 Surface and Ground Water

There are several surface waters around the project area, including River, Stream as well as Swampy area. Major River running around the project area is Ogun River, which runs from Abeokuta to Lagos Lagoon. Lot 1 and 2 component crosses the Ogun River. There is another major surface water in Badagry area (Lot 3) along which transmission line will run.

For surface water, water sampling was carried out at 8 locations (Lot 1), 12 locations (Lot 2) and 16 locations (Lot 3).

The result of water sampling indicated pollution regarding DO, TSS, COD, etc, of which concentrations were above WHO drinking water standard in most of surface water resource. The pollutions may be attributed to human activities. The detail of result is shown in Appendix 4.

7-5-1-7 Soil

The soil in the project area have moderate fertility. Generally, Concentrations of heavy metals and other in the soil parameters are show levels below the set limits under the WHO and FMEnv soil standards. However, there are apparent exceedances of certain parameters in each Lot. These include:

Lot 1: High levels of nitrates are observed in the project area. This NO3 limits may be attributed to intense agricultural activities (e.g. use of fertilizers, land use practices) in the area.).

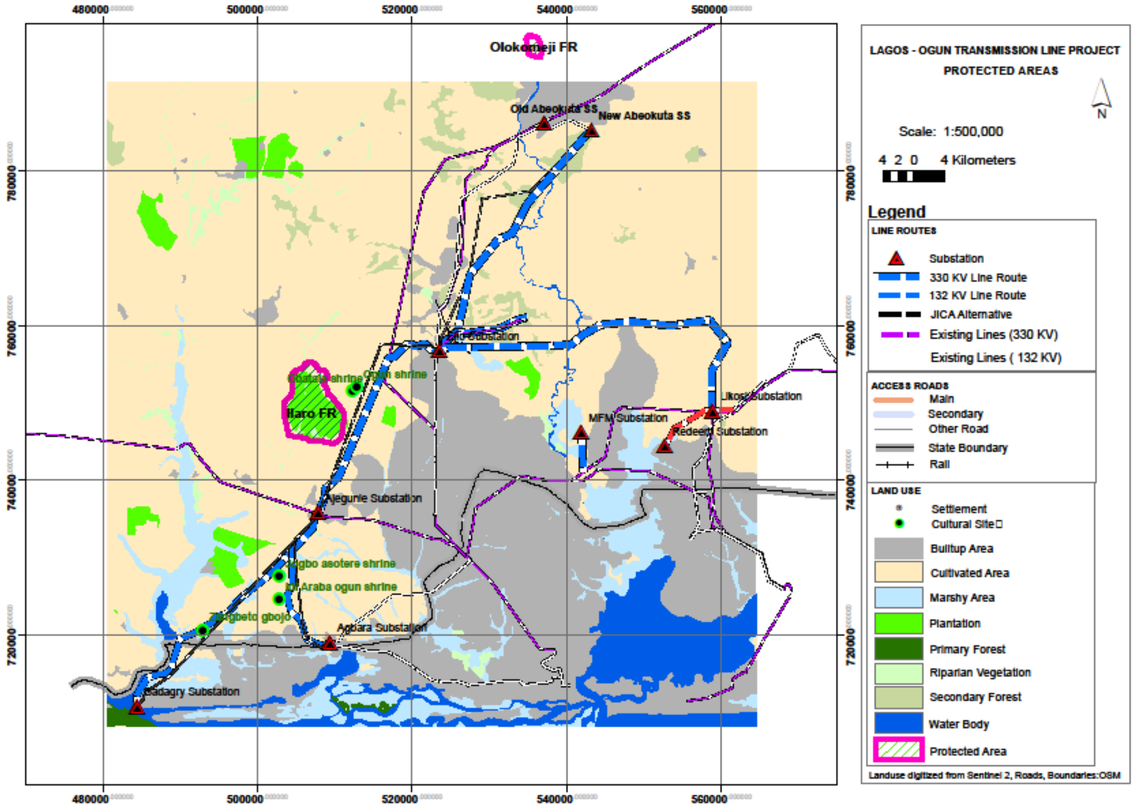
Lot 2: The soils have moderate fertility status with the more fertile soils located on the Ewekoro axis underlain by shale and limestone. The plant-extractable Cu, Cd and Ni contents of the soils are within the acceptable limits for soils. There are observed was however an elevated concentrations of Pb in the soil around the Thames Valley College compared with other areas. This may could be attributed due to used lead expended leaded batteries in the area.

Lot 3: The concentration of Cu in about two-thirds of the samples taken during the survey exceeds the limits at all sampling points both for top soil and for subsoil. This may be attributed to agricultural activities and municipal and industrial solid wastes, especially around the Agbara axis.

7-5-2 Biological Environment

7-5-2-1 Natural Conservation Areas

There are no protected areas within the zone of influence of the proposed project. The closest protected area is Ilaro Forest Reserve located approximately 3km from the route of transmission line. This Ilaro Forest Reserve is mainly used for teak plantation. There is no IBA (Important Bird Area) located within 10km from the project area.



Source: EEMS 2018

Figure 7-12 Protected areas close to the Project Area

7-5-2-2 Terrestrial Habitat

(1) Lot 1

The survey of the site revealed that the area shows partial degradation resulting from human activities. These activities range from housing, firewood collection and farming. Each of these activities conferred different outlook on the ranges where they were carried out. A closer look of the profiles of the vegetation of the area showed that the site can be stratified into grassland, riparian forest, secondary forest regrowth and farmland. Grassland form major expanse of land in Ejio-Olorunsogo section caused by man-made land conversions. The percentage of each land use type within ROW is shown in Table 7-14. The affected area of each land use type within ROW is shown in Figure 7-14. The pictures of representative areas in Lot 1 are shown in Figure 7-13.

Table 7-14 Land Use Type within affected area for Lot 1

Land use type	Affected area (Ha)
Primary Forest	0
Secondary Forest	63
Swampy area	0
Riparian vegetation	0
Water body	1
Cultivated area	175
Fallow field	0
Built-up area	0
Plantations	0
Others	0
TOTAL AREA	239

Source: EEMS 2018

Grassland: Ejio-Olorunsogo section

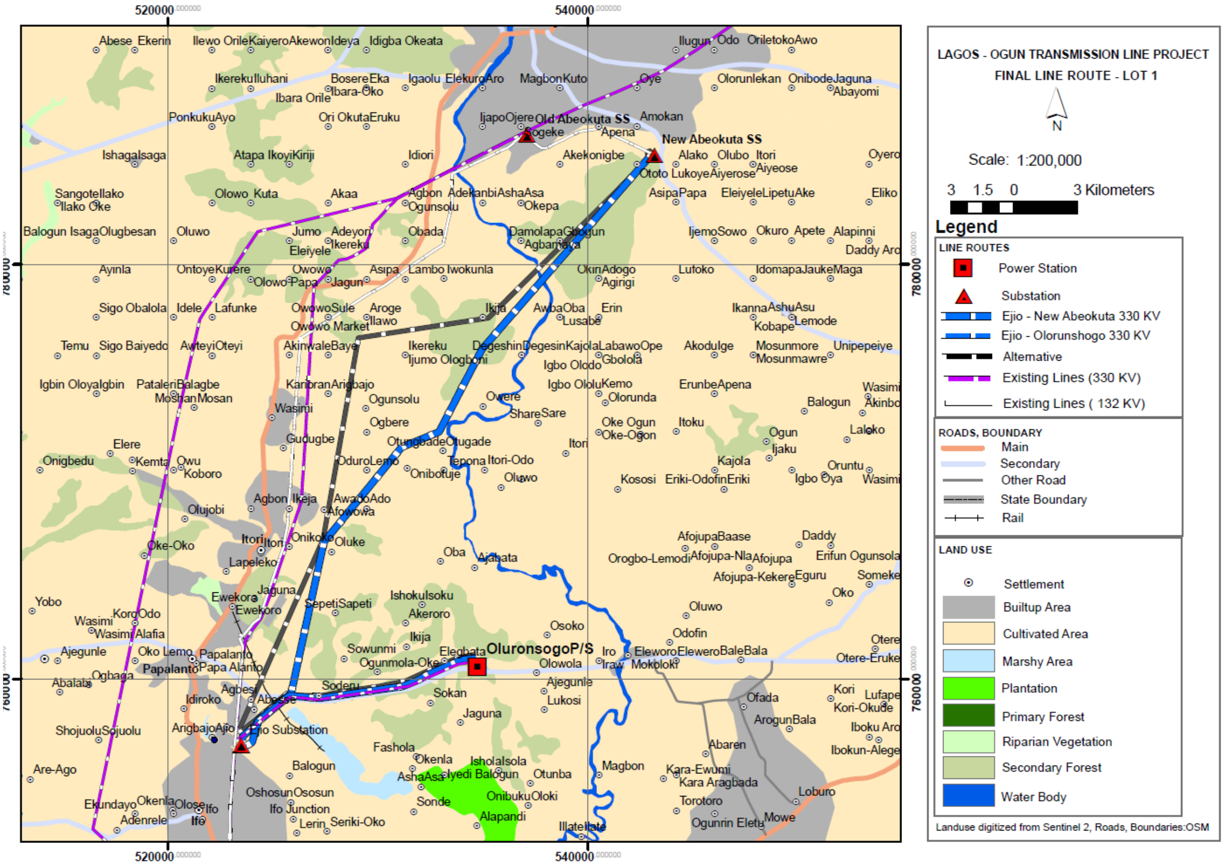
Riparian forest : Ejio-New Abeokuta section

Farmland with mixed crops: Ejio-New Abeokuta section

Farmland with cassava: Ejio-New Abeokuta section

Source: Lagos-Ogun Transmission Line ESIA for Lot1

Figure 7-13 Pictures of representative areas in Lot 1



Source: Lagos-Ogun Transmission Line ESIA for Lot1

Figure 7-14 Land use map for Lot 1 area

(2) Lot 2

The main block of the Nigerian forest formation along these routes is called lowland rainforest. The high human activities along the proposed transmission lines have greatly transformed the complex structure and species richness of these routes. The entire area under study along the transmission lines and Associated Substation Facilities, on the basis of structure and species composition has been classified as degraded lowland rain forest, made up of mixtures of trees, shrubs, herbs and grasses. The affected area of each land use type within ROW is shown in Table 7-15. The affected area of each land use type within ROW is shown in Figure 7-16. The pictures of representative areas in Lot 2 are shown in Figure 7-15.

Table 7-15 Land Use Type within affected area for Lot 2

Land use type	**Affected area (Ha)**
Primary Forest	0
Secondary Forest	0
Swampy area	17.02
Riparian vegetation	32.44
Water body	0
Cultivated area	3.96
Fallow field	309.13
Built-up area	0
Plantations	0.9
Others	0
TOTAL AREA	363.45

Source: EEMS 2018

Farmland

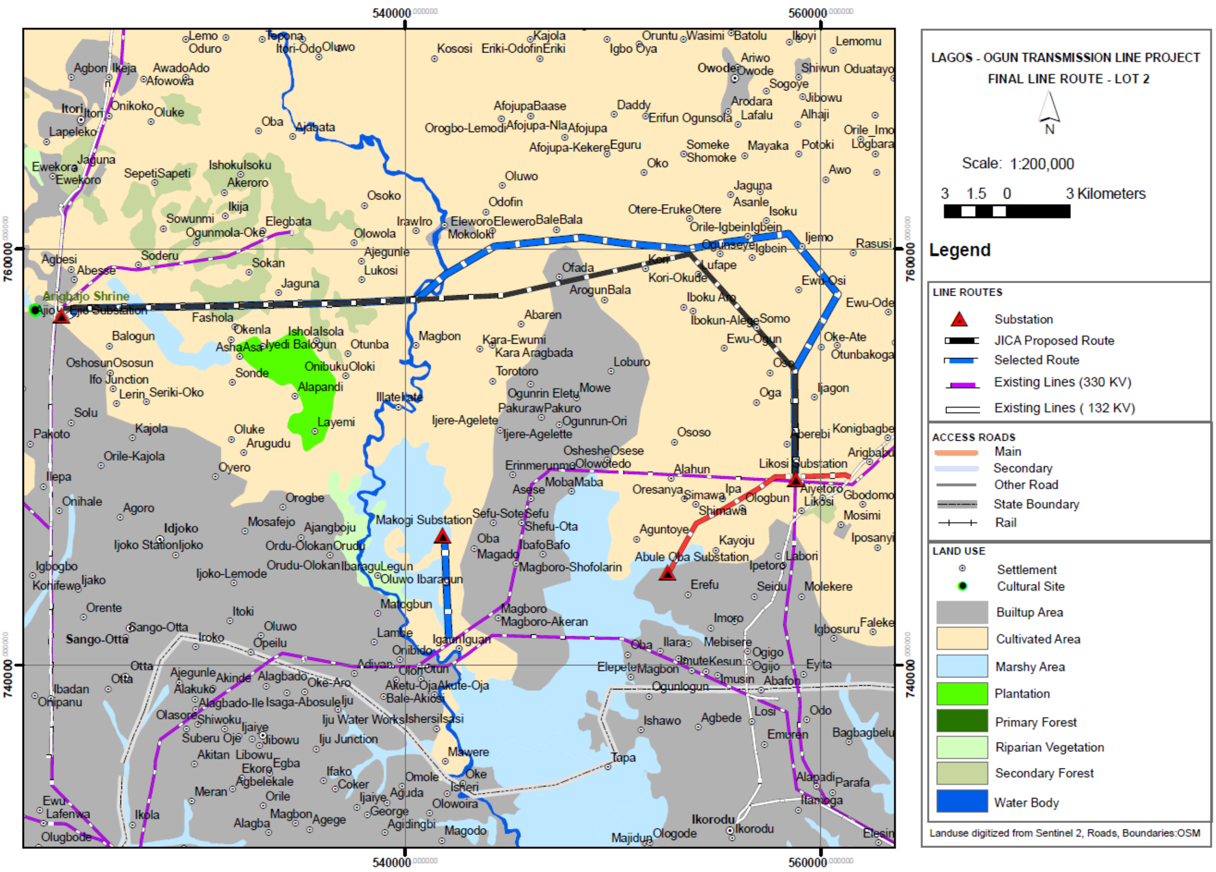
Freshwater Fallowland vegetation

Freshwater Fallowland vegetation

Fallowland vegetation with many woody species

Source: Lagos-Ogun Transmission Line ESIA for Lot2

Figure 7-15 Pictures of representative areas in Lot 2



Source: Lagos-Ogun Transmission Line ESIA for Lot2

Figure 7-16 Land use map for Lot 2 area

(3) Lot 3

The Study area consists of the following habitat types; Secondary Forest, Marshy area and Riparian vegetation (refer to Table 7-4). Estimate of the percentage cover by each habitat type obtained in respect to transect covered during field study is presented in Table 7-16. The affected area of each land use type within ROW is shown in Figure 7-18**.** The pictures of representative areas in Lot 3 are shown in Figure 7-17.

Table 7-16 Land Use Type within affected area for Lot 3

Land use type	LOT3
Primary Forest	0
Secondary Forest	56.08
Swampy area	44.28
Riparian vegetation	13.94
Water body	16.52
Cultivated area	85.64
Fallow field	158.57
Built-up area	19.43
Plantations	0

Land use type	LOT3
Others	2.21
TOTAL AREA	396.67

Source: EEMS 2018

Grassland: Ejio substation

Grassland : Ejio-New Ajegunle section

Shrub : Agbara area

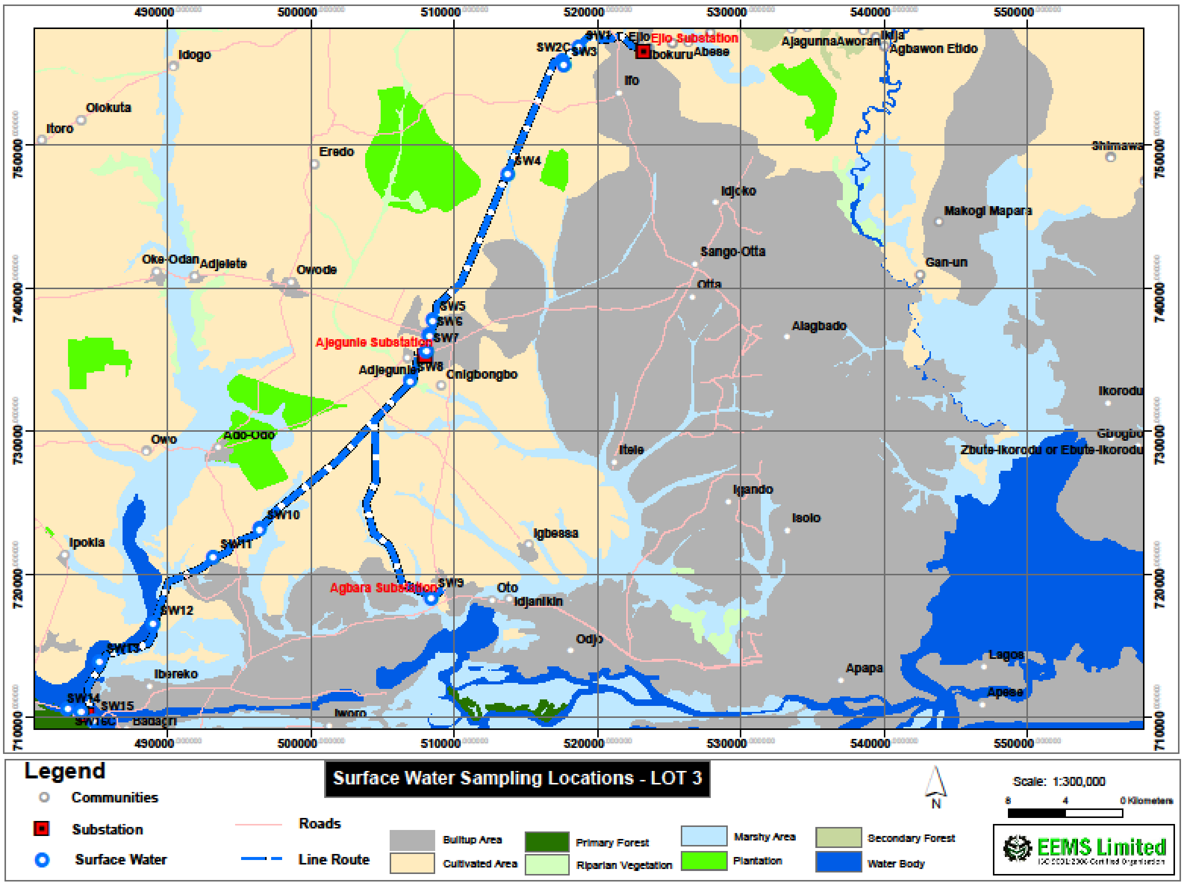
Secondary forest: Abgara - Ajegunle

Swampy area: Iragbo (north of Badagry)

Swampy area: Ajegunle – Badagry sub station

Source: Lagos-Ogun Transmission Line ESIA for Lot3

Figure 7-17 Pictures of representative areas in Lot 3



Source: Lagos-Ogun Transmission Line ESIA for Lot3

Figure 7-18 Land use map of Lot 3 area

7-5-2-3 Terrestrial Flora

Lot 1:

A total of twenty-three (23) tree species and eighty-three (83) understorey species belonging to 15 and 43 taxonomic families. The results revealed that trees formed the dominant life form in the study area, which accounted for 48% followed by Herb (23%), Shrub (18%), Grass and Climbers accounted for 9 % and 2% respectively. Number of species per study site ranged from 1-11 species for trees and 12-28 species for understorey. There were no species with conservation value as per the IUCN Red List.

Lot 2:

The floristic composition of the vegetation of the proposed transmission lines and Associated Substation Facilities is diverse in species even over a relatively homogenous area. A total of 32 plant species belonging to16 families/sub-families and comprising trees/shrubs, herbs and grasses were recorded within the proposed project area. The IUCN status of the plant resources for the studied area was evaluated using IUCN version 2017 -3 criterion. Only one plant species sampled in a riparian habitat (*Mitragyna ledermannii*) is categorized as Vulnerable (VU) as per the IUCN Red List. According to IUCN, this species is threatened by overexploitation due to its commercial value as general-purpose timber.

Lot 3:

A total of one hundred and twenty-two (122) flora species in forty-eight (48) taxonomic families were inventoried in the entire studies area. Some species were observed to occur solely in riparian habitat. Some of these indicator species include *Lasimorpha senegalensis*, *Mitragyna ledermannii*, *Raphia hookeri* and *Nymphaea lotus.* Derived savanna habitats were generally richer in species than the riparian forest habitats.

The IUCN status of the plant resources for the studied area was evaluated using IUCN version 2017 -3 criterion. The results showed that *Mitragyna ledermannii (*sampled in the riparian habitat*)* was the only Vulnerable (VU) species, which is also found in Lot2.

7-5-2-4 Terrestrial Fauna

Lot 1:

Farming , Hunting and ravaging activities of cattle and frequent collection of firewood and felling activities in the past are suspected to be major factors for inability of the wild fauna to thrive and triumph abundantly in the area. Bush bucks, Hare, Grass cutter, were the most abundant of all the mammals found. Birds recorded include: wood pecker, Morning dove, Cattle egret, Glossy sterlon etc. All the species encountered in the studies (e.g. birds, mammals, amphibians) are common or are listed as least concern in the IUCN Red list. The list of identified fauna species in Lot 1 is shown in Table 7-17.

Table 7-17 List of identified fauna species for Lot 1

Common Name	Biological Name	Direct Observation	IUCN
MAMMALS			
Bush Buck	*Tragelahpus scriptus*	●	-
Fruit Bat	*Rousethus smithii*	●	-
Hare	*Lepus capensis*	●	LC
Mona monkey	*Cercopithecus mona*	●	LC
Grass Cutter	*Thryonomis swinderianus*	●	-
Palm Squarrel	*Epixerus ebii*	●	LC
Forest Genet	*Genetta trigrina*	●	-
AVIAN			
Woodpecker	*Dendropicos fuscescens*	●	LC
Senegal coucal	*Centropis senegalensis*	●	-
Morning Dove	*Streptopelia decipens*	●	-
Grey heron	*Ardea cinera*	●	-
Cattle Egret	*Ardeola ibis*	●	LC
Francolin	*Francolinus bicalcaratus*	●	LC
Village Weaver Bird	*Ploceus cucllatus*	●	-
Senegal Parrot	*Poicephalus senegaus*	●	-
Glossy Sterlon	*Lamprotornis nitens*	●	LC
Willow Warbler	*Phylloscopus trochilus*	●	LC

Common Name	Biological Name	Direct Observation	IUCN
Barn Owl	*Tyto alba*	●	LC
Grey Plantain Eater	*Crinifer piscato*	●	-
Orange Cheeked Waxbill	*Estrilda melpoda*	●	LC
Tawny-Flanked	*Prinia subflava*	●	LC
Senegal Firefinch	*Lagonosticta senegala*	●	LC
REPTILIA			
Red-necked Cobra	*Naja melanolenca*	●	-
Lizard Buzzard	*Kaupifalco monogramicus*	●	-
AMPHIBIANS			
Nigeria Banana frog	*Afrixalus nigeriensis*	●	LC
Toad	*Amitophrnus supercillaris*	●	-

Source: Lagos-Ogun Transmission Line ESIA for Lot1

Lot 2:

Major wildlife components of the study area belong to the vertebrate classes of Reptilia, Amphibia, Aves and Mammalia. Their habitats include the farmlands and residential areas. Wildlife resources especially mammals reported in the area are remarkably few, because the project area has been exposed to significant human impacts from industrial development, hunting and clearance for agriculture. These would explain the sparse wildlife around the project area and suggest a less likely occurrence of rare or endangered species compared to unimpacted areas. Most of the wildlife taxa would, therefore, be classified as not evaluated or “data deficient” based on IUCN (1994) guidelines. None of the species identified is classified as threatened as per IUCN Red List. The list of identified fauna species in Lot 2 is shown in Table 7-18.

Table 7-18 List of identified fauna species for Lot 2

Common Name	Biological Name	Direct Observation	IUCN
MAMMALS			
Common Rats	*Rattus rattus*	●	LC
House Mouse	*Mus musculus*	●	LC
Giant Bush Rat	*Cricetomys gambianus*	●	LC
African Palm Squirrel	*Epixerus ebii*	●	LC
Ground Squirrel	*Xenus erythropus*		-
Grass Cutter	*Thryonomys swinderianus*		LC
African Civet	*Civettictis civetta*	●	LC
Bates Pygmy Antelope	*Neotragus batesi*	●	LC
Bushbuck	*Tragelaphus scriplus*		-
Maxwell’s Duiker	*Cephalopus maxwelli*	●	-
Yellow backed duiker	*Cephalopus silvicultor*		-
AVIAN			
Black Kites	*Milvus nigrans*	●	-
Chicken Hawk	*Accipter erythropus*	●	-
Cattle Egret	*Ardeola ibis*		LC
Great White Egret	*Egretta alba*		LC

Common Name	Biological Name	Direct Observation	IUCN
Common Vultures	*Necrosyrtes monarchus*	●	-
Francolin	*Francolinus bicalcaratus*		LC
Pin-Tailed Whydah	*Vidua macroura*		LC
Pied Crow	*Corvus albus*		LC
Wood Pecker	*Dendropicos pyrrhogaster*		LC
Bronze Manikin	*Lonchura cucullatus*		-
Village Weaver Bird	*Plesiositagra cucullatus*	●	-
White-Crested hornbill	*Tropicranus albocristatus Cassin*		-
Nectar Bird	*Anthreptes collaris Vieil.*		-
REPTILIA			
Rainbow Lizard	*Agama agama*	●	-
Nile Monitor Lizard	*Veranus niloticus*	●	-
Royal Pyton	Pyton regis	●	-
Black Cobra	*Naja melanoleuca*		-
Green Tree Mamba	*Dentroaspis viridis*	●	-
Black Tree Snake	*Thrasops occidentalis*		LC
AMPHIBIANS			
Frog	*Dicoglossus sp*	●	-
Long-Legged Frog	*Ptychodena sp*	●	-
Toad	*Bufo regularis*	●	

Source: Lagos-Ogun Transmission Line ESIA for Lot2

Lot 3:

A total of seventy nine (79) fauna resources were inventoried in the study. This comprises of 61 fauna species that were sighted (direct evidence) and 18 fauna species that were obtained via indirect evidences. Grass cutter was the most abundant of all the mammals found in the area. Birds recorded include: Cattle egret, buff-tailed corone, the great egret, etc. The avi-fauna group recorded the highest number of species, followed by the mammalian group. The reptilian group recorded and amphibians however, recorded the least number of species. There were two major habitats in the censored area which are derived savannah and riparian/swamp habitat. Derived savanna was observed to record the highest number of species. This high number of species in savanna habitat is attributed to disturbed environment, since fast growing species (colonizers) dominate such habitat.

Analysis for the conservation status of the species censored in the proposed project area was conducted using IUCN, 2017 Red List of Threatened species. Results revealed that none of the censored species were threatened. The list of identified fauna species in Lot 3 is shown in Table 7-19.

Table 7-19 List of identified fauna species for Lot 3

Common Name	Biological Name	Direct Observation	IUCN
MAMMALS			
The brown rat	*Rattus norvegicus*	●	LC
The bush rat	*Rattus fuscipes*	●	LC
The black rat	*Rattus rattus*	●	LC
The little free-tailed bat	*Chaerephon pumilus*	●	LC
The hammer-headed bat	*Hypsignathus monstrosus*	●	LC
The Gambian epauletted fruit bat	*Epomophorus gambianus*	●	LC
AVIAN			
The cattle egret	*Bubulcus ibis*	●	LC
The buff-tailed coronet	*Boissonneaua flavescens*	●	LC
The great egret	*Ardea alba*	●	LC
The western bronze-naped pigeon	*Columba iriditorques*	●	LC
Laughing Dove	*Spilopelia senegalensis*	●	LC
REPTILIA			
Rainbow Lizard	*Agama agama*	●	-
Lizard	*Mabuya sp*	●	-
Smyth's Water Snake	*Grayia smythii*	●	-
Jameson's mamba	*Dendroapis jamesonii*	●	-
The forest cobra	*Naja melaoleuca*	●	-
The African rock python	*Python sebae*	●	-
AMPHIBIANS			
Forest White-lipped Frog	*Hylarana albolabris*	●	-
Hallowell's toad	*Amietophrymus maculates*	●	-
the Lime reed frog	*Hyperolius fusciventris burtoni*	●	-
the variable reed frog	*Hyperolius concolor*	●	LC
The crowned bullfrog	*Haplobatrechus occipitalis*	●	-

Source: Lagos-Ogun Transmission Line ESIA for Lot3

7-5-2-5 Migratory Bird

Some avian species are known to migrate. Avian migration is either a regular or irregular (nomadism, irruption, or invasions) seasonal movement between north and south. In some species, the movement is one directional. In Nigeria as in other countries in the Northern hemisphere, migratory birds commence this movement between February, March and April to warmer areas and return between August, September and October to winter grounds. Migratory movement often results in high mortality and predation. In this study, a total of 4 migratory birds were inventoried (see Table 7-20). The bird survey was conducted in December 2017. Based on the consultation with Nigerian Conservation Fund (NCF) who is an NGO dedicated to nature conservation in Nigeria, it was indicated that;

- There is no fact that the presence of transmission line causes bird strike around the project area. Since no bird strike happened, survey has not been conducted,

- Migration route is not main concern for NCF since bird can fly over transmission lines; however, NCF concerns place to stay in winter.
- December is a good timing for bird survey since many species of bird visit the area and the migratory birds fly from outside of Nigeria, e.g. Europe from December to February in general (the biodiversity survey in this EIA study was conducted in December 2017).

Table 7-20 Migratory Species around the Project Area

Common Name	Biological Name	IUCN status	HABITAT	NESTLING GROUNDS	Breeding season	Major threats	Conservation actions
The great egret	*Ardea alba*	LC	Terrestrial and freshwater	Reed beds, bamboo, bushes.	April to July	Wetland degradation and loss	Colony protection, control of vegetation management.
Grey Heron	*Ardea cinerea*	LC	Freshwater	Low trees and bushes	February to June	Renewed hunting and timber harvesting	-
Little Egret	*Egretta garzetta*	LC	Mangrove	On grounds of protected sites, mangroves.	March to July	Wetland degradation and loss through drainage for agriculture.	Nesting sites should be protected
Black Kite	*Milvus migrans*	LC	Terrestrial and freshwater	Branches of trees	July to October	Poisoning, shooting and pollution of water	Establish non-intrusion zone around colonies.

Source: Lagos-Ogun Transmission Line ESIA for Lot3

7-6 Description of Social Environment

7-6-1 Profile of the Project area

7-6-1-1 Political context and Administrative structure

Nigeria is a Federal Republic made up of 36 States and a Federal Capital Territory. Nigeria became an independent state in 1960 and a republic in 1963. These are further sub-divided into 770 local government areas which form the third tier of government while the central and state governments form the first and second tier respectively.

7-6-1-2 Population

The components of the proposed project are located in Lagos and Ogun States. In both States, there are 20 Local Government Areas each.

Lagos State is the smallest as its surface area, however, supports the largest population among the other states of the nation. By the National Bureau of Statistics, the population of Lagos State was about 5.7million in 1991 and 9.1million in 2006. There is no data to show its ethnic composition, one can assume that it is composed with various ethnic groups, as it had been the capital of the country for long time and is one of the prominent large cities in Africa today.

Ogun State shares its southern boundary with Lagos State. By the National Bureau of Statistics, its population in 1991 was about 2.3million and 3.5 million in 2006. The major ethnic group is the Yoruba, followed by the Egba, the Yewa-Awori, the Egun, etc. [2]

No indigenous person by the definition of the World Bank, to which JICA refers, is present in the proposed project areas.

7-6-1-3 Socio Economic Activity

Lagos State is the center of financial, commercial and industrial activities of the nation. According to the Nigerian Service Portal, in 2010, a total GDP of Lagos State was about USD33, 679 million and is the economic base of the nation shouldering more than 65% of all business activities in the country. A total GDP of Ogun State is USD10, 500 million and industry, commerce and agriculture are major activities.

Lagos State, with the Port of Lagos, is also a center of trading activities including crude oil exportation, which is a major earning for the country. With many financial institutions, large enterprises and international enterprises, it plays a major role in financial and economic activities of the country. Currently, the Eko Atlantic City project, a planned district with residential and office areas, is under development by reclaiming land in the coastal area of Lagos City. Another project to develop a free trade zone is also ongoing in Lekki, the eastern coastal area of Lagos. While experiencing rapid economic development, Lagos has problems typical of a large city, such as expansion of the slum areas and a high crime rate and unemployment rate.

With its location adjoining to the large city Lagos and a vast land, Ogun State hosts factories and industries of both national and international enterprises such as Nestle, Unilever, GraxoSmithKline, Honda, etc. The education sector of the state is also developed with nine university campuses. Other land development projects, such as a large compound with a mega church, residences, schools, and other facilities, are also undertaken in many areas in the State.

7-6-2 Social Economic baseline in project area

7-6-2-1 Affected Communities

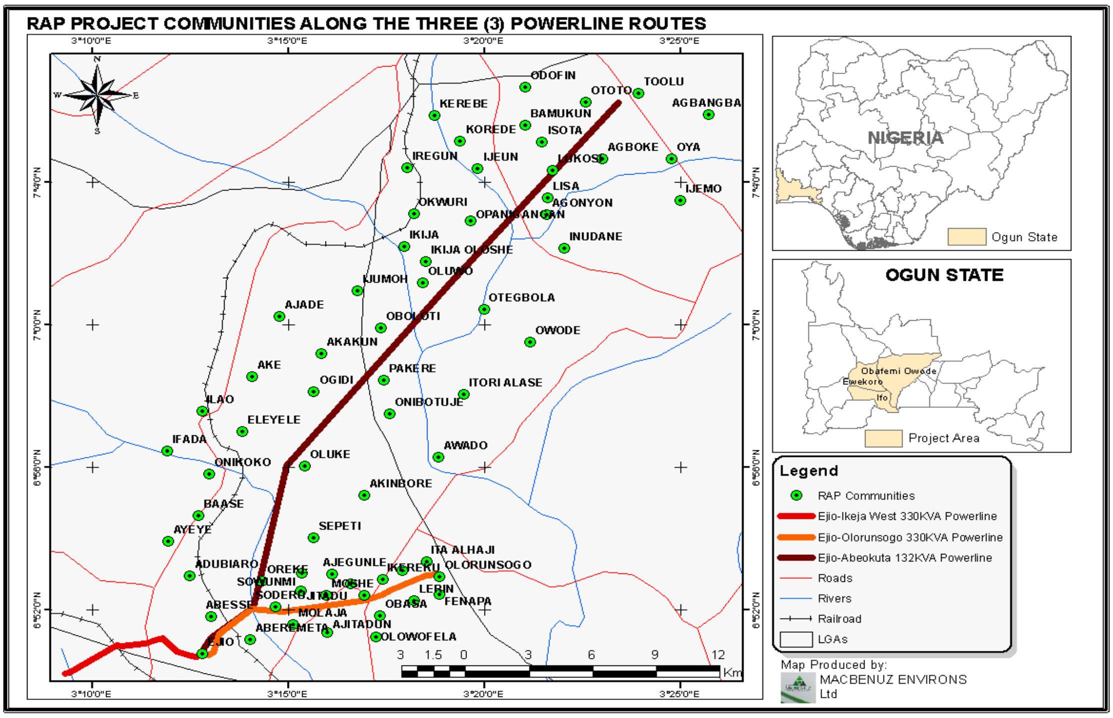
There are 6 Local Government Areas (LGAs) and approximately 200 communities within the spatial boundary of the project (700m wide each of ROW) as shown in Table 7-21 and Figure 7-19, Figure 7-20, Figure 7-21.

[2] Ogun State Government Official Home Page

Table 7-21 Project Affected LGA and Communities*

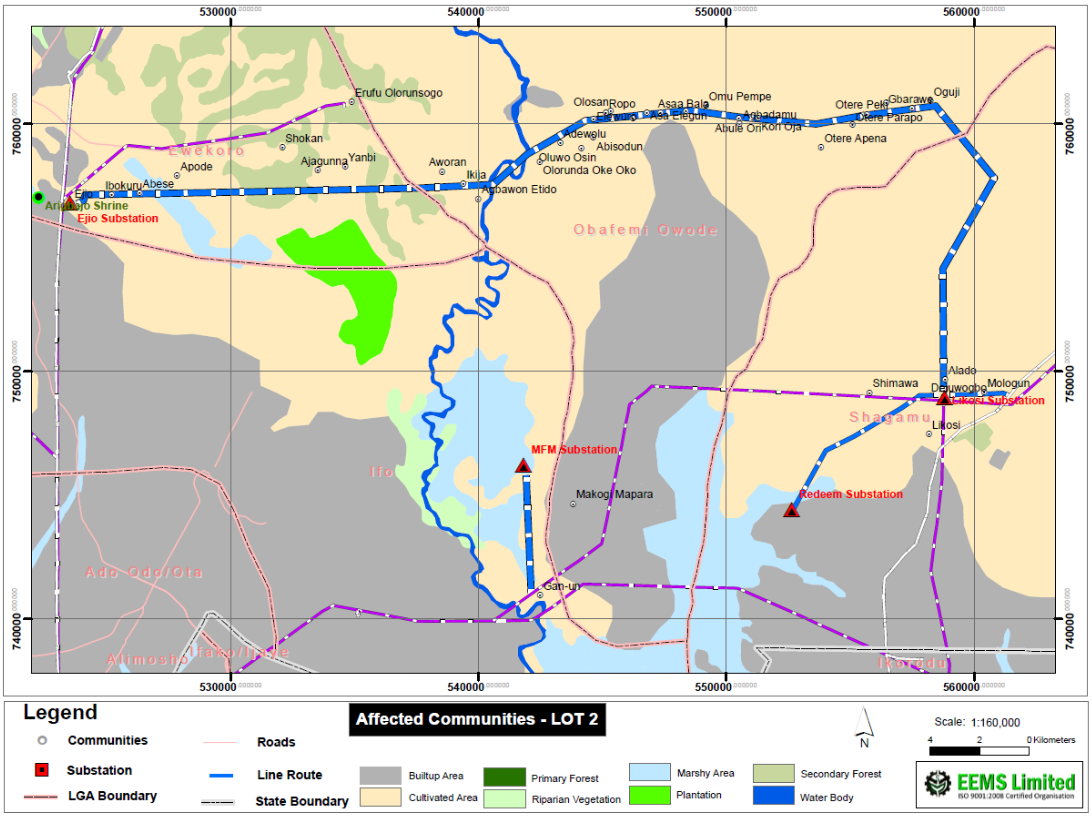
Lot #	State	Local Government Areas within study area	Number of Affected Communities
1	Ogun	Ewekoro	40
		Ifo	9
		Obafemi Owode	22
2	Ogun	Ewekoro	3
		Ifo	12
		Obafemi Owode	25
		Sagamu	38
3	Ogun	Ewekoro	8
		Ifo	16
		Ado Odo Ota	44
	Lagos	Badagry	9

*The number of community area within the project boundary is still preliminary and subject to change.
Source: JICA study team



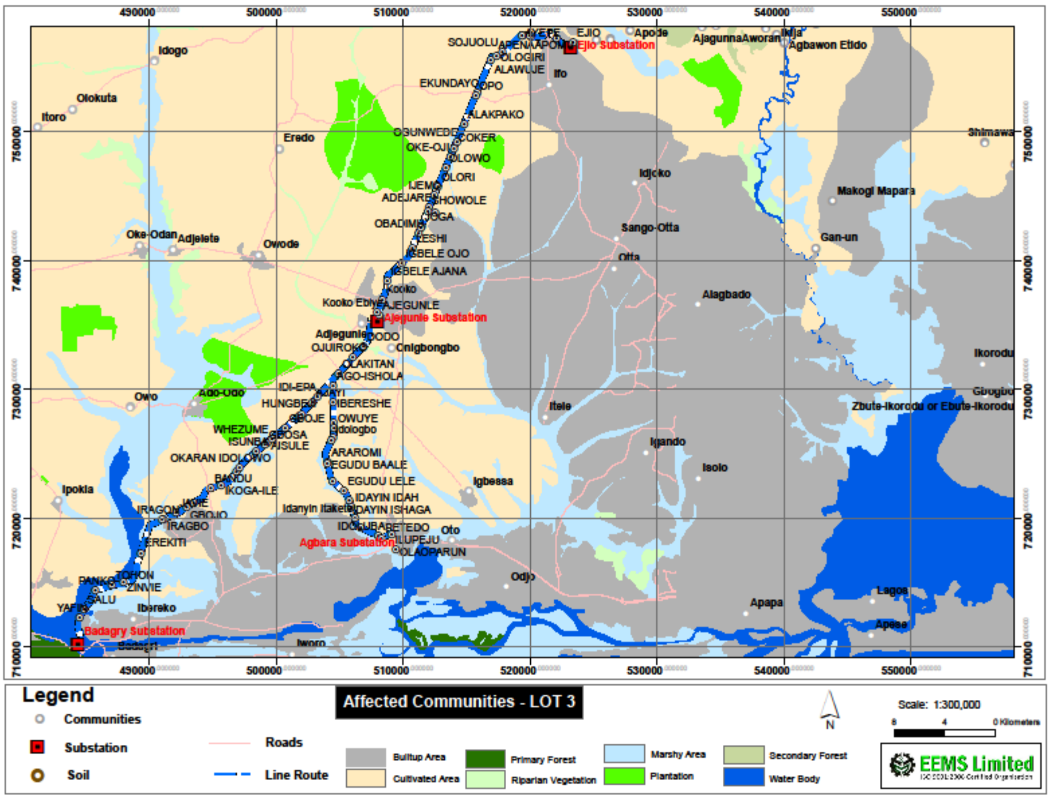
Source: Godirra 2018

Figure 7-19 LOT 1 Affected Communities



Source: EEMS 2018

Figure 7-20 LOT 2 Affected Communities



Source: EEMS 2018

Figure 7-21 LOT 3 Affected Communities

7-6-2-2 Population

The population of each affected LGA is shown in Table 7-22.

Table 7-22 Population Data in Project Affected Area (2016)

State	LGA	Total	Male	Female
Ogun	Obafemi Owode	326,700	50%	50%
	Ewekoro	76,600	51%	49%
	Ifo	750,000	51%	49%
	Ado-Odo/Ota	733,400	51%	49%
	Sagamu	355,700	50%	50%
Lagos	Badagry	327,400	51%	49%
	Total	2,569,800		

Source: National Population Commission projection from 2006 census

7-6-2-3 Age Structure and dependency rate

The age structure in the project area is shown in Table 7-23 below. The total dependency ratio is the proportion of the population not in the work-force who are 'dependent' on those of working-age, it's a calculation which groups those aged under 15 with those over 65 years as the 'dependants' and classifying those aged 15-65 years as the working-age population. The higher the dependency ratio, the more people who are not of working age, and fewer who are in the labour force (and paying taxes). The national average for Nigeria was 88.2% in 2015.

Table 7-23 Age Structure in Project Affected Area (2016)

LGA	1-14	15-44	45-65	>65	Dependency rate
Obafemi Owode	36%	37%	25%	3%	63%
Sagamu	37%	39%	24%	1%	60%
LGA	1-14	15-39	40-65	>65	
Ewekoro	35%	28%	26%	11%	85%
Ifo	39%	28%	27%	7%	83%
Ado-Odo/Ota	37%	28%	25%	10%	88%
Badagry	38%	28%	26%	8%	85%

Source: National Population Commission projection from 2006 census

7-6-2-4 Existing Infrastructure

The existing infrastructures such as water supply, electricity, transportation measures, health care facilities, waste management are summarized below.

(1) Water supply

The sources of water for household use within project area include borehole, well and river/stream. Type of water supply system is different area by area. It can be said that the most of communities within the project area depend on the water from river/stream or rainwater. On the other hand, rainwater while some of communities are connected with borehole (/portable water supply system, including Likosi and Ejio and Gan-un communities in (Lot 2) and portable water supply system (62.2% of some communities in Odo Ota LGA,(62.2%) and more than 50% of communities in Ewekoro, community (50.6%) and Ifo community, and (53.2%) in Badagry in Lot 3).

(2) Electricity

The national electricity supply is reported to be irregular and unreliable. Access to electricity supply decreases as one goes from more urbanized area in southern part (Lot 3 area) to suburban area in northern part (Lot 1 area). In Lot 3, around 62% are connected to the national grid. In Lot 2, few communities (Ejio, Likosi, Sagamu and Gan-un) are connected to the national electricity grid. In Lot 1, around 80% of communities have no electricity and only financially capable individuals generate their own electricity through diesel generators. Majority of households that do not have electricity use kerosene for lighting and fuel wood for cooking.

(3) Transportation

Road infrastructure and network appear more established as one goes from Lot 3 to Lot 1. In Lot 3, the project areas is traversed by several roads (Lagos-Abeokuta expressway, Sango-Idi-Iroko Rd, Sokoto Rd, Ado Rd, Coker-Atan Rd). In Lots 1 and 2, communities are connected to the main trunk road (Ifo-Abeokuta express in Lot 2; Papalanto - Shagamu road in Lot 1) by a network of small feeder roads. There are reports that some existing roads are not in good state with pot holes and gallops and absence of drainages. Feeder roads that connect to villages and settlements are mostly unpaved earth roads. Transportation is mainly by motor vehicles and motorcycles.

(4) Health care

Health facilities are more established in Lot 3 compared to Lot 2 and 1. In Lot 3, there are 9 Primary Health Centres (PHC) and 58 hospitals. All of the LGAs have PHCs, except Ifo LGA. In Lot 2, PHC in Likosi and Sagamu General Hospital are the only health facilities that serve the whole communities in the project area. In Lot 1, there are only 2PHCs found in Olosunsogo and Obaeerin communities. All other communities have no clinic or health centre. There are a few private clinics, which were usually too expensive for the masses.

(5) Education

In Lot 3, there over 755 primary schools, 181 secondary schools and 1 tertiary institution in the project area. About 90% of these schools are privately owned. In Lot 2, primary schools cannot be accessed within 1-5km distance, except for few communities (Ejio, Likosi, Ewu Lisa, Ganun, Simawa, Sagamu) and there is no public secondary school. In Lot 1, most communities do not have schools. There are a few primary schools and fewer secondary schools. Overall, communities in the project area only have access to government owned schools because private schools have high tuition fees. Students normally walk long distances to attend school.

(6) Waste Management

Common waste disposal methods in the project area include open dumping and burning of wastes. With regards to sewage, around 60% use toilets in Lot 3. In contrast, only few households use water toilets in Lots 2 and 1. For communities which do not use toilets, common disposal methods include disposal to pit latrines, bush, or rivers.

7-6-2-5 Indigenous People

For all Lots 1-3, the communities in the study area predominantly belong to the Yoruba race. In Other tribes/nationalities represented are the Eguns, Igbos, Hausa/Fulani, Igedes, and Igala in Lot 2. It should be noted that the World Bank safeguard officer in Nigeria office stated that no indigenous groups are identified in Nigeria including the project area based on the 4 conditions described in WB OP 4.10.

7-6-2-6 Cultural Heritage Sites

There are archaeological and sacred sites, such as traditional burial grounds and shrines in the communities. These sites are highly valued by the people and considered sacred and encroachment in such areas would attract serious resentment from the communities. The people celebrate several traditional festivals, the observance of which is believed to be for the general well-being of the people. The picture of some of identified archaeological and sacred sites in each Lot is presented in Figure 7-22.

Lot1			
	Sacred place for Shokpono	Tombs by residential homes at Abese	Sacred Esu deity at Ijumo
Lot 2			
	Oluweri Mapojo Shrine- Ibokuru	Ojualale Shrine- Ikija	Lagindigbi Orisa- Olorunsogo
Lot 3			
	Idi Araba ogun shrine	Obatala shrine	Ogun shirne

Figure 7-22 Identified Archaeological and Sacred Sites in each Lot

7-7 Impact Assessment

The summary of the Impact Assessment is provided in Table 7-25 for construction stage and Table 7-26 for operational stage. Potential environmental impacts during construction are likely to be temporary and localised to the Project Site. Significant negative impacts include land acquisition/resettlement, vegetation clearing along ROW and substation areas, and use of surface water resources.

7-7-1 Planning and Construction Stage

7-7-1-1 Environmental Pollution

(1) Air pollution

The movement of vehicles for the construction will result in PM, SO_2, CO, NOx, CO_2 emissions. Dust will also be generated during land preparation activities, vehicle movements, and material transport. However, impact will be local and limited to construction sites and access. A low number of vehicles and equipment will be required and the construction period will only be short term.

There are residents close to the transmission line and access roads. They may be affected by air emissions and dust during construction and material transport.

Therefore, the impact of air emissions and dust generated during construction is considered to be minor due to the relatively low number of vehicles and equipment required compared to the already existing traffic load on the roads, limited earthworks required on the site, and also to the relatively short duration of the construction phase.

(2) Water pollution

The risk of accidental oil spills from heavy machinery is present during the construction phase and could result into both surface water and groundwater contamination. Moreover, groundwater could be contaminated during digging of foundation pits for the towers or substations, particularly near watercourses or the swampy area, such as Badagry area. Unsound waste management practices are likely to have an effect on water quality of surface water sources (e.g. improper waste disposal in surface waters) during heavy rainfall events.

It is noted that local communities use surface water sources. For example, Oke-Oji River and the Ajegunle River for bathing and washing and the Badagry Canal is used for water transport by the Communities). With this receptor sensitivity, coupled with the magnitude of the potential consequences of an uncontrolled spill and storm water runoff, potential impact on water resources is rated as moderate.

(3) Soil Contamination

Soils can be contaminated during the construction phase by accidental oil/fuel spills from heavy machinery at storage yards, work sites, and during material transport. In the event of an accidental spill, the proportion of soil contamination will depend on the magnitude of these accidental events.

Local communities use groundwater as water resource and there are agricultural areas, which will be crossed by the transmission line, thus receptor sensitivity is moderate. Considering the medium magnitude of this activity and medium receptor sensitivity, the impact is moderate.

(4) Bottom Sediment contamination

There would be potential contamination of bottom sediment from inadvertent release of hazardous or contaminating materials (liquid fuel, solvents, lubricants, aluminum oxide paint, etc.) due to the construction of foundation of tower as well as access road, especially within swampy area such as Badagry area. The magnitude of impact on sediment contamination by the activities is considered to be moderate.

(5) Solid Waste

Waste generated from the construction work will include vegetation, metal chips, waste plastic, wood shavings, waste glass and waste oil. Furthermore, household waste generated from worker`s activities will include cans, bottles and garbage. If such waste is inadequately handled, soil, surface water and underground water may be contaminated, and sanitation problems may arise. This may be of concern since there are nearby communities in the area. The impact magnitude on this item is considered to be Minor.

(6) Noise and vibration

During construction phase, construction activities, traffic, as well as the use of construction equipment and machinery are likely to lead to a temporary increase in noise levels, but this will be limited to the surrounding area where noise generating equipment and machinery are used. The construction activities will be undertaken during daytime and will be concentrated and done sequentially so that no area is prone to extensive duration of noise impacts. Considering the construction activity schedule and nature of construction, overall noise impact on nearby sensitive receptors with embedded controls in place will be of Moderate significance, especially in construction areas close to local residents.

7-7-1-2 Natural Environment

(1) Topography, Geology and Soil erosion

During the construction phase, construction of access roads, digging of foundation pits for the towers and removal of vegetation (for foundation purposes) are the activities likely to affect soil structure and quality. Excavation works and removal of vegetation, especially on steep slopes, would render soils unstable and more vulnerable to erosion. Soil quality may also deteriorate as a result of vegetation clearing. Considering that only small areas are exposed and impact is localized and very few ground water sources, duration short, sensitivity of the receptor medium and its magnitude will be Moderate, during the construction period

(2) Groundwater

Groundwater could be contaminated during digging of foundation pits for the towers or substations as well as accidental spills and improper disposal of waste and wastewater, including potential alkaline wastewater generated due to the cast in piling method, particularly near watercourses or the swampy area. Giving that wastewater generated from the construction area is properly treated, the risk on groundwater contamination is considered to be minor.

Regarding to the impact on aquifer, considering the size and depth of foundation of towers (4 m x 4m x 4m), the impact to aquifer is considered to be limited.

(3) Hydrogeological situation

Sources of impacts to watercourses are removal of vegetation, construction of access roads, vehicle movement along the ROW and construction sites and excavation/piling for tower installations. Vegetation removal in riparian areas can increase soil erosion in erosion prone areas, causing sediment to be deposited into the waterbodies, especially during rain events. However, with a pylon spacing of an average of 300- 400m, no pylons will be installed in any of the riverbeds. The hydrodynamics of these watercourses are not expected to be varied significantly. Therefore, the impact on hydrogeology is considered to be minor.

(4) Protected area

There is no protected area, which is designated by the country, within the project area. The closest protected area is Ilaro Forest Reserve located approximately 3km from the route of transmission line. This Ilaro Forest Reserve is mainly used for teak plantation. There is no IBA (Important Bird Area) located within 10km from the project area. No protected area or other ecologically important area (e.g. IBA) will be likley affected by the project.

(5) Flora, Fauna, Biodiversity and Ecosystem

1) Terrestrial Flora and Fauna

The transmission line will require the vegetation clearance within ROW. The vegetation with height of over 4m will be subject for the vegetation clearance, corresponding to an area of 227.66ha. In addition, it is planned to clear whole vegetation including small shrub within toal10m width of centreline of ROW for the purpose of construction of access road as well as footprint of substations, corresponding to an area of approximately 146.46ha.

Vegetation clearance will lead to a permanent loss of woody species in terrestrial habitat found along the corridor. In addition, habitat fragmentation and degradation will result in modification of species composition in flora and fauna communities and the introduction and risk of spread of invasive species. Table 7-24 presents the different habitats within ROW at each Lot.

Table 7-24 Land Use Type within affected area

Land use type	Affected area (Ha)			
	LOT1	**LOT2**	**LOT3**	Total
Primary Forest	0	0	0	0
Secondary Forest	63	0	56.08	119.08
Swampy area	0	17.02	44.28	61.3
Riparian vegetation	0	32.44	13.94	46.38

Water body	1	0	16.52	17.52
Cultivated area	175	3.96	85.64	264.6
Fallow field	0	309.13	158.57	467.7
Built-up area	0	0	19.43	19.43
Plantations	0	0.9	0	0.9
Others	0	0	2.21	2.21
TOTAL AREA (ha)	239	363.45	396.67	999.12
Vegetation with over 4m height within ROW*	63	50.36	114.3	227.66
Vegetation clearance within affected area	35	62.618	48.842	146.46

Prepared by JICA study team based on data base in Nigeria

Most of the transmission line ROW consists of various type of land use, including secondary forest, marshy area, cultivated area, fallow area or built-up area. Most of the area are already considered to be impacted by human activities. The flora present in the transmission line ROW does not include flora species identified in the IUCN Red List of threatened species, except a riparian tree species (*Mitragyna ledermannii*) which is listed as vulnerable (VU). *Mitragyna ledermannii* is observed in riparian forest in Lot 2 and Lot 3. This species are threatened by overexploitation due to its commercial value as a general-purpose timber.

In addition, there are many species identified which offer provisioning services. Some provide food/fire, other are sources of raw materials and medical service. These species includes *Albizia adianthifolia, Albizia zygia, Abuliton mauritiana, Asystasia vogeliana, Annona senegalensis, Bambusa vulgaris, Ceiba pentandra* and *Eleaise guineensis.* These plant species will need to be cleared, reducing their availability for local communities. However, since the affected area would be limited to the proposed RoW (30m width or 50 m width) and the local species will regenerate again with similar habitat, impact is considered as minor.

Vegetation losses represent habitat loss for local fauna and flora. Even if local fauna consists mostly of common species, terrestrial habitats impacted are susceptible to host some threatened wildlife species. Small fauna species are more susceptible to be impacted by habitat loss. The survey did not identify any fauna species with high conservation status (species with IUCN conservation status is Least Concern (LC) are only identified), however, appropriate management measure is required to be implemented to minimize the impact.

2) Aquatic Flora and Fauna

The construction of the roads, vegetation clearing, and pylon construction may cause wetland and riparian habitat loss. Aquatic macrophytes are represented by the plants in river and vegetation supported by wetlands. Some species observed to occur solely in riparian habitat, include Lasimorpha senegalensis, *Mitragyna ledermannii*, *Raphia hookeri* and *Nymphaea lotus.* All along the ROW, *Mitragyna ledermannii* is the only Vulnerable (VU) species.

Impact on aquatic and semi-aquatic habitats will be limited in areas where there will be direct construction of pylons and substations [*i.e. tower foundation*]. Also, aquatic habitat might be indirectly impacted due to the result of construction activity, such as sediment run off, accidental spill. Although, the impacts will be local and the magnitude will be low, areas with aquatic habitat are highly sensitive, the impact significance is moderate.

(6) Landscape

Aesthetic impacts during the construction phase will be limited to work zones. Deforestation of the ROW will change the landscape in rural areas, which is very limited since it is mainly crossing a agricultural areas. The area already has many existing transmission lines as well as many telecommunication towers. The changes in the landscape is not likely produce significant impacts in most areas.

(7) Global Warming

GHGs will be emitted from material production as well as energy use in construction activity. In addition, there will be carbon loss due to the forest clearance. In addition, deforestation will be required within ROW, which would be contributor to GHG emission. Although the transmission line route was selected to avoid and minimize impact on forest areas as practically reasonable, it is assumed that total 374 ha of vegetation (among of which 227.66ha is vegetation over 4m height and 146.46 is small vegetation) is required to be cleared. Carbon loss from forest clearance is estimated by multiplying aboveground biomass in project area and carbon fraction value to convert dry matter to carbon as a conservative approach (all cleared vegetation is considered as forest type). Carbon loss due to deforestation is calculated as 29,757 t-CO_2 equivalent as a conservative approach. Formula used for the calculation is as below.

$C_{LB} = B_{AG} \times A \times CF \times 44/12$

C_{LB} =Carbon stocks in living biomass in forest (t-CO_2e/y)

A = land area of organic soils, (ha)

CF = carbon fraction of dry matter (t-C/t-dm) (default = 0.5, IPCC GPG-LULUCF)

B_{AG} = aboveground biomass, (t-dm/ha)

Parameter	Description		C	Unit	Source
A	land area of Forest		374	ha	JICA team
B_{AG}	Aboveground biomass	Evergreen Forest	43.4	t-dm/ha	Table 3.2.2, IPCC GPG-LULUCF
CF	Carbon fraction of dry matter	Default value	0.5	t-C/t-dm	IPCC GPG-LULUCF

Carbon loss due to deforestation will **29,757** t-CO_2 equivalent.

$$29{,}757 \text{ t-}CO_2e = 43.4\text{t-dm/ha} \times 374\text{ha} \times 0.5 \text{ t-C/t-dm} \times 44/12$$

During the construction stage, emission from construction activities as well as the deforestation is considered to contribute to the GHG emission at certain level. GHG emission will be short and temporally, but the deforestation impact is permanent. Therefore, the impact on climate change during the construction stage is considered to be moderate.

7-7-1-3 Social Environment

(1) Land acquisition and resettlement

The entire project consists of about 203 km high voltage transmission lines and 6 high voltage substations. The Project will involve acquiring the RoW which is about 50m width for the 330kVA transmission line, and 30m width for the 132 kVA transmission line. The total project area is approximately 931 ha consisting of 87 ha of the land for substations and 844 ha of land for transmission lines. Loss of land and crops will have to be compensated before the beginning of the project. These aspects are discussed in detail in Section 7-8.

(2) Employment and Local Economy

There will be no significant adverse impacts on local and regional economy during the line construction. On the other hand, the project could generate some temporary jobs during construction of the transmission lines and substations. In addition, there would be supply chain opportunities for Nigerian companies that can provide goods and services needed by the company.

(3) Utilization of land and local resource

The land use of the affected project area is mostly cultivated area, with primary forest, secondary forest, marshy area and riparian vegetation. There will be a change in land use caused by land take for ROW, vegetation clearance, and access restriction.

No significant cumulative impact is expected on the land use in relation to the existing transmission lines and there would no area that would be significantly restricted from the development. In addition, those people who were involuntary relocated due to the development of existing transmission line would not become the subject for involuntary relocation for this project.

(4) Social Institution

The project area covers various area with different types of administrative system, i.e., administrative division (State and Local government level etc.) and traditional community and (kingdom and chiefdom) and their roles. There was potential conflict on how to name the project component, such as name of substations.

(5) Social Infrastructure

Influx of outside workers may pose additional pressure on social infrastructure, like medical posts, emergency services, water supply, roads and solid waste management. However, there will be no significant impact on the social infrastructure, except temporarily limiting their access.

To the extent possible, existing road will be used as access roads to the ROW. New access road may only be required at swampy area at north of Badagry substation. Access roads are planned to be restricted to 3m for a total distance of around 16 km across the entire project site. The new access road will be built while minimizing environmental and social impacts by planned countermeasures.

(6) Vulnerable group

Marginalization of vulnerable groups (e.g. women heads of households, disabled or elderly, etc.) might be increased if appropriate engagement is not carried out. The impact and mitigation measures for vulnerable group is discussed further in Section 7-8 and 7-9.

(7) Cultural and historical heritage

There are archaeological and sacred sites, such as traditional burial grounds and shrines in the communities which are located within the ROW. 78 shrines in total (11 shrines in Lot 1, 48 shrines in Lot 2 and 19 shrines in Lot 3) are located in the Project area. These sites are not structures seen in Asian countries (e.g. temples and Japanese shrines), are sometimes stones and trees but highly valued by the people and considered sacred and encroachment in such areas would attract serious resentment from the communities. Through the consultation with communities, it was agreed that those cultural heritages will be relocated. The relocation of these cultural heritages is addressed in the Resettlement Action Plan and this will be implemented with continuous consultations with affected communities.

(8) Water right and fishing wright

The project area will not affect any area which would cause conflict related to fishing right since the transmission line route is located onshore. Transmission towers will not be built in any river, such as Ogun River.

(9) Public health and Sanitation, Infectious diseases

During the construction phase, the influx of foreign workers in local communities can increase the risk of communicable diseases such as the transmission of HIV/AIDS. Also, construction areas can be a source of pollution and various disturbances to the surrounding environment – such as waste, septage, and wastewater, if not properly managed. However, this impact remains low since the construction period will be temporary and short term.

(10) Working condition

In the construction, occupational accidents may occur particularly among unskilled labour force, ranging between minor incidents such as cuts and major incidents related with working at height, tower collapse and the risk of electrocution.

(11) Hazardous and security risk

Temporary influx of outside workers in the communities may lead to tensions between outside (partly possibly expatriate) labour and local population due to differences in wealth and culture.

(12) Accidents (Construction work and traffic)

Transport of construction materials, machineries, and workforce will increase traffic volume in the villages. This can be a source of accidents.

Also, occupational accidents may occur particularly among unskilled labour force, ranging between minor incidents such as cuts and major incidents related with working at height, tower collapse and the risk of electrocution.

7-7-2 Operational Stage

7-7-2-1 Environmental Pollution

(1) Air pollution

Sulfur hexafluoride is used in insulation and current interruption applications in transmission network systems and in gas-insulated switch. There is a risk of leakage of SF_6 due to the inappropriate maintenance of the facility.

(2) Water pollution

No impact on the surface waters in the area is anticipated from the operation of the transmission line and the substations since the foundation of transmission line or substation will not be installed within surface water such as a river.

(3) Soil Contamination

There is the potential soil contamination caused due to the inappropriate handling of hazardous chemical, such oils at substation site.

(4) Solid waste

Wastes such as waste oil, general waste will be generated from maintenance activities and substations. Wastes will be collected by licensed waste contractor and disposed at licensed waste management facilities.

(5) Noise and vibration

Noise from overhead line due to Corona effect is expected form transmission line and sub stations. Considering the voltage grade of the Project transmission line and that it will only reach its maximum during rainy events, it is highly unlikely that the corona discharge noise will exceed the normal background noise levels in the area.

(6) Soil Erosion

During maintenance, vehicular movement along unpaved access roads, could cause soil compaction which will affect soil organisms. This effect is likely to affect soils in swampy areas of Badagry. Considering that only small areas are exposed and that frequency of routine inspection of the lines is low, the impact will be minor.

(7) Groundwater

It is assumed that the activity during the operation of transmission line and substations will not interfere with the groundwater, therefore no impact is expected on groundwater.

(8) Hydrogeological situation

It is assumed that the activity during the operation of transmission line and substations will not interfere with the hydrological situation, therefore no impact is expected on hydrological situation

(9) Flora, Fauna, Biodiversity and Ecosystem

During the operational stage, maintenance of the ROW requires regular clearing of vegetation. This vegetation disturbances will lead to a loss of habitats for some terrestrial fauna species. This long-term modification of natural habitats could cause a barrier effect for small fauna, limiting their movements. Nonetheless, these impacts remain limited given the already altered environment caused by human activities.

Power lines are susceptible to impact bat population and birds population during operational phase because the presence of these lines pose risks of collision and electrocution to these species. In general, aquatic birds, including shorebirds, waterfowl, cranes, and herons, are known as the most common victims of power transmission lines (Rioux et al. 2013). Collision risks are higher for species with small binocular fields of vision and large blind areas. Also, Collisions are thought to be more common during migratory movements (Morkill and Anderson 1991).

Based on the consultation with Nigerian Conservation Fund (NCF), which is an NGO dedicated to nature conservation in Nigeria, it is reported that there is no evidence of any bird strike incident via transmission line around the project area.

(10) Landscape

Most of the project area is already developed and there are several existing transmission lines running around the project area and there are no area within the project site with significant landscape value. However, transmission line will be visible even from far place and would change the landscape in the area at a certain extent.

(11) Global Warming

When there are significant leaks from aging equipment, and gas losses occur during equipment maintenance and servicing, the project will have a significant contribution of the emission of GHG emissions since the Sulfur hexafluoride, which is an extremely potent greenhouse gas, is used in the transmission network systems. However, the improvement of electricity grid would contribute to mitigate the GHG emission as a whole and also identified as the key action plan for climate change Nigeria`s nationally determined contribution (NDC) implementation. Therefore, the climate change impact during the operational stage is considered to be positive. Assuming that the maintenance will be conducted appropriately.

7-7-2-2 Social Environment

(1) Local Economy

There are opportunities for businesses and economic development of the country through stabilization of electric power supply to the project area and surrounding areas. In addition, construction works may give rise to positive impact on employment and livelihood.

(2) Utilization of land and local resource

Enhancement of local economy as a result of stabilization of electric power may change the land use in the project area and may result in degradation of greenery area in the region. The degree and nature of the impact on land use due to stabilization of electric power would be varied and it is difficult to predict the impact. However, it is expected that stabilization of the electricity would mainly contribute in improving the condition of existing development, assuming that the land development will be controlled and managed by the regulatory authorities.

(3) Social institution

No negative impact is expected during the maintenance period

(4) Social infrastructure

Improved electricity supply in the area will result in the improvement of social services and may reduce cost of providing these services. These include water supply, schools, telecommunications, etc. that would have otherwise relied on captive power generating plants.

(5) Vulnerable group

Stabilization of electric power would improve the local community, resulting in the improvement of poor condition in the project region as whole.

(6) Misdistribution of benefit and damage, local conflict of interest, gender

No negative impact is expected during the maintenance period

(7) Water right and fishing right

No commercial fishing is practiced in the areas for substation and tower constructions. The project area is not likely affect area which would cause conflict with fishing right. Transmission towers will not be built in any river, such as Ogun River.

(8) Working condition

There may be risks to occupational health & safety while conducting regular and emergency maintenance and repair works. The likelihood of these risks is lower compared to construction stage, as there will be less hired labour and fewer activities, compared to the construction phase.

(9) Hazard and security risk

There may be fire risks due to lack of maintenance (e.g. oil leakage from transformers).

(10) Accidents

There are risks of electrocutions, bush fires, line snapping and tower collapse during the operational phase. The ROW shall be maintained to be cleared and residences or other permanent structure shall be out of ROW. To mitigate this risk, appropriate maintenance program shall be developed for transmission line and substation.

7-7-3 Summary of impacts

(1) Planning and Construction Stage

Table 7-25 Impact Assessment Results during Construction Phase

Environmental Item		Scoping Rate		Impact Assessment Result	Potential Receptor	Impact Rating
		Planning Stage	Construction Stage			
Social Environment	1) Land acquisition/Involuntary Resettlement	A-	D	• A total of 526 households (HHs) with 1,989 PAPs in currently occupied residential land will need to be physically relocated. The structure of HHs will need to be demolished or displaced before the construction • 1,873 of unoccupied structures (e.g. uncompleted structure) will need to be demolished or displaced before the construction. • There are total 3,992 of private land owner of agricultural land whose land will be affected by the project. • Total 372 project affected units are identified occupying on affected land without recognised land occupancy in Likosi S/S.	All affected properties and livelihood	A-
	2) Local economy such as employment and livelihood etc.	D	B-/B+	• Creation of temporary jobs for local's residents and Nigerian nationals with skilled trades ; • Supply chain opportunities for Nigerian companies that can provide goods and services needed by the company.	Local residents of affected communities and Nigerian nationals Nigerian companies and local SMEs	B+
	3) Utilization of land and local resources	B-	B-	Land use • The land use of the affected project area is mostly cultivated area, with primary forest, secondary forest, marshy area and riparian vegetation. Change in land use cause by land take for ROW, vegetation clearance, and access restriction •	Land on the RoW and substation	B-
	4) Social institutions such as social infrastructure and local decision-making institutions	B-	B-	• The project area covers various area with different types of administrative system, i.e., administrative division (State and Local government level etc.) and traditional community and (kingdom and chiefdom) and their roles. There was potential conflict on how to name the project component.	Affected administrative institution	B-
	5) Existing social infrastructures and services	B-	B-	• Influx of outside workers may pose additional pressure on social infrastructure, like medical posts, emergency services, water supply, roads and solid waste management.	Affected communities in project area	B-
	6) Vulnerable group such as the poor, women, children, elderly, disabled etc.	C	C	• Increased marginalization of vulnerable groups (e.g.: women heads of households, disabled or elderly, etc.)	Affected vulnerable people	B-

Environmental Item	Scoping Rate: Planning Stage	Scoping Rate: Construction Stage	Impact Assessment Result	Potential Receptor	Impact Rating
7) Ethnic minority	D	D	Not applicable		
8) Misdistribution of benefit and damage	C	C	• There is potential impact on this item in case that there is not sufficient/transparent information disclosure on project information including land acquisition/resettlement matters, procedures and schedules of construction work such as operation of construction machines and vehicles, and staying of construction workers, and benefits after operation. • The RAP is prepared and disclosed to PAPs.	Affected communities in project area	B-
9) Local conflict of interests	C	C	Same as a above	Affected communities in project area	B-
10) Gender	B-	B-	There are 688 of HHs with woman heads in the project affected area	Households with woman head	B-
11) Children's rights	D	B-	There is no child labor issue on the general construction sector in the project area. Therefore, the no impact is expected on this item	Not applicable	D
12) Cultural and historical, heritage site	C	C	• Shrines are located within the RoW along the transmission line and need to be relocated. • Potential interactions between construction works and cultural festivals due to traffic, noise and/or vibration impacts	Affected communities along the RoW Lot 1: Affected communities in Ifo, Obafemi-Owode and Ewekoro LGAs & their shrines (e.g Ogun. Yemoja and Alale, etc shrines).	B-
13) Water rights, fishing rights and rights of common	D	C	• The project area will not affect area which would cause conflict with fishing right since the transmission line route goes on on-shore area. When crossing the river, no installation of foundation of tower is required in the inside of the River, such as Ogun River.	Not applicable	D
14) Public health and Sanitation	D	B-	• Potential for increase in prevalence of sexually transmitted diseases in local communities	Affected communities in project area	B-
15) Infectious diseases such as HIV/AIDS	D	B-	• Potential for increase in prevalence of sexually transmitted diseases in local communities	Affected communities in project area	B-
16) Working condition (including occupational health)	D	B-	• Occupational accidents may occur particularly among unskilled labour force, ranging between minor incidents such as cuts and major incidents related with working at height, tower collapse and the risk of electrocution.	Construction labour force	B-
17) Hazards/security risks	D	B-	• Temporary influx of outside workers in the communities, risking tensions between outside (partly possibly expatriate) labour and local population, due to differences in wealth and culture.	Workers and affected communities in project area	B-

Environmental Item		Scoping Rate: Planning Stage	Scoping Rate: Construction Stage	Impact Assessment Result	Potential Receptor	Impact Rating
	18） Accidents (Construction work and traffic)	D	B-	• Increased risks of traffic safety incidents on public roads	Affected communities in project area	B-
Natural environment	1） Topography and Geology	D	B-	• Change to soil structure (erosion and compaction) as a result of excavation and backfilling and removal of vegetation (at the tower foundation pits and possibly parts of the access roads)	Soil on construction sites, especially vulnerable at following areas; • Lot1: panigangan, Iregun, Inandan, Okuri Site • Lot2: Likosi/Dejuwogbo and Redeem • Lot3: Badagry substation	B-
Natural environment	2） Soil erosion	D	B-			
Natural environment	3） Groundwater	D	B-	• Potential groundwater contamination from accidental spills and improper disposal of waste and wastewater, including potential alkaline wastewater generated due to the cast in piling method.	Groundwater resources around the construction sites	B-
Natural environment	4） Hydrological situation	D	C	• Potential impact on hydrological condition due to the construction activities including the construction of foundation as well as the access road within the swampy area.	Swampy area around the construction sites including Lot 3: Badagry area	B-
Natural environment	5） Coastal zone	C	C	No coastal zone is affected by the project	Not applicable	D
Natural environment	6） Protected Area	C	C	No protected area is affected by the project	Not applicable	D
Natural environment	7）Flora, Fauna, Biodiversity and Ecosystem	D	B-	<u>Terrestrial Flora and Fauna</u> • A vegetation area needs to be cleared (ROW clearance) and constitute the permanent loss of habitat. • Habitat fragmentation and degradation will result in modification of species composition in flora and fauna communities and the introduction and risk of spread of invasive species • Disturbance to habitats, fauna and flora arising from dust, air emissions, light, noise and vibration, traffic, accidental spillages and sediment run-off • Loss of species that offer provisioning Service	Flora and fauna and habitat in the area of influence and within ROW and Substations	B-

Environmental Item		Scoping Rate: Planning Stage	Scoping Rate: Construction Stage	Impact Assessment Result	Potential Receptor	Impact Rating
				Aquatic • Impact on aquatic and semi-aquatic habitats will be limited in areas where there will be direct construction of pylons and substations • Sediment runoff or accidental discharge possibly impact on aquatic habitat	Local surface water and the inhabiting flora and fauna: Lot 2: Oniyan (Ogun River), Abese (River Wagunu), Asa Elegun, Kori, and Mologun Lot3: Badagry area	
	8) Landscape	D	C	• Temporary presence of an active construction site with storage of materials and equipment within the RoW and/or the site for the substation.	People living close to the construction sites.	B-
	9) Local climate	D	D	Not applicable		
	10) Global warming/climate change	D	B-	• GHG emission from construction activities • Reduction in carbon sink ability of the environment due to vegetation clearing.	Local & global climate	B-
Environmental Pollution	1) Air pollution	D	B-	• Localized impairment of air quality by exhaust emissions from vehicles and equipment engines (SO_2, CO, NOx, CO_2, PM) • Elevated dusted levels in nearby communities as a result of dust raised by vehicle movements, wind, and handling of dusty material	Affected communities in project area	B-
	2) Water pollution	D	B-	• Potential surface contamination from accidental spills and improper disposal of waste and wastewater, including potential alkaline wastewater generated due to the cast in piling method.	Surface water and swampy area around the construction sites including • Lot 3: Badagry area	B-
	3) Soil contamination	D	B-	• Potential contamination of soil from inadvertent release of hazardous or contaminating material (liquid fuel, solvents, lubricants, aluminium oxide paint, etc.)	Soil on construction site, especially by construction camp and each tower	B-
	4) Bottom sediment contamination	D	B-	• Potential contamination of bottom sediment from inadvertent release of hazardous or contaminating material (liquid fuel, solvents, lubricants, aluminium oxide paint, etc.) due to the construction of foundation of tower as well as access road within swampy area. • No construction of pillar is expected within the water source, such as in River.	Bottom sediment on construction site, especially within swampy area including • Lot 3: Badagry area	B-
	5) Solid waste	D	B-	• Generation of vegetation waste due to the clearing of vegetation, general waste from work force, scrap metal, concrete waste.	Around the construction site	B-
	6) Noise and vibration	D	B-	• Nuisance noise from construction activists	Affected communities in project area	B-

Environmental Item		Scoping Rate		Impact Assessment Result	Potential Receptor	Impact Rating
		Planning Stage	Construction Stage			
	7） Ground subsidence	D	D	Not applicable		
	8） Odor	D	D	Not applicable		
	9） Radio disturbance	D	D	Not applicable		
	10) Electromagnetic field	D	D	Not applicable		

(2) Operational Phase

Potential impacts during operation will be limited to vegetation loss from maintaining ROW, wastes from maintenance activities, risks to occupational health and safety, and impacts from accidental events.

Table 7-26 Impact Assessment Results during Operational Phase

Environmental Item		Scoping Rate Operation Stage	Impact Assessment Result	Potential Receptor	Impact Rating
Social Environment	1) Land acquisition/Involuntary Resettlement	D	Not applicable		
	2) Local economy such as employment and livelihood etc.	A+	• There is an opportunities for businesses and economic development of the country through stabilization of electric power supply to the project area and surrounding area. In addition, temporary road for construction work and new road construction for maintenance of transmission line may give rise to positive impact on employment and livelihood.	Local economy	B+
	3) Utilization of land and local resources	C	• Enhancement of local economy as a result of stabilization of electric power may change the land use in the project area. The degree and nature of the impact would be varied and it is difficult to predict the impact. However, stabilization of the electricity would mainly contribute to improve the condition of existing development area and pressure will be on natural environmental area (forest, swampy area) is assumed	Local land resource	B+
	4) Social institutions such as social infrastructure and local decision-making institutions	C	• No negative impact is expected during the maintenance period	Not applicable	D
	5) Existing social infrastructures and services	B+	• Improved electricity supply for the national grid	Social infrastructure	B+
	6) Vulnerable group such as the poor, women, children, elderly, disabled etc.	C	Stabilization of electric power would improve the local community, resulting in the improvement of poor condition in the project region as whole.	Vulnerable people	B+
	7) Ethnic minority	D	Not applicable		
	8) Misdistribution of benefit and damage	C	• No negative impact is expected during operational stage	Not applicable	D
	9) Local conflict of interests	C	• No negative impact is expected during operational stage	Not applicable	D
	10) Gender	C	• No negative impact is expected during operational stage	Not applicable	D
	11) Children's rights	D	• No negative impact is expected during operational stage	Not applicable	D

	Environmental Item	Scoping Rate Operation Stage	Impact Assessment Result	Potential Receptor	Impact Rating
	12）Cultural and historical, heritage site	D	• Potential interactions between maintenance works and cultural festivals due to traffic, noise and/or vibration impacts	Affected communities in the RoW	B-
	13）Water rights, fishing rights and rights of common	C	The project area will not affect area which would cause conflict with fishing right. When crossing the river, no installation of foundation of tower is required in the inside of the River, such as Ogun River.	Not applicable	D
	14）Public health and Sanitation	D	Not applicable		
	15）Infectious diseases such as HIV/AIDS	D	Not applicable		
	16）Working condition (including occupational health)	B-	• Potentially workers may be exploited and occupational health & safety risks may occur in the regular and emergency maintenance and repair works.	Workers	B-
	17）Hazards/security risks	B-	• There is a risk of a fire from transmission line and tower, and sub-station facilities.		B-
	18）Accidents	B-	• External safety risks of electrocutions, bush fires, line snapping, tower collapses	Affected communities along the Row Maintenance workers	B-
Natural environment	1）Topography and Geology	D	Not applicable		
	2）Soil erosion	B-	• Compaction effects on soil structure due to vehicular movement in swampy areas during line maintenance	Lot 3: Ecologically sensitive areas, particularly around Badagry	B-
	3）Groundwater	C	• No negative impact is expected after the construction.	Not applicable	D
	4）Hydrological situation	C	• No negative impact is expected after the construction.	Not applicable	D
	5）Coastal zone	D	Not applicable		
	6）Protected Area	D	Not applicable		
	7）Flora, Fauna, Biodiversity and Ecosystem	B-	<u>Flora and Fauna</u> • Impact due to alien species • Impact on aquatic species due to maintenance of ROW	Flora and fauna within the RoW	B-
			<u>Avifauna</u> • Habitat of ecological importance for birds in the project area is around marshy area around Badagry. • Based on the consultation with the consultation with The Nigerian Conservation Foundation (NCF), it was evident that there is no fact that the presence of transmission line cause the bird strike around the project area.	Birds in the area of influence	B-

Environmental Item		Scoping Rate Operation Stage	Impact Assessment Result	Potential Receptor	Impact Rating
	8）Landscape	C	• Transmission lines and towers will be visible from far and become an extrinsic element in the landscape.	Communities near RoW	B-
	9）Local climate	D	Not applicable		
	10）Global warming/climate change	(D)B-/+	• the improvement of electricity grid would contribute to mitigate the GHG emission as a whole and also identified as the key action plan for climate change Nigeria`s nationally determined contribution (NDC) implementation.	Local and global climate	B+
Environmental Pollution	1）Air pollution	D	• There is a risk of leakage of SF6 due to the inappropriate maintenance of the facility.	Workers on site, communities in project area.	B-
Environmental Pollution	2）Water pollution	B-	• No impact on the surface water and hydrogeology of the area is anticipated from the operation of the transmission line and the substations	Local surface water sources	D
Environmental Pollution	3）Soil contamination	(D)C	• Potential contamination of soil from inadvertent release of hazardous or contaminating material.	Areas along RoW and substations	B-
Environmental Pollution	4) Bottom sediment contamination	D	Not applicable		
Environmental Pollution	5）Solid waste	(D)B-	• Wastes such as waste oil, general waste will be generated from maintenance activities and substations.	Areas along RoW and substations	B-
Environmental Pollution	6）Noise and vibration	B-	• Noise from overhead line due to Corona effect is expected form transmission line and sub stations. Considering the voltage grade of the Project transmission line and that it will only reach its maximum during rainy events, it is highly unlikely that the corona discharge noise will exceed the normal background noise levels in the area.	Affected communities along the RoW and substations	B-
Environmental Pollution	7）Ground subsidence	D	Not applicable		
Environmental Pollution	8）Odor	D	Not applicable		
Environmental Pollution	9）Radio disturbance	D	Not applicable		
Environmental Pollution	10) Electromagnetic field	D	Not applicable		

7-7-4 Environmental and Social Management Plan (ESMP)

(1) Implementation System

1) Pre-construction and construction stage

The Environmental and Social Management Plan (ESMP) and monitoring activity will be implemented by EPC Contractor under the supervision of TCN during pre-construction and construction stage. TCN has set up a Project Implementation Unit (PIU), who will be responsible for the project execution during this stage.

In the PIU, Environmental and Social Unit will be a responsible administrator to manage environmental and social aspect including the implementation of ESMP. PIU will coordinate with TCN Management and TCN Lagos Regional Office for the necessary support for the preparation and implementation of ESMP. Figure 7-23 illustrates the structure of the institutional arrangements.

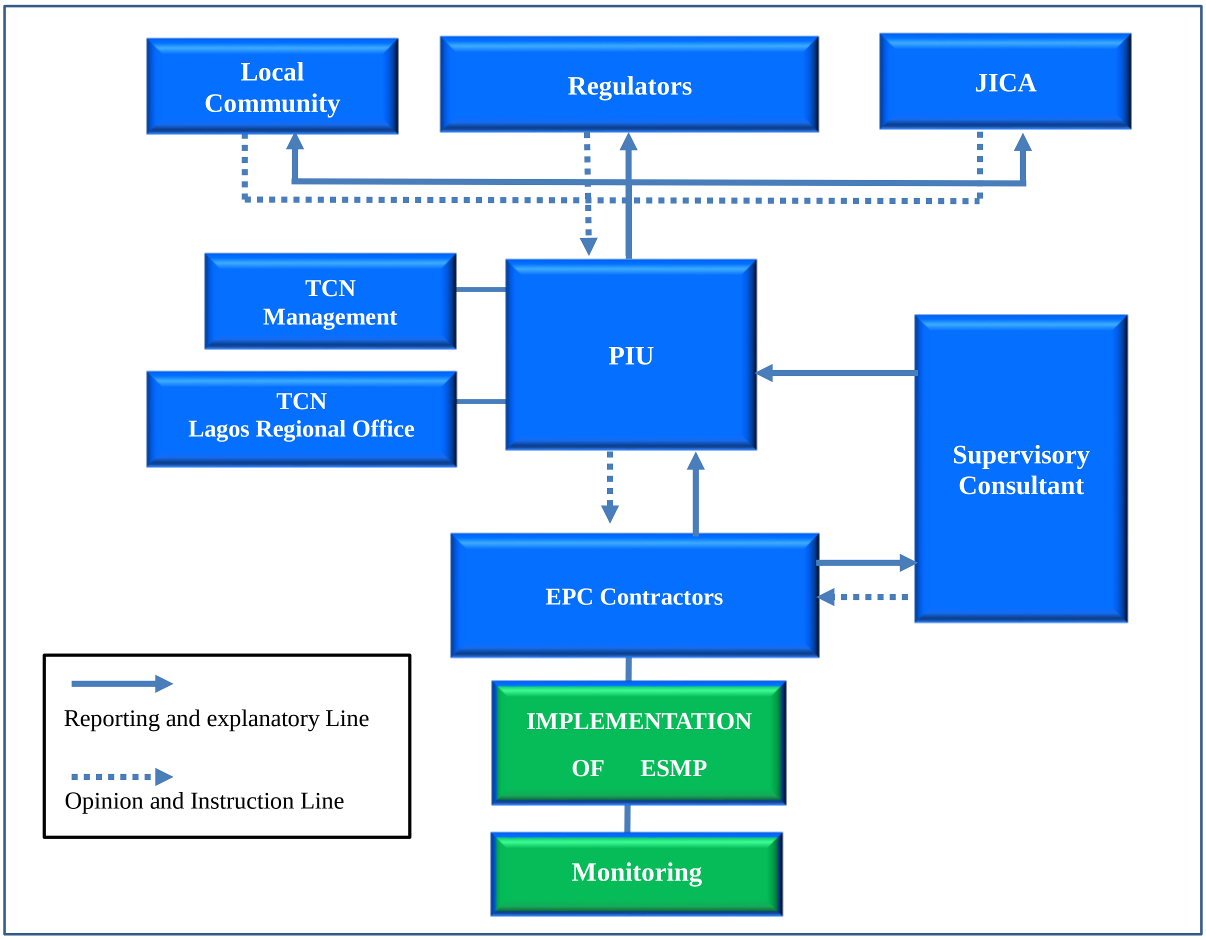


Figure 7-23 Implement structure of ESMP for pre and during construction stage

PIU will instruct contractors to ensure that implementation of ESMP will be carried out in appropriate manner. In order to confirm the implementation of environmental management and to consider further mitigation measures, the contractors shall carry out environmental monitoring according with monitoring plan and prepare and submit the environmental monitoring report to PIU and Supervisory Consultant. It is responsibility of contractors to obtain necessary permit prior or during the construction stage, including the tree cutting permit and waste generation permit from the State Government. The operator (i.e. contractors in this project) is required to submit a Site Waste Management Plan (SWMP) to Federal Ministry of Environment prior to the commencement of construction works in accordance with National Environmental (Construction Sector) Regulations, 2011. PIU and Supervisory consultant will also monitor that the contractors has obtained these permit appropriately.

PIU shall regularly hold explanation session to local communities, and continuously listen to their grievances, then submit the monitoring report regularly to stakeholders, including Regulators (such as FMEnv and State Governments) and JICA regarding these grievance, as well as the implementation status of environmental management and environmental monitoring.

2) Operational stage

TCN after the transfer of operation will take a responsibility for the implementation of ESMP during operational stage. The HSE coordinator of TCN will be the responsible for all environmental and issue, including;

- Communicate with the regulatory authorities and communities.
- Communicate with communities
- Prepare relevant HSE documents,
- Implement the necessary mitigation measures as described in ESMP
- Carry out monitoring and prepare monitoring report
- Conduct internal audit

(2) Management Plan

The Environmental and Social management and mitigation measures, and the responsibilities for implementation are in Table 7-27 and Table 7-28 respectively. The EPC contractors have responsibility for implementing the mitigation actions during construction phase. The budget for implementation shall be included in the EPC contract as part of the overall construction cost.

Additional detailed specific plans shall be developed by EPC Contractor to support the implementation which are included in the standalone ESMP report. These Plan shall be reviewed and approved by PIU prior to the commencement of the construction. The list of the management plans for this project is below.

- Waste Management Plan;
- Vegetation Management Plan
- Local Content Plan

- Traffic Management Plan;
- Occupational Health and Safety Management Plan.

(3) Monitoring Plan

The monitoring plan in Table 7-29 (Construction stage) and Table 7-30 (operational Stage) contain details of responsibilities, parameters to be monitored. Monitoring methods and standards/targets as well as locations and monitoring frequency. EPC Contractors will carry out the monitoring during the construction stage at the cost of EPC contractors under the supervision by PIU. During the operational stage TCN HSE Department will carry out the monitoring.

Monitoring Report will be prepared and submitted as followingMonitoring Report	Prepared by	Submitted to
Construction stage		
Monthly Monitoring Report	EPC Contractors	PIU
Quarterly Monitoring Report	PIU	- FMEnv, OGMEnv and LAMEnv - JICA
Operational stage		
Annual Monitoring Report	TCN-HSE Dept.	- FMEnv, OGMEnv and LAMEnv - JICA

(4) Capacity Building

It is recommended to conduct capacity building for PIU and officers in Lagos office to improve the capacity for the implementation of ESMP, especially on following items.

- Training on the Handling and clean-up of PCB contaminated materials,
- Monitoring & Modelling,
- Environmental Audit,
- Basic Sampling Techniques,

Table 7-27 Environmental and Social Management and Mitigation Measure (Construction Phase)

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	Sub-station	Access and maintenance road		Mitigation Action/Cost	Supervision	External Monitoring or Reported to (when necessary)
Air quality	Localized impairment of air quality by exhaust emissions from vehicles and equipment engines (SO_2, CO, NOx, CO_2, PM)	Affected communities in area of influence	×	×	×	▪ Maintain and operate all vehicles and equipment engines in accordance with manufacturers recommendations ▪ Stationary generators to be located to facilitate dispersion	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV
	Elevated dust levels due to vehicle movements, wind, and handling of dusty material	Affected communities in area of influence	×	×	×	▪ Cover properly loose materials and keep top layers moist ▪ Regular cleaning of equipment, drains and roads to avoid excessive buildup of dirt ▪ Spray surfaces prior to excavation ▪ Use covered trucks for the transportation of materials that release dust emissions ▪ Speed limits on-site of 15 km/h on unhardened roads and surfaces	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV
Climate change	GHG emissions that could add to climate change effects	Global warming	×	×	×	▪ Maintain and operate all vehicles and equipment engines in accordance with manufacturers specifications, location of stationary generators to facilitate dispersion, restriction of vegetation clearing to only the required area	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV
Noise, vibration	Nuisance noise from construction activities	Affected communities in area of influence Construction workers	×	×	×	▪ Select 'low noise and vibration' equipment or methods of work ▪ To minimize vibration of vehicles and trucks, access road will be graded ▪ Heavy materials will be transported only during daytime ▪ Use temporary noise barriers for equipment (e.g. sound proofing walls around stationary power generating sources). ▪ Maintain and operate all vehicles and equipment's in accordance with manufacturers recommendations	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	Sub-station	Access and maintenance road		Mitigation Action/Cost	Supervision	External Monitoring or Reported to (when necessary)
						▪ Ensure periods of respite are provided in the case of unavoidable maximum noise level events Inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as providing the contact details of the responsible person. ▪ Noisy activities (activities that can be heard in nearby communities) restricted to day-time working hours ▪ Provide appropriate PPE to construction workers and visitors			
Soils, geology and land-use	Change to soil structure (erosion and compaction) as a result of excavation and backfilling and removal of vegetation	Soil on construction site	×	×	×	▪ Construction of foundations to be undertaken in the dry period as reasonable as possible. ▪ Protect excavated soil materials from erosion (e.g. ▪ Ensure that the land is physically restored (include revegetation where possible) before leaving to next tower location and before the next rainy season. ▪ Use of existing road for transport of man and material to the extent possible.	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV
	Potential contamination of soil from inadvertent release of hazardous or contaminating material (liquid fuel, solvents, lubricants, aluminium oxide paint, etc.)	Soil on construction site, especially by each tower	×	×	×	▪ Implement effective site drainage on the construction yard to allow for the directed flow of surface water off site. This shall include cut-off drains to divert surface runoff from exposed soils or construction areas. ▪ Install oil/water separators and silt traps before effluent, leaves the site. ▪ Minimise bare ground and stockpiles to avoid silt runoff. ▪ Bunding of areas where hazardous substances are stored (e.g. fuel, waste areas). Regular checking and maintenance of all plant and equipment to minimize the risk of	EPC Contractor EPC Contractor	TCN/PIU Supervision Consultant TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV FMENV, OGMENV and LAMENV

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	Sub-station	Access and maintenance road		Mitigation Action/Cost	Supervision	External Monitoring or Reported to (when necessary)
						fuel or lubricant leakages. ▪ Training of relevant staff in safe storage and handling practices, and rapid spill response and clean-up techniques. ▪ Set-up and apply procedure regarding dealing with contaminated soils. ▪ Development and implementation of a Waste Management Plan to ensure that waste is disposed of correctly. ▪ Spread sheet underneath the tower structure prior to start any painting activity.			
Water resources	Potential surface and groundwater contamination from accidental spills and improper disposal of waste and wastewater	Local groundwater-well and bore hole	×	×	×	▪ See above measures to mitigate 'Potential contamination of soil' impact	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV
	Potential impact on hydrological condition due to the construction activities including the construction of foundation as well as the access road within the swampy area.	Rivers and streams crossed	×		×	▪ Natural flow of a River shall not be blocked ▪ Based on an appropriate project design, avoid erecting towers within wetlands. If unavoidable, select the most optimized site for each tower considering human uses and areas of higher ecological integrity. ▪ Prohibit construction of permanent access roads along river banks, in swamps or in areas where soils are saturated ▪ Consider and Select the engineering design for construction work, including construction of foundation as well as access road, which would minimize the impact on hydrological condition. ▪ Cement will be mixed outside swampy area, river and stream and will be brought at construction site to avoid wastewater discharge to water resources ▪ In case that impact to water sources is	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	Sub-station	Access and maintenance road		Mitigation Action/Cost	Supervision	External Monitoring or Reported to (when necessary)
						unavoidable, drinking water will be provided during the period when impact is expected (i.e. construction period)			
Terrestrial ecology	Vegetation loss and disturbance to habitats, fauna and flora by construction activities	Flora and fauna and habitat in the area of influence Flora and fauna and habitat in the area of influence	×	×	×	▪ Minimize the construction of new access roads. Promote the use of existing access roads for machinery and vehicle movements. ▪ Promote the use of existing roads for transporting material and tower parts to the construction sites in order to reduce the project's footprint and minimize the need for new access roads ▪ Herbicides should not be used for vegetation clearing ▪ Clearing should be minimised and restricted to the area required for construction purposes only and disturbance to adjacent vegetation communities and/or remnant trees within the corridor should be strictly controlled.	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV
						▪ Revegetation will be carried out, as necessary. Revegetation will use species locally native to the site. The site of revegetation shall be identified and provided by the relevant government agency.	TCN 100,000USD	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV
	Vegetation clearing will cause habitat disturbances that could create suitable conditions for invasive species to spread	Flora and fauna and habitat in the area of influence	×		×	▪ Implementation of the invasive species management plan as part of the Vegetation Management Plan.	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV
	Potential avian collision	Birds in the area of influence	×	×	×	▪ Consult with relevant agency (e.g. local NGO) to seek any advice for mitigation measures to be considered for the design and construction of the transmission line. ▪ "Bird diverters" on the top (ground) wire to make the lines more visible to birds shall be installed, particular in the swampy areas of	EPC Contractor	PIU Supervision Consultant	FMENV, OGMENV and LAMENV

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	Sub-station	Access and maintenance road		Mitigation Action/Cost	Supervision	External Monitoring or Reported to (when necessary)
						Badagry ▪ Complete tree and/or brush cutting prior to or after the core nesting season			
	Loss of species that offer Provisioning Services	Local communities who rely on provisioning service, especially around swampy area.	×		×	▪ Site clearance activities to be restricted to the minimum required area	EPC Contractor	PIU Supervision Consultant	FMENV, OGMENV and LAMENV
						▪ Provide a training/education for the sustainable livelihood practice to local communities, as necessary, with cooperation of relevant agency.	NGO, Expert, Academia 50,000USD	TCN/PIU	FMENV, OGMENV and LAMENV
Aquatic ecology	Loss/disturbance of aquatic species	Rivers/streams/Swampy area crossed	×		×	▪ Natural flow of a River shall not be blocked ▪ Conduct activities during the dry period to minimize disturbance of sensitive shoreline and wetland areas ▪ Adjust pylon siting to span rivers and wetlands areas, or limit equipment access in wetlands, wherever possible. ▪ Perform all vegetation clearing work manually along streams/rivers and swamps. ▪ Avoid vegetation clearing along stream shores and on steep slopes. ▪ Based on an appropriate project design, avoid erecting towers within wetlands. If unavoidable, select the most optimized site for each tower considering human uses and areas of higher ecological integrity. ▪ Prohibit construction of permanent access roads along river banks, in swamps or in areas where soils are saturated ▪ Dismantle temporary access roads built for construction phase in swamps and wetland areas. Perform this dismantlement during the dry season and dispose of materials outside wetland areas;	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	Sub-station	Access and maintenance road		Mitigation Action/Cost	Supervision	External Monitoring or Reported to (when necessary)
						▪ Avoid equipment and vehicle movements in rivers, floodplains and wetland areas. If unavoidable, reduce access to a minimum length in wetlands and floodplains and select the most optimized site for the access considering human uses and areas of higher ecological integrity			
Waste management	Potential contamination of soil from inadvertent release of hazardous or contaminating material (liquid fuel, solvents, lubricants, aluminium oxide paint, etc.)	Surrounding environment and communities	×	×	×	▪ Prepare and implement the waste management plan	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV
Visual amenities	Temporary presence of an active construction site with storage of materials and equipment within the ROW and/or the site for the substation.	People living close to the construction sites.	×	×	×	▪ Maintain construction site in orderly condition and do not distribute material over many sites before usage.	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV
Land planning and use	Change in land use cause by land take for towers, vegetation clearance, and access restriction	Land on the RoW	×		×	▪ Site clearance activities to be restricted to the minimum required area. ▪ Provision of predefined route, barriers or boundary markings to prevent incursion of machinery and workers into neighboring areas ▪ See below measures under 'Resettlement'	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV
Stakeholder and Community expectation/ relations Management	Community concerns linked to impacts associated with construction phase issues (like air and dust emissions, traffic, influx and community	Affected communities in area of influence	×	×	×	▪ Follow mitigation for construction phase air quality, water quality, noise and traffic. ▪ Inform communities about details of construction activities (e.g., employment opportunities, schedule, timing of noise activities, traffic including movements of oversized loads) by billboards, posters and	PIU RIC	TCN/PIU	FMENV, OGMENV and LAMENV

Indicator	Potential impact	Receptor	Project Component: Transmission Line	Project Component: Sub-station	Project Component: Access and maintenance road	Mitigation or enhancement measures	Responsibilities: Mitigation Action/Cost	Responsibilities: Supervision	Responsibilities: External Monitoring or Reported to (when necessary)
	safety/security, noise/vibration, etc.) and adverse impact/inconveniencies resulting from it.					community meeting ▪ Set-up and effectively monitor construction grievance redress mechanism ▪ Engage communities in the monitoring activities to enhance transparency and involvement.			
Community Health, Safety and Security	Increased risks of traffic safety incidents on public roads	People living close to access roads and road users	×	×	×	▪ Implement a traffic management plan including design of access point, signalization, speed limits, training of drivers, use of traffic guards, procedures for transport of oversized loads (e.g., engines), maintain log of traffic related incidents, sensitization of road users and people living close to the construction site.	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV
	Risk of erosion into creeks, which are used as source of domestic water for the communities	People who use the river water as source of domestic water	×	×	×	▪ Follow mitigation for construction phase water quality			
	Temporary influx of outside workers in the communities, risking tensions between outside (partly possibly expatriate) labour and local population, due to differences in wealth and culture.	Affected communities in area of influence	×	×	×	▪ Priority of employment shall be given to locals. ▪ A Local Content Plan should be prepared to facilitate involvement of local labour. ▪ Develop a code of behaviours for workers. All workers to receive training on community relations and code of behaviour. ▪ Periodic refreshing as needed based on community liaison/grievance mechanism feedback.	EPC Contractor	TCN/PIU Supervision Consultant	FMENV, OGMENV and LAMENV
	Potential for increase in prevalence of sexually transmitted diseases in local communities and other diseases	Affected communities in area of influence	×	×	×	▪ Do sensitization and awareness to all EPC workers regarding sexually transmitted diseases ▪ Provide Sexually transmitted disease awareness material to all EPC workers and host communities	EPC Contractor	TCN/PIU Supervision Consultant	National Agency for Control of AIDS (NACA)
Resettlement	Land acquisition	Affected properties and	×	×	×	▪ Follow principles and procedures of	PIU	TCN/PIU	Witness

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	**Sub-station**	**Access and maintenance road**		**Mitigation Action/Cost**	**Supervision**	**External Monitoring or Reported to (when necessary)**
		livelihood				Resettlement Action Plan (RAP), including way forward, micro-plans per affected household.	RIC		NGO
Labour and working conditions	Exploitation of workers	Labour force	×	×	×	▪ Develop transparent human resources policies and procedures for recruitment process, working conditions and Terms of Employment wages, worker-employer relations, Grievance Redress Mechanism, non-discrimination, monitoring, roles and responsibilities following Nigerian Labour Law and ILO conventions. ▪ Provide reasonable, and if applicable negotiated, working terms and conditions. ▪ Establish worker's grievance redress mechanism, so that potential conflicts can be dealt with in an early and proper way. ▪ No use of child labour (workers under age 18) or forced labour ▪ Provisions to ensure compliance with labour standards by supply chain and subcontracts, including training if required. ▪ Provide proper work place facilities for water/sanitation/rest rooms etc. ▪ A worker's grievance redress mechanism will be in place.	EPC Contractor	TCN/PIU Supervision Consultant	TCN relevant department
	Activities and staff at site may create security risk (e.g. infiltration of criminal)	Workers and local communities	×	×	×	▪ Liaise with community security structure ▪ Provision of security during the construction work ▪ Make security plan and emergency response and contacts with security forces. Coordinate if applicable with TCN security measures for their site. ▪ Provide the identification tag for all workers and visitors.	EPC Contractor	PIU Supervision Consultant Nigerian Security and Civil Defense (NSCDC)	Nigerian Police Force
	Creation of tension between security	Local communities	×	×	×	▪ Provide the training and awareness to security personnel	EPC Contractor	TCN/PIU Supervision	Nigerian Police

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	Sub-station	Access and maintenance road		Mitigation Action/Cost	Supervision	External Monitoring or Reported to (when necessary)
	personel and local communities					▪ Establish the communication with local communities and awareness		Consultant Nigerian Security and Civil Defense (NSCDC)	Force
	Risk of health & safety incidents amongst labour force, including minor incident's such as cuts and major incidents such as loss of life	Construction labour force	×	×	×	▪ Develop project specific health and safety procedure, including provisions for training and certifications to be followed by all workers including subcontractors.	EPC Contractor	TCN/PIU	TCN HSE department
Employment and economy	Creation of temporary jobs for locals residents and Nigerian nationals with skilled trades	Local residents of affected communities and Nigerian nationals	×	×	×	▪ Prepare a local content plan to enhance ability to locate local hires and Nigerian nationals. Include provisions for hiring women and youth and for "equal pay for work of equal value". ▪ A local hiring office (or offices) to be set-up for use by all contractors to advertise positions, receive applications, and provide guidance to applicants.	EPC Contractor	TCN/PIU	TCN
	Supply chain opportunities for Nigerian companies that can provide goods and services needed by the company	Nigerian companies and local shops	×	×	×	▪ Prepare a local content plan to facilitate identification and selection of qualified local and Nigerian companies to provide needed supplies and services. Include provisions for advance notice to local companies, along with selection criteria including health and safety, to allow them to prepare for upcoming opportunities.	EPC Contractor	TCN/PIU	TCN
Infrastructure	Influx of outside workers may pose additional pressure on social infrastructure, like medical posts, emergency services,	Affected communities in area of influence	×	×	×	▪ Coordinate with medical posts and emergency services to prepare for water supply and waste management. ▪ Install proper and independent facilities at construction site for water supply, sanitation, solid and liquid waste, so that pressure on	EPC Contractor	TCN/PIU	TCN

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	Sub-station	Access and maintenance road		Mitigation Action/Cost	Supervision	External Monitoring or Reported to (when necessary)
	water supply, solid waste management					community infrastructure is limited.			
Cultural heritage	Shrines are located within the RoW along the transmission line and need to be relocated.	Affected cultural heritage	×		×	▪ The shrines will be relocated to outside the RoW, where the local communities will continue to use them. The exact location and ceremony for relocation will be managed by the communities ▪ During road construction, shrines will be avoided	RIC	PIU	Witness NGO
	Potential interactions between construction works and cultural festivals due to traffic, noise and/or vibration impacts	Affected communities along the RoW and substation	×	×	×	▪ Consult with local communities on festivals and potentials for interaction with construction works. If required cease works on the specific dates.	RIC	PIU	Witness NGO

Table 7-28 Environmental and Social Management and Mitigation Measure (Operations Phase)

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	Sub station	Access and maintenance road		Mitigation Action	Supervision	External Monitoring or Reported to (when necessary
Air pollution / Climate Change:	Accidental significant leaks of SF6 from aging equipment, and gas losses occur during equipment maintenance and servicing	Air quality	×	×		▪ Impact of SF6 shall be mitigated through the improvements in the leak rate of new equipment, refurbishing older equipment, and the use of more efficient operation and maintenance techniques.	TCN	TCN HSE Dept.	FMENV,
Noise, vibration & EMF	Noise & EMF from overhead line due to Corona effect and EMF effect	Affected communities along the RoW and Substations	×	×		▪ Avoiding over loading Transmission Lines ▪ Keep residences and other permanent structures such as schools, shops or offices out of the RoW to minimize exposure to Noise and EMFs. ▪ Noise and vibration sources will be installed center portion of Substation site as reasonable as practicable, avoiding site boundaries.	TCN	TCN HSE Dept.	FMENV,
Soils, geology and land-use	Potential contamination of soil from inadvertent release of hazardous or contaminating material (liquid fuel, solvents, lubricants, aluminum oxide paint, etc.)	Soil in substations and maintenance road	×	×	×	▪ Proper management of hazardous substances storage space (e.g. fuel, waste areas). Regular checking and maintenance of all plant and equipment to minimize the risk of fuel or lubricant leakages. ▪ Training of relevant staff in safe storage and handling practices, and rapid spill response and clean-up techniques. ▪ Development and implementation of a Waste Management Plan to ensure that waste is disposed of correctly.	TCN	TCN HSE Dept.	FMENV, OGMENV and LAMENV
Terrestrial ecology	Impairments of natural habitats and associated flora communities	Flora and fauna around the ROW	×		×	▪ Maintain all maintenance work inside the footprint of RoW to reduce encroachment on natural habitats ▪ Clearly mark the extent of vegetation control in the ROW. Identify and mark the vegetation to be preserved along sections of the ROW ▪ Undertake selective control of the vegetation in order to keep low scrubby and herbaceous species that do not represent a risk for the powerline (species that cannot grow more than 4m in height) ▪ Use mechanical method for vegetation control	TCN	TCN HSE Dept.	FMENV, OGMENV and LAMENV

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	Sub station	Access and maintenance road		Mitigation Action	Supervision	External Monitoring or Reported to (when necessary
						inside the ROW. ▪ Forbid use of chemical pesticides to control vegetation in the ROW			
		Bats and Birds in the area of influence	×		×	▪ Schedule RoW maintenance activities to avoid breeding and nesting seasons of bird species with special status ▪ Develop and implement a mortality monitoring program, as necessary, with cooperation of local NGO.	TCN	TCN HSE Dept.	FMENV, OGMENV and LAMENV
	Potential Impact due to introduction of alien species	Flora and fauna around the ROW	×		×	▪ Develop and implement vegetation management plan to control the introduction of alien species ▪ A monitoring program of invasive species propagation within the right-of-way should be instituted and, if present, shall be removed.	TCN	TCN HSE Dept.	FMENV, OGMENV and LAMENV
	Loss of species that offer Provisioning Services	Local communities who rely on provisioning service, especially around swampy area.	×		×	▪ Undertake monitoring of natural resources exploitation and implement a sensitization program in order to educate and increase local communities' awareness on natural resources protection	TCN	TCN HSE Dept.	FMENV, OGMENV and LAMENV
Aquatic ecology	Degradation of aquatic species	River crossings along the ROW	×		×	▪ Wastes shall not be disposed along water courses or sensitive areas. ▪ Existing access roads shall be utilized during maintenance of the ROW. ▪ Avoid equipment and vehicle movements in rivers, floodplains and wetland areas as reasonable as practicable. ▪ Forbid use of chemical pesticides to control vegetation in the ROW	TCN	TCN HSE Dept.	FMENV, OGMENV and LAMENV
Waste management	Wastes such as waste oil, general waste will be generated from maintenance activities and substations	Surrounding environment and communities	×	×	×	▪ Prepare and implement the waste management plan	TCN	TCN HSE Dept.	FMENV, OGMENV and LAMENV
Visual	Transmission lines and	Communities	×		×	▪ Vegetation will be felled, but if possible smaller trees	TCN	TCN HSE	FMENV,

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	Sub station	Access and maintenance road		Mitigation Action	Supervision	External Monitoring or Reported to (when necessary
amenities	towers will be visible from far and become an extrinsic element in the landscape.	around the project area				can be kept. .		Dept.	OGMENV and LAMENV
Stakeholder and Community expectation/ relations Management	Management of Community concerns linked to impacts associated with operation phase issues	Affected communities in the area of influence	×	×	×	▪ Set-up, manage and manage grievance redress mechanism ▪ Engage communities in the monitoring activities to enhance transparency and involvement. ▪ Prepare and implement Stakeholder Engagement Plan(SEP). ▪ Enhance ongoing consultations with local communities by TCN to create continuous dialogue, trust and planning of community development activities according to SEP. ▪ Explain effects of electromagnetic fields to communities to limit concerns. Keep fields within limits of International Commission on Non-Ionizing Radiation Protection (ICNIRP). ▪	TCN	TCN HSE Dept.	FMENV, OGMENV and LAMENV
Community Health, Safety and Security	External safety risks of electrocutions, bush fires, line snapping, tower collapses	Affected communities along the RoW and Substations	×	×	×	▪ Develop an emergency response plan following TCN and international best practice including provisions for prevention and response to electrocution, fires, repair of snapped lines and collapsed towers, roles and responsibilities. Coordinate with emergency services of LGAs ▪ Keep residences and other permanent structures such as schools, shops or offices out of the wayleave to minimize exposure to EMFs ▪ Communicate to communities in RoW the safety risks of the transmission lines and provide response measures. Put sign boards on towers about electrocution risk. ▪ Implement the anti-climbing device for on the Transmission Tower.	TCN	TCN HSE Dept.	FMENV, OGMENV and LAMENV
Labour and working	Exploitation of workers	Labour force for maintenance work	×	×	×	▪ Develop transparent human resources policies and procedures for recruitment process, working	TCN	TCN HSE Dept.	FMENV, OGMENV

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	Sub station	Access and maintenance road		Mitigation Action	Supervision	External Monitoring or Reported to (when necessary
conditions						conditions and Terms of Employment wages, worker-employer relations, Grievance Redress Mechanism, non-discrimination, monitoring, roles and responsibilities following Nigerian Labour Law and ILO conventions. ▪ Provide reasonable, and if applicable negotiated, working terms and conditions. ▪ Establish worker's grievance mechanism, so that potential conflicts can be dealt with in an early and proper way. ▪ No use of child labour (workers under age 18) or forced labour. ▪ Provisions to ensure compliance with labour standards by supply chain and subcontracts, including training if required. ▪ A worker’s grievance mechanism will be in place. ▪			and LAMENV
	Occupational H&S risks in operation and maintenance	Labour force	×	×	×	▪ TCN should follow their Occupational HSE plan following Nigerian and international requirements: train staff, monitor and keep record. Special focus on slip-trip, fall from height and electrocution in maintenance and repair works, emergency prevention and management. Use personal protection equipment. ▪ Have medical emergency equipment at hand.	TCN	TCN HSE Dept.	FMENV, OGMENV and LAMENV
Employment and Economy	Improved electricity supply for the national grid, creating opportunities for businesses and economic development in the country.	National level Nigeria	×	×	×	▪ Regular maintenance of the project to ensure reliable production of power	TCN	TCN HSE Dept.	FMENV, OGMENV and LAMENV
Cultural heritage	Potential interactions between maintenance works and cultural festivals due to traffic,	Affected communities in the RoW	×		×	▪ Consult with local communities on festivals and potentials for interaction with maintenance works. I f required cease works on the specific dates.	TCN	TCN HSE Dept.	FMENV, OGMENV and LAMENV

Indicator	Potential impact	Receptor	Project Component			Mitigation or enhancement measures	Responsibilities		
			Transmission Line	Sub station	Access and maintenance road		Mitigation Action	Supervision	External Monitoring or Reported to (when necessary
	noise and/or vibration impacts								

Table 7-29 Environmental and Social Monitoring Plan (Construction Phase)

Component	Parameters to be Monitored	Method	Standards/Targets	Location	Frequency	Responsibility		Cost Estimates (NGN)
						Implementation	Supervision	
Air quality	Dust	Visual inspection of construction sites, access roads; verification of equipment and machinery	Avoid significant degradation of baseline conditions.	Along ROW, access roads and work areas	Daily	EPC Contractor	TCN/PIU	Included in EPC Contractor Fee
	SO_2, NOx, CO, PM10, PM2.5, TSP	Ambient air quality measurements	IFC and National ambient air quality standards (FMENV)	Around substations (6)	Quarterly	EPC Contractor	TCN/PIU	Included in EPC Contractor Fee (8,000,000/ year)
Noise	Noise Levels	Noise level measurements	IFC and FMENV noise standards	Along ROW and around substations (20)	Quarterly	EPC Contractor	TCN/PIU	Included in EPC Contractor Fee (19,200,000/ year)
Soils integrity	Visual signs of contamination Status of drainages, bundwalls, stockpiles, etc.	Visual inspection of construction sites and access roads	Avoid the use of erosive processes or control them Reduce soil compaction Avoid soil profile structure destruction Avoid any soil contaminations	Along ROW, access roads and work areas	daily	EPC Contractor	TCN/PIU	Included in EPC Contractor Fee
	Soil biological, physical and chemical properties	Sampling and analyses of soils	Compare with Baseline condition	Around substations (6)	Once the construction completed	EPC Contractor	TCN/PIU	Included in EPC Contractor Fee (10,800,000/year)
Water quality	Water physico-chemical and microbiological - pH, temperature, TSS, turbidity, phosphorus, metals, sulphate, BOD, COD, coliform, fungi, etc.	Analysis of surface and ground water samples Visual detection of pollution signs (presence of oil, waste, etc.)	Avoid significant degradation of baseline conditions WHO and FMENV water quality standards	Groundwater: Around substations (max 8) Surface water: Rivers and Surface water (50)	Twice a year	EPC Contractor	TCN/PIU	Included in EPC Contractor Fee (50,400,000/year)
Aquatic ecology	Degradation of aquatic ecology	Visual inspection of rivers and streams	Avoid equipment and vehicle movements in rivers and swamps.	The construction area around rivers and swamps	Daily	EPC Contractor	TCN/PIU	Included in EPC Contractor Fee
Vegetation integrity and Fauna protection	Vegetation cover Pictorial comparison (before and after)	Visual inspection of construction sites	Avoid significant degradation outside the ROW. Protection of flora species with conservation status	ROW	Once during vegetation removal in the ROW	EPC Contractor	TCN/PIU	Included in EPC Contractor Fee

Component	Parameters to be Monitored	Method	Standards/Targets	Location	Frequency	Responsibility		Cost Estimates (NGN)
						Implementation	Supervision	
Waste management	Type and amount of waste generated Disposal of wastes	Keep the record	All waste are appropriately treated and disposed according with applicable regulation	ROE and substation sites	Daily	EPC Contractor	TCN/PIU	Included in EPC Contractor Fee
Visual amenities Land planning and use	Orderliness and cleanliness of sites disturbance outside ROW	Visual inspection of construction sites and access roads	Good housekeeping practice Site clearance activities to be restricted to the minimum required area. Provision of predefined route, barriers or boundary markings to prevent incursion of machinery and workers into neighboring areas	ROW and substation sites	Daily	EPC Contractor	TCN/PIU	Included in EPC Contractor Fee
Stakeholder relations management	No of complaints/ concerns received including vibration Status of grievance resolutions	Interview neighboring communities Stakeholder meetings Inspection of complaints/grievance log book	As per Resettlement Action Plan	Neighboring communities	Continuous	EPC Contractor	TCN/PIU	Included in RAP cost
Health, Safety and Security	Incidences	Inspection and review of incidence log	ILO requirements and Factories Act minimum labour standards	All work sites and base camps	Daily	EPC Contractor	TCN/PIU	Included in EPC Contractor Fee
Employment and economy	Proportion of employees from local community materials procured from local community made in Nigeria materials used	Inspect employee records Random interview with workers on site Inspection of procurement records Interview with suppliers and vendors	Semi-skilled and non-skilled labour employed from local community Materials available in the communities are used Made in Nigeria products are utilized, except where not available	Work sites and base camps	Daily	EPC Contractor	TCN/PIU	Included in EPC Contractor Fee

Table 7-30 Environmental and Social Monitoring Plan (Operational Phase)

Component	Parameters to be Monitored	Method	Standards/Targets	Location	Frequency	Responsibility (Implementation and Supervision)	Cost Estimates (NGN)
Air quality	SO_2, NOx, CO, VOC, PM, SF_6	Visual inspection of substations and access roads; verification of equipment and machinery records Ambient air quality measurements	Avoid significant degradation of baseline conditions. WHO and National ambient air quality standards (FMENV)	Substations (6)	The 1st year and every 3 years	TCN-HSE Dept.	1,500,000/3 years
Noise and EMF	Noise Levels, EMF Levels	Noise level measurements EMF measurement	Avoid significant degradation of baseline conditions. WHO and FMENV noise standards ICNIRP EMF exposure limits	Along ROW and around substations (20)	The 1st year and every 3 years	TCN-HSE Dept.	6,000,000/3 years
Soils integrity	Visual signs of contamination Status of drainages, bundwalls, stockpiles, etc	Visual inspection of substation sites	Avoid the use of erosive processes or control them Reduce soil compaction Avoid soil profile structure destruction Avoid any soil contaminations	Substations (6)	The 1st year and every 3 years	TCN-HSE Dept.	Included in TCN`s administrative cost
	Soil biological, physical and chemical properties	Sampling and analyses of soils	Compare with baseline condition	3 locations / substations (6) Total 18	The 1st year and every 3 years	TCN-HSE Dept.	6,500,000/3 years
Terrestrial ecology	Introduction of Alien species	Visual inspection of alien species within and around the ROW	Avoid the introduction of alien species	Around ROW	The 1st year and every 3 years	TCN-HSE Dept.	Included in TCN`s administrative cost
	Avian collision	Visual inspection of incident of bird strike around the transmission line	Avoid avian collision Once bird strikes are identified during the monitoring, TCN will take mitigation measures (e.g. coloring or light installations to improve noticeability)	Around ROW	Every 1 year for fist 3 Year	TCN-HSE Dept.	Included in TCN`s administrative cost
	Natural resource exploitation	Visual inspection and interview with communities	Increase awareness on natural resource protection	Around ROW	Continuous	TCN-HSE Dept.	Included in TCN`s administrative cost
Vegetation integrity and Fauna protection	Vegetation cover Pictorial comparison (before and after the maintenance)	Visual inspection of areas around substations and along the ROW	Avoid significant degradation outside the ROW and undeveloped areas. Protection of flora species with conservation status Avoid habitat loss and disturbances for local fauna	ROW	At the time of ROW maintenance	TCN-HSE Dept.	Included in TCN`s administrative cost
Waste management	Type and amount of waste generated	Keep the record	All waste are appropriately treated and disposed according with applicable	ROW and substations	ROW At the time	TCN-HSE Dept.	Included in TCN`s administrative cost

Component	Parameters to be Monitored	Method	Standards/Targets	Location	Frequency	Responsibility (Implementation and Supervision)	Cost Estimates (NGN)
	Disposal of wastes		regulation		of ROW maintenance Substations Regularly		
Visual amenities Land planning and use	Orderliness and cleanliness of sites disturbance outside acquired sites	Visual inspection of areas around substations and along the ROW	Good housekeeping practice Site clearance activities to be restricted to the minimum required area. Provision of predefined route, barriers or boundary markings to prevent incursion of machinery and workers into neighboring areas	ROW	Daily	TCN-HSE Dept.	Included in TCN`s administrative cost
Stakeholder relations Management	No of complaints/ concerns received Status of grievance resolutions	Interview neighboring communities Stakeholder meetings Inspection of complaints/grievance log book	Grievances are resolved effectively Complaints and issues are addressed timely	Neighboring communities	The 1st year and every 3 years	TCN-HSE Dept.	Included in TCN`s administrative cost
Health, Safety and Security	Incidences	Inspection and review of incidence log	ILO requirements and Factories Act minimum labour standards	Transmission Tower and Substations	Daily	TCN-HSE Dept.	Included in TCN`s administrative cost
Employment and economy	Proportion of employees from local community materials procured from local community made in Nigeria materials used	Inspect employee records Random interview with workers Inspection of procurement records Interview with suppliers and vendors	Semi-skilled and non-skilled labour employed from local community if required Made in Nigeria products are utilized, except where not available	Transmission and Substations	As required	TCN-HSE Dept.	Included in TCN`s administrative cost

7-8 Land Acquisition and Resettlement

7-8-1 Extent of Potential Impact

The entire project consists of about 203 km high voltage transmission lines and 6 high voltage substations. The Project will involve acquiring the Right of Way (RoW) which is about 50m width for the 330 kVA transmission line, and 30m width for the 132 kVA transmission line. Land will also be required for temporary access road and campsites/logistic bases, however they are planned to be rent by EPC contractors. The total project area is approximately 931 ha consisting of 87ha of the land for substations and 844 ha of land for transmission lines.

7-8-2 Policy of Land Acquisition and Compensation

Land required for the construction, operation and maintenance of the project shall be acquired and allocated to the project by the Government.

The legal framework provides the basis for three key elements of the Resettlement Action Plan (RAP). They include:

- Establishing rates for compensation;
- Determining eligibility for compensation and resettlement assistance, including development initiatives aimed at improving the social and economic well-being of affected populations;
- Establishing mechanisms to resolve grievances among affected populations related to compensation and eligibility.

Land ownership (Right of Occupancy) in Nigeria is subject to a range of diverse cultural and traditional practices and customs. Land can be classified according to the following broad categories:

Communal land: consists mostly of under-developed forests and is owned by the community collectively and not a particular individual. Those individuals who clear it first claim ownership.

Clan or family land: is owned by clans and families, as the name suggests.

Institutional land: land allocated to traditional institutions such as traditional authorities and chiefs.

Individual land: land acquired by an individual, which may be inherited by the immediate family, depending on customary practices

It is noted that the land which fall into the categories of *Clan or family land*, *Institutional land* and *Individual land* is considered as private land.

The legal framework for land acquisition and resettlement in Nigeria is the Land Use Act (LUA) of 1978, reviewed under Cap 202, 1990 and now Cap L5, Laws of the Federal Republic of Nigeria (LFN), 2004.

The relevant World Bank policy (OP) 4.12, which addresses land acquisition and resettlement, was adopted in 2001.

The differences between the Land Use Act and the Bank's OP 4.12/JICA Guidelines mostly concern rehabilitation measures, which are neither proscribed, underprovided for, nor mandated in the Act.

In case that a land is donated on a voluntary basis without payment of full compensation, Environment & Social Framework for IPF Operations issued by the World Bank need to be considered. The Guidance Notes providing guidance for the borrower on the application of the Environmental and Social Standards, ESS5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement, stated in footnote 10 that "*Subject to prior Bank approval, this may be acceptable providing the Borrower demonstrates that: (a) the potential donor or donors have been appropriately informed and consulted about the project and the choices available to them; (b) potential donors are aware that refusal is an option, and have confirmed in writing their willingness to proceed with the donation; (c) the amount of land being donated is minor and will not reduce the donor's remaining land area below that required to maintain the donor's livelihood at current levels; (d) no household relocation is involved; (e) the donor is expected to benefit directly from the project; and (f) for community or collective land, donation can only occur with the consent of individuals using or occupying the land. The Borrower will maintain a transparent record of all consultations and agreements reached*".

The land for Abule Oba (Redeem) Substation is planned to be donated by a Christian group, Redeem on a voluntary basis. TCN informed the plan of this Project to Redeem through stakeholder engagement. Redeem understood that they could refuse the request from TCN and for it. Through the conversation between Redeem and TCN, Redeem selected a small piece of land, where no households or individual person live, use or occupy. Also, it was confirmed that the land donation will not affect Redeem's future activities and Redeem can receive benefit by connecting to the national grid so that Redeem doesn't need to use their own generation facilities. The agreement on the voluntary land donation has been concluded between TCN and Redeem.

7-8-3 Institutional Framework

7-8-3-1 Relevant Institutions

This section gives highlights on relevant institutions for planning and implementation of land acquisition and resettlement in the project. A number of institutions have been identified and will be involved in the overall implementation of this project. TCN especially the Project Implementation Unit (PIU) will take responsibilities in implementing the Resettlement Action Plan and monitoring its progress, with support from Wayleave and the Chemical Resettlement and Environment (CR&E) Departments of TCN and a constituted Local Resettlement Committee, Federal Ministry of Power etc.. Multi-stakeholders, including the funding agencies, relevant government agencies and even NGOs will also support TCN when necessary. Summary of institutions including their role is shown in Table 7-31below.

Table 7-31 Summary of Institutions

Name	Descriptions
The Federal	Responsibilities for commitments proposed in the RAP exist within

Name	Descriptions
Government of Nigeria (FGN)	Federal Government of Nigeria, ratifications of multilateral and endorsed agreements and conventions, and are delegated internally to the relevant Ministry, which in this case is the Federal Ministry of Power, Works and Housing.
Federal Ministry of Powerg (FMP)	All consultation efforts are coordinated by the Ministry of Power through the Transmission Company of Nigeria (TCN). The FMP is responsible for the approval of payment of compensation to PAPs. Payment is effected by TCN.
Transmission Company of Nigeria (TCN)	TCN as the implementation agency for the project on behalf Federal Government of Nigeria. The TCN established the Project Implementation Unit (PIU) the end to end delivery of the project on its behalf.
TCN Project Implementation Unit (PIU)	PIU is a unit established by TCN with responsibility for the end to end delivery of all JICA funded projects, including planning, ESIA, ESMP, RAP, engineering, procurement and construction. PIU, headed by a substantive Project Director with members representing relevant departments serves as the interface with other relevant agencies for this project and the overall coordinator of all efforts for realizing this project.
TCN Wayleave Department, Property Department, Chemical, Resettlement and Environment (CR&E) Department	Oversee compensation and resettlement activities of the project. PIU will liaise with the TCN Wayleave department on RoW acquisition process associated with crops in agricultural land department and Property Department on RoW acquisition process associated with structures. Verify the compensation rates/budget and schedule as used in RAP to ensure proper implementation and provide recommendations to Project Implementation Unit for improvement/approval. Also the department support PIU to conduct: Internal monitoring and evaluation of RAP activities; In coordination with TCN-PIU and Local Resettlement Committee, organize meetings with PAPs and communal authorities, to disseminate copies of Resettlement Information Booklet (RIB) and entitlement forms; Document the complaints and grievances raised by complainants and ensure timely solution by responsible institutions in line with the project approved RAP; Organizing seminars to disseminate the RAP report to relevant stakeholders, communities, etc.; and Assist local people in overcoming the difficulties during the implementation period. Perform other functions as is required by the department in the TCN Organogram. The department staffs in Lagos Regional Office will assist PIU to communicate with communities and PAPs and oversee field work by the RAP Implementation Consultant (RIC) to conduct activities listed above as same as Regional staffs have supported RAP preparation.
Lagos and Ogun States Governments	State governments facilitate the land acquisition and resettlement through their relevant ministry, bureaus and organizations including:

Name	Descriptions
	Lagos State Lands Bureau which ensure optimal utilization of land resources to for sustainable development of the state and take responsibilities on land policy and land matters, acquisition of land for State purposes, land Registration (Administration & Control) in conjunction with Ministry of Justice, compensation for acquired lands, issuance & revocation of Certificates of Occupancy (C of O), etc. *Lagos State Ministry of Physical Planning and Urban* which has responsibilities on comprehensive land use, re-planning, improvement. *Lagos State Ministry of Women Affairs and Social Development* which has the responsibility to promote Gender Equality and provide Empowerment facilities for Socio-economic Development for people displaced by the project in Lagos State, to promote the survival, protection, participation and development of children, to provide care, support, rehabilitation and empowerment for the vulnerable groups (challenged persons, older persons, destitute and the likes), etc. *Ogun State Bureau for Lands and Survey* which is responsible for the issuance of right of way (ROW) and certificate of occupancy (C of O) for portions of line route and substation sites that falls within Ogun State. Other functions of the Agency include preparation and issuance of Certificates-of-Occupancy and other certificate evidencing titles, preparation and issuance of Right-of-Occupancy, land application processing and administration, etc. *Ogun Ministry of Urban and Physical Planning* is responsible for the formulation of Physical Planning policies and the coordination of physical development within the State. *Ogun State Ministry of Women Affairs and Social Development*, which has the responsibilities to promote Gender Equality and provide Empowerment facilities for Socio-economic Development as same as relevant ministry of Lagos state.
Local Government Authorities (LGA)	The project will pass through six LGAs, five in Ogun State –Obafemi Owode, Ewekoro, Ifo, Ado-Odo/Ota and Sagamu as well as Badagry LGA in Lagos State. The LGAs have roles in the administration (e.g. registration etc.) of lands in rural areas and hence, will be involved in the resettlement process as well as sites for the substations.
Local Council Development Authorities (LCDA)	LGAs are split into Local Council Development Areas by Ogun/Lagos states for administrative purpose. These lower-tier administrative units (LCDAs) provide public services to citizens in the area of their jurisdiction.
The Customary	The line route will pass through the Chiefdoms as several villages under

Name	Descriptions
District Councils	them. The Obas (traditional head of chiefdom) and Community or Village Heads (Baales) have important role to play in the project with respect to mobilization of the community members to support the project, grievance redress, peace and security of personnel, equipment and facilities to be installed. Close contact and regular consultation shall be maintained with customary chiefs throughout the life of the project
RAP Implementation Consultant (RIC)	RIC will be retained by TCN PIU to implement RAP practically. The RIC, having good credentials and knowledge about the project area, is responsible for the following: - Provision of information on compensation and resettlement activities; - Consultation with PAPs, management of compensation payment; - Reporting the progress of RAP implementation to relevant institutions; and - Deliver the corridor of ROW to TCN.
Local Resettlement Committee (LRC)	This committee will be established in each LGA in the project area to support TCN PIU and RIC. The role of LRC includes: - Assistance to identify and select the resettlement sites; - Witnesses of the final agreement with the PAP in relation to compensation valuation and signing of agreements with households and selection of resettlement sites - Identification of vulnerable people and households; and - Work with PIU to address specific concerns of these peoples. These LRCs will comprise of a respected person (e.g. a retired senior citizen, Iman/Alfa or Church Priest), Customary Chiefdom, LCDA chairman, officer from department of security service and elected representatives of affected PAPs including women leader and youth leader.
Witness NGO	To enhance transparency and trust from PAPs it is planned that a witness NGO will be retained. Witness NGO will conduct external monitoring to ensure that proper procedures and stated compensation processes are followed, that PAP grievances are well taken care of, and that PAPs are treated with fairness. Witness NGO will participate even LRC meetings as an observer with neutrality and independence in order to ensure proper management of compensation processes, reconstruction and management of grievances by LRC. The role of witness NGO includes: - Revise reports of compensation payment process; - Meet with PAPs; - Check implementation of the measures, livelihood restoration, etc. in the field; and - Provide comments and recommendations. All PAPs will be informed of the NGO role and function and need to have access to its representatives, in a confidential manner if necessary, to explain

Name	Descriptions
	and discuss their difficulties to report grievances. A witness NGO should be retained through a public proposal and selection process by the PIU to provide independent advice and report on RAP implementation and management focusing on consultation activities, compensation and resettlement related activities and grievances management. This NGO could be a recognized and credible Human Right advocacy group or an NGO active in environmental management or rural development in the project area.
Contractors	Each contractor shall appoint a qualified environmental and social manager who, after approval by the PIU, will be responsible for management on-site and for the implementation of management measures from the ESMP and RAP as well. Contractors may give employment opportunities for PAPs as a part of assistance and training in the RAP. This manager will report the progress and results of their works regularly to the PIU during the entire construction period.

7-8-3-2 RAP implementation System

The responsibility of RAP implementation will be allocated among multiple stakeholders, including the TCN, RIC and LRC. TCN has set up a Project Implementation Unit (PIU), which will be mainly responsible for the project execution.

Within the PIU, the Environmental and Social Unit will be the responsible administrator, which will manage RAP implementation. PIU will coordinate with TCN Management and TCN Lagos Regional Office for the necessary support for the preparation and implementation of RAP. Figure 7-24 illustrates the organizational structure of RAP implementing agencies.

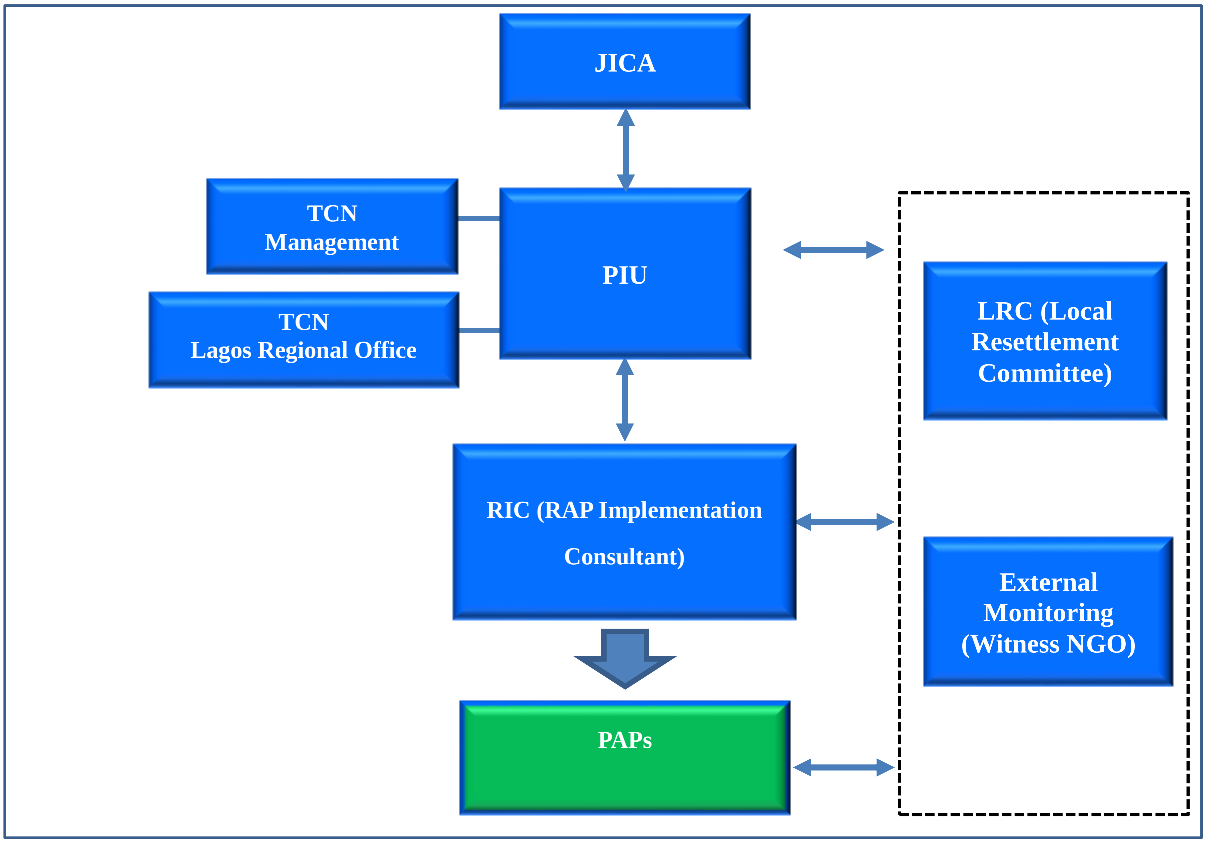


Figure 7-24 Organizational Structure of RAP Implementing Agencies

7-8-4 Land Acquisition Process

This section summarizes the land acquisition process that is applied for the Project. Generally, the steps of the process listed below are implemented in sequence. However, some steps may be implemented in parallel:

- The Project owner communicates the relevant authorities such as Lagos/Ogun states about the Project;
- The Project owner communicates the landowners in the Project area about the Project;
- The Project owner develops the Resettlement Action Plan. During the preparation of the RAP, field studies including stakeholder consultations, census survey, and PAPs identification, are carried out;
- Upon completion, the RAP may be submitted to the States for validation of RAP;
- The implementing units are established and organized, including LRC;
- The Project owner starts PAP engagement activities for RAP implementation phase;
- The Project owner explains compensation package and offers compensation to PAPs;
- Negotiations are conducted through personal contacts with the PAP regarding compensation;
- Upon accepting the compensation offer by the PAPs, the Project owner provides full payment of compensation before commencement of civil works;
- The project owner notifies the States regarding completion of compensation payment to the PAPs;
- The PAPs provides the Certificate of Indemnity for access rights over land in favour of the Project

owner. This Certificate serves as evidence of acquisition of the land and access rights;

- The project owner notifies issuance of the Certificate of Indemnity the by PAPs; and
- The relevant States issue/gazette the Certificate of Occupancy (C of O) to the Project Owner.

7-8-5 Project Affected Persons and Assets

This section gives highlights on project affected persons and assets in the project area.

7-8-5-1 Summary of Projected Affected Persons and Assets

All affected persons and assets including land within the project area were recorded and counted during the RAP study conducted by TCN. The number of Project Affected Units (PAU) such as project affected persons (PAPs) and affected households (HHs) in each lot area are summarized in Table 7-32 and Table 7-33 below. A total of PAU such as number of land where structures are located or agricultural/commercial activities are operated will be 7,040. A total of 526 HHs with 1,989 PAPs in residential land will need to be physically relocated based on the currently planned line route. The structures owned and occupied by the project affected HHs will need to be demolished or displaced before the construction. 1,873 of unoccupied structure (e.g. uncompleted structure and nobody live currently) will need to be demolished or displaced before the construction as well.

There are total 3,992 of land owner of agricultural land whose private land will be affected by the Project. Agricultural lands in the project area are firmed by family basis. Number of family member who participate in the farming cannot be calculated exactly since contribution of each family member for the firming change season by season. Hence, the number of agricultural land owner is considered to be the number of PAPs associated with agricultural land.

Total 372 project affected units are identified occupying lands without recognized land occupancy in the project area for Likosi S/S.

It should be noted that the number of PAPs of each type of land indicate the number of PAPs who own/use/live each type of land but some households own multiple type of lands (e.g. residential land and agricultural land). Hence, if the numbers of PAPs are summed up, some PAPs may be double counted.

Table 7-32 Summary of Project Affected Land

		Land Use	Number of owner (Project Affected Units)	Area Size (m^2)	Relocation Assistance Needed (compensation for land)
Lot1	Government Land	Residential Land	0	0	No
		Commercial Land	0	0	
		Agricultural Land	0	0	
		Public Facility Land	0	0	
		Others	0	0	
		Sub-Total	0	0	
	Community Land or Private Land	Residential Land	207	15,560.61	Yes
		Commercial Land	27	2,374.91	
		Agricultural Land	127	55,421.50	
		Others	140	772.28	
		Sub-Total	501	74,129.30	
	Lot 1 Total		**501**	**74,129.30**	
Lot2	Government Land	Residential Land	372	188,900.00	No
		Commercial Land	0		
		Agricultural Land	89	61,100.00	
		Public Facility Land			
		Others (	0	0	
		Sub-Total	461	250,000.00	
	Community Land or Private Land	Residential Land	700	795,859.89	Yes
		Commercial Land	4	3,136.14	
		Agricultural Land	1,129	1,957,600.00	
		Others (incl. Abule Oba and Makogi)	4	296,336	
		Sub-Total	1,835	3,052,932.03	
	Lot 2 Total		**2,296**	**3,302,932.03**	
Lot3	Government Land	Residential Land	0	0	No
		Commercial Land	0	0	
		Agricultural Land	0	0	
		Public Facility Land	0	0	
		Others (Badagry)	1	250,000.00	
		Sub-Total	1	250,000.00	
	Community Land or Private Land	Residential Land	1,188	- *1	Yes
		Commercial Land	30	- *1	
		Agricultural Land	2,647	- *1	
		Others	22	- *1	
		Sub-Total	4,242	-	
	Lot 3 Total		**4,243**	-	
Grand Total			**7040**	-	

Data source: Goddira 2018, SEEMS 2018 and EEMS 2018

Table 7-33 Summary of Project Affected Structures

Lot	Type of Primary Structure	Remark	Project Affected Units (PAUs)	Project Affected Persons (PAPs)		Project Affected Units (PAUs)	Project Affected Persons (PAPs)	
			Number of owner (HHs)	Physically displaced persons	Economically displaced persons	Number of owner (HHs)	Physically displaced persons	Economically displaced persons
			Title holder			Non-title holder (Encroacher)		
Lot1	Residential Structure	Occupied	44	239				
		Unoccupied	163	163[*2]				
	Residential Tenant Structure	Occupied	0	0				
	Commercial Structure		27	27[*1]	27[*1]			
	Other Structure	Public and Religious	140					
	Sub-Total		**374**	**429**	**27**	**0**	**0**	**0**
Lot2	Residential Structure	Occupied	74	74		84	84	
		Unoccupied	575	575[*2]		271	271	
	Residential Tenant Structure	Occupied		37		0	0	0
	Commercial Structure		1	1	1	1	1	1
	Other Structure	Public and Religious	56	56		16	16	
	Sub-Total		**706**	**743**	**1**	**372**	**372**	**1**
Lot3	Residential Structure	Occupied	324	1,592				
		Unoccupied	864	864[*2]				
	Residential Tenant Structure	Occupied	0	0	0			
	Commercial Structure		30	30[*1]	30[*1]			
	Other Structure	Public and Religious	22					
	Sub-Total		**1240**	**2486**	**30**	**0**	**0**	**0**
Grand Total			**2320**	**3,658**	**58**	**372**	**372**	**1**

Data source: Goddira 2018, SEEMS 2018 and EEMS 2018

*1: Only family business is operated in the project area. Wage earner is not applicable in the project area. Only business owner will be compensated.

*2: Number of residents who will live in the unoccupied structures including under construction cannot be calculated. The value represents the number of structure owners

7-8-5-2 Project Affected Land

The land in the project area are used for some purposes including:

- Agricultural use
- Residential use
- Commercial use
- Public use (TCN own land in Likosi, school, church, etc.)
- Others (not specifically used, e.g. forest)

The boundaries of each land are indicated by wall, fence or some markers in some land, some others are not clearly specified. During the consultation stages, RAP team obtained the boundary information including the coordination of the land boundary through community leaders, PAPs owning the land and its neighbours.

7-8-5-3 Project Affected Household

Characteristic information of the Project Affected Households were collected during census study conducted by TCN. This section highlight key information of the project affected households. Some other information related to the household are also mentioned in the Section 7-6 above.

(1) Household Size

Summary of household size obtained during the census survey are shown in Table 7-34. No big difference was identified among three lot project areas. The average of persons per household in the project area is 6.3.

Table 7-34 Summary of Household Size in Project Area

		Household Size (persons per household)					
		1-2	3-5	6-10	11-15	>15	Total
Lot 1 Project Area	Number of HHs	48	635	827	166	0	1,676
	Ratio	3%	38%	49%	10%	0%	
Lot 2 Project Area	Number of HHs	5	71	73	9	0	158
	Ratio	3%	45%	46%	6%	0%	
Lot 3 Project Area	Number of HHs	219	1,889	1,011	211	147	3,478
	Ratio	6%	54%	29%	6%	4%	
Overall	Number of HHs	272	2,595	1,911	386	147	5,311
	Ratio	5%	49%	36%	7%	3%	
	Estimated Average HH Size	6.3					

Data source: Goddira 2018, SEEMS 2018 and EEMS 2018

(2) Occupation, Livelihood and Income

The compositions of occupations in each project area (and LGA) are shown in Table 7-35 below. It is observed that the major occupations of the people in the communities are farming, fishing and hunting. Some people, as shown from the prevalence figures of the occupations combined two or more occupations (e.g. fishing and farming, fishing and trading or even farming and civil service job) to boost their income. Most of harvested crops are generally consumed by the households in the project area and only excess are sold to generate income.

During the study in Lot 1, most of the youths (about 85%) complained of unemployment hence they resorted to self-employment jobs of fishing, farming, trading or other labourious jobs. There have been no help from governments or any other organizations in the employment of the youths and no help to even enable them enhance their occupations of farming, trading or other jobs.

Table 7-35 Summary of Occupation in Project Area

Lot #	Local Government Areas (LGAs)	Occupation (%)							
		Farmer, Hunter and Fisherman	Pastoralist	Self-employed Business Person	Private employee	Public Employee	Trading	Teaching and Nursing	Others
1	Ewekoro, Ifo, Obafemi Owode	127	-	-	10	-	-	-	10
2	Obafemi Owode	12	-	64	15	-	6	3	-
	Ifo	33	-	34	33	-	0	0	-
	Ewekoro	6	-	29	53	-	6	6	-
	Sagamu	3	-	61	18	-	17	1	-
3	Ewekoro	72.3	1.7	24.2	8.9	17.3	6.2	-	1.2
	Ifo	78.5	0.5	17.3	2.8	24.7	3.1	-	0.8
	Ado-Odo/Ota	81.6	2.8	19.9	4.7	18.6	3.2	-	0.7
	Badagry	80.6	0.4	18.4	3.3	20.7	2.9	-	0.2

Data source: Goddira 2018, SEEMS 2018 and EEMS 2018

The income level of majority of the people in the area is low because most of them are farmer, hunter, fisherman (they are not merchandised fisherman, people fish sometimes for their selves), artisans or working as labour in companies around their vicinity. Also, evidence from Focused Group Discussions (FGDs) shows that a significant proportion of the youths are not gainfully employed and are not in any form of school for career development. Most of the aged are poor, except those whose children are in the city, who send money home. Some of the women are successful traders while some are house wives.

The ratio of people that are living in the poverty line (on less than N10,000/month equivalent to less than USD 1/day) consists of approximately 10 – 20 % of the people in the project area, especially 80% of people in Lot 1 project area earn less than N 20,000 monthly and are considered being poor compared other Lot 2 and 3 project area. Some people earn above N60,000, but those with this relatively high income are mainly those with multiple economic activities such as agriculture and business and are mainly in urban areas or close to urban areas.

7-8-5-4 Project Affected Vulnerable Groups

In the project area, the RAP study team identified some vulnerable groups including:

- Woman headed household including widows

- Physically disadvantaged persons
- Aged persons (>65)
- unemployed youths

Especially many female heads of households are identified in the project area, female heads of households constitute 8% (Lot 1), 3% (Lot 2) and 12.7% (Lot 3) of total households in each lot area respectively. The project is likely to increase the vulnerability of women if compensation and support for vulnerable group including women are not considered enough since vulnerable group tend to be affected by external factors more than non-vulnerable group. Consultations in the project area have shown that, in general, women do not own land although the land law stipulates that land belongs to the family. This makes women in a disadvantaged state since men control resources such as land other important assets and potentially compensation from the Project.

Some aged persons headed households were also identified and recorded for compensation (relocation assistance).

Four handicapped headed households were identified in the Lot 1 project area. Two of these handicapped PAPs are cripples and another two have sight problem.

7-8-5-5 Project Affected Structures

The project affected structures are mostly residential house, others are buildings still under construction, warehouse, etc.. On the average, the use of bricks as walling materials is predominant. However, the use of mud bricks is most pronounced among communities in some LGAs including Ifo and Badagry. It was also observed that walling materials for a house could be mud, bricks and woods especially rural area. Also, some houses are walled exclusively of bamboo, tarpaulin and zinc.

Zinc in Alapako

Mud in Olowo

Concrete in Berese

Source: EEMS 2018

Figure 7-25 Type of Material for Structures

Some houses equip other secondary structures including fence, wall, warehouse etc. and those structures are also counted and recorded for compensation.

Many non-occupied residential structures such as completed houses but nobody live in currently, and uncompleted houses including only foundation are observed in the project area. Those are also recorded as project affected structures.

7-8-5-6 Economic Trees and Crops

Virtually all affected communities are located in areas where significant portions of lands are entirely used for agriculture where crops such as cassava, maize, plantain, sugarcane, kolanut, oil palm etc. are mainly grown. All of the impacted households have cultivated parcel or farming area affected by the wayleave. More than thousands of households were growing crops and economic trees in the wayleave. The numbers of affected trees and crops with commercial value in each Lot, are summarised in Table 7-36. Cassava is the most common food crops in the affected communities especially in Likosi/Dejuwogbo, Omu Pempe, Oluwo Oshin, Abisodun, Adewolu, and Otere Apena etc. Sugarcane is a popular cash crop in Asa Bala, Asa Elegun and Abese while Kolanut is a common crop grown in Sagamu area.

In the construction period crops will have to be destroyed in the wayleave area. Compensation of a year of harvesting of the area under cultivation in the wayleave should be given to all the households.

Table 7-36 Summary of Affected Economic Trees and Crops

	Unit	Lot 1	Lot 2	Lot 3	Total
ABURA	stand	0	0	384	384
ACACIA	stand	0	0	1	1
ADYMEN	stand	0	0	22	22
AFRICAN STAR APPLE	stand	5	0	0	5
AFARA	stand	3	0	0	3
AFUFORO TREE	stand	10	0	0	10
AGBALUMO	stand	0	24	0	24
AGBO TREE	stand	13	0	0	13
AKOKO TREE	stand	13	0	0	13
AKPA	stand	10	0	0	10
AKPOTO TREE	stand	4	0	0	4
ALIGATOR PEPPER	stand	2	0	0	2
AMARANTHUS	stand	0	0	18	18
APA	stand	61	0	6	67
APPLE	stand	15	0	67	82
APARA	stand	0	3	0	3
ARABA TREE	stand	5	0	0	5
ARERE	stand	1	0	0	1
AROEADO	stand	0	0	1	1
AUSTRY TREE	stand	6	0	0	6
AVOCADO PEAR	stand	11	0	6	17
AWEN	stand	14	0	0	14
AYIRA TREE	stand	35	0	0	35
AYURE	stand	10	0	0	10
BAMBOO	stand	435980	7916	38024	481920
BANANA	stand	3715	697	5877.6	10289.6
BAOBAB	stand	8	0	0	8
BARREN LAND	stand	2504.18	0	0	2504.18
BEANS	stand	0	300	0	300
BITTER KOLA	stand	5	2	302	309
BITTER LEAF	stand	576	5	3047	3628
BREAD FRUIT	stand	12	0	829	841
BUTTER BREAD	stand	0	0	13	13
CASHEW	stand	627	25	1089.8	1741.8
CASHIA	stand	8	0	0	8
CASSAVA	stand	680278.6	239540	4748190	5668008
CHERRY	stand	105	26	1955.2	2086.2
CHEW STICK TREE	stand	16	0	0	16

	Unit	Lot 1	Lot 2	Lot 3	Total
CITRUS	stand	0	279	68	347
COCOA	stand	1556	396	5671	7623
COCONUT	stand	779	44	4964.6	5787.6
COCOYAM	stand	19412	5450	811193.4	836055.4
COTTON WOOL	stand	0	0	360	360
DATE PALM	stand	0	88	0	88
DOGOYARO	stand	32	0	0	32
EFO LEAVES	stand	400	0	0	400
EWE LEAF	stand	0	495	21	516
EWEDU	stand	18800	1000	0	19800
EWERAN	ha	0	0.09	0	0.09
FLUTED PUMPKIN	stand	150	0	0	150
FRUIT	stand	0	1	5	6
GARDEN EGG	stand	0	600	960	1560
GINGER PLANT	stand	221	0	0	221
GERMAN TREE	stand	6	0	0	6
GINSIN HERBS	stand	55	0	0	55
GMELINA	stand	7	0	12	19
GPARUN	stand	3	0	0	3
GRAPE FRUIT	stand	0	0	54	54
GREEN LEAVES	stand	6700	0	0	6700
GROUNDNUT	stand	1030	0	0	1030
GUAVA	stand	257	203	665	1125
HARD WOOD	stand	18620	12886	2023.4	33529.4
HERBAL TREE	stand	2179	0	1	2180
IDI	stand	3	281	0	284
IDIN	stand	0	637	0	637
IDINGO	stand	0	129	0	129
IGIOWO	stand	7	0	0	7
INDIAN BAMBOO	stand	0	0	21	21
IRIN	stand	0	0	7	7
IROKO	stand	302	0	1489	1791
IRUGBA	stand	9	0	0	9
JATROVA PLANTS	stand	3	0	0	3
KACHIA	stand	165	0	0	165
KOLA NUT	stand	471	4084	8878.2	13433.2
LEMON	stand	0	0	10	10
LIME ORANGE	stand	6	0	0	6
LOCAL PEAR	stand	0	0	52	52
LOCUST BEAN	stand	47	0	14	61
MAHOGANY	stand	104	0	12	116
MAIZE	ha	9.484	1.1	41.714	52.298
MANGO	stand	208	91	3821	4120
MASQURADE TREE	stand	0	0	2	2
MELINA	stand	0	0	60	60
MOI MOI LEAF	stand	35108	0	0	35108
MORINGA	stand	21	14	41	76
NEEM	stand	0	0	39	39
NEEN TREE	stand	6	0	0	6
OAK	stand	131	0	0	131
OBESHE	stand	41	0	0	41
OIL PALM	stand	0	4293	18108.4	22401.4
OGBO	stand	0	0	2	2
OGBONO	stand	0	0	9037	9037
OKRA	stand	102	0	80	182
OKRO	stand	0	5800	0	5800
OMO	stand	0	0	6	6
OMOYI	stand	1	0	0	1
OPEPE	stand	0	0	246	246
OPOTO	stand	1	0	0	1
ORANGE	stand	174	24	2677.6	2875.6
ORINATA	stand	5	0	0	5

	Unit	Lot 1	Lot 2	Lot 3	Total
ORE TREE	stand	6	0	0	6
ORUDUDU	stand	0	0	56	56
OWO	stand	4	0	0	4
PALM TREE	stand	11828	0	4823.6	16651.6
PAW PAW	stand	1128	567	3259.2	4954.2
PEAR	stand	24	2	20	46
PEPPER	stand	2650	11120	384583	398353
PINEAPPLE	stand	7573	3464	967.6	12004.6
PLANTAIN	stand	12611	9436	26437.2	48484.2
POTATO	stand	500	0	764	1264
PUMPKIN	stand	0	0	18899	18899
PUMPKIN LEAF	stand	0	0	1	1
RAFFIA PALM	stand	2828	2174	9863.4	14865.4
RICE	stand	75300	0	0	75300
ROPHIS	stand	0	0	5	5
RUBBER TREE	stand	67	0	0	67
SAPO	stand	22	0	65	87
SCENT LEAF	stand	5	0	712	717
SHAKPO	stand	5	0	0	5
SHAWASHOP	stand	0	0	7	7
SHEA BUTTER	stand	237	32	8	277
SHRUBS	stand	120	0	0	120
SOFT WOOD	stand	15368	15196	2111	32675
SOUR SHOP	stand	1	0	0	1
SOYA BEANS	stand	6150	0	0	6150
SPINACH	stand	0	0	1036	1036
STAR APPLE	stand	10	0	0	10
SUGARCANE	stand	263742.2	34200	18525	316467.2
SWEET POTATO	stand	325	0	120	445
TEAK	stand	0	0	6715.6	6715.6
TICK	stand	113	0	0	113
TIMBER	stand	335	0	25	360
TOMATO	stand	2575	555	2896	6026
UMBRELLA TREE	stand	10	0	9	19
VEGETABLE	stand	5661	9700	6728	22089
VELVET TAMARIND(ICHEKU)	stand	1	0	0	1
WALNUT	stand	11	1	39	51
WATER MELON	stand	150	0	0	150
WRAPPING LEAVE	stand	150	0	0	150
YAM	stand	2732	900	29281	32913

Data source: Goddira 2018, SEEMS 2018 and EEMS 2018

7-8-5-7 Shrines and Cultural Heritages

There are archaeological and sacred sites, such as traditional burial grounds and shrines in the communities as described in Section 7-7-1-3. 78 shrines in total (11 shrines in Lot 1, 48 shrines in Lot 2 and 19 shrines in Lot 3) are located and need to be relocated in the Project area. These sites are highly valued by the people and considered sacred and encroachment in such areas would attract serious resentment from the communities. The people celebrate several traditional festivals, the observance of which is believed to be for the general well-being of the people.

There are shrines and believers in the traditional worship. Many of the people that have shrines are also either Christians or Muslims. They believe that their shrines depict their ancestral believe and heritage. They believe that the gods of the shrines listen to their needs and offer them protection against evil. They also informed us that the gods of the shrines provide people with children for the barren, protection from evil, good luck in life endeavor, etc.

7-9 Compensation Strategy

7-9-1 Eligibility

Any person who will suffer loss or damage to a piece of land, a structure, economic trees / crops, business, trade or loss of access to productive resources, as a result of the project will be considered eligible for compensation and/ or resettlement assistance. Eligible PAPs include the following:

- Those that have formal rights to land (including statutory, customary, traditional and religious rights, recognized under the Federal and/or State Laws of Nigeria);
- Those who do not have formal legal rights to land at the time the census began but have a claim to such land or assets provided that such claims are recognized under the state and/or federal laws of Nigeria or become recognized through a process identified in entitlement matrix;
- Those who have no recognizable legal right or claim to the land they are occupying, using or getting their livelihood from, but were occupying or making use of the land before the cut-off date announced by the project; and
- Those enumerated as owners of assets/improvements on land (Grave, Shrines, Economic trees and/or Crops whether they own the land or are tenants.

Compensation for land will be made as Land Relocation Assistance to the PAPs who have formal rights to land, and the PAPs who do not have formal legal rights to land at the time the census began but have a claim to such land provided that such claims are recognized under the state and/or federal laws of Nigeria or become recognized through a process (details are described in Section 7-9-3 below). The other PAPs will be eligible for the compensation of other type of loss except for land including, structures, economic trees, etc.

7-9-2 Cut-off Date

Cut-off date is a date to determine the eligibility to receive compensation. Any new structures or arrivals after cut-off date within the project area are not subject to the compensation. The set cut-off date for the 3 Lots are different (See Table 7-37). It is important to note that while Lots 1 and 2 set the cut-off date during the last day of survey, Lot 3 set the cut-off date on the day of commencement of survey.

Table 7-37 Cut-off Date for Each Lot

Lot	Set Cut-off Date
1	Cut-off date was set on March 4, 2018, the date on which final field work was carried out in the last community Ajade. This was communicated in the local language during community consultations (district heads and village heads).
2	Cut-off date was set on June 8, 2018 when PAPs identification, enumeration and valuation exercise for each community concluded.
3	Cut-off date was set on January 12, 2018 when commencement of the enumeration established. Enumeration was conducted from January 12 to February 13.

7-9-3 Entitlement Matrix

The entitlement matrix is the basis for compensation budget, resettlement and income restoration measures to be administered by the TCN. The matrix shows specific and applicable categories of Project Affected Persons (PAPs) under this project as well as types of losses and entitlement plan for PAPs. Table 7-38 below provides an entitlement matrix for PAPs.

Table 7-38 Entitlement Matrix

Item	Type of loss	Entitled Persons	Entitlements	Responsibility
A. LAND				
A1	Loss of residential and commercial land	Private landowner with title deed or similar ownership document, and customary recognized in the community	• Land relocation assistance for land (cash compensation) will be at market value based on the market survey results conducted by TCN. • Livelihood restoration (assistance and training):G1 • Special assistance, if applicable: H1	TCN/PIU
A2	Loss of residential and commercial land	Land user of public owned land	• No compensation for land • Livelihood restoration (assistance and training): G1 • Special assistance, if applicable: H1	TCN/PIU
A3	Loss of agricultural land	Landowner and land user with legal title	• Land relocation assistance for land (cash compensation). • Cash compensation for loss of crops and trees during the construction stage at the market value of crops based on the harmonized compensation rate in South-west area in Nigeria: C1 • Livelihood restoration (assistance and training): G2 • Special assistance, if applicable: H1	TCN/PIU
A4	Loss of agricultural land	Landowner and land user without legal title	• No compensation for land. • Cash compensation for loss of crops and trees during the construction stage at the market value of crops based on the harmonized compensation rate in South-west area in Nigeria: C1 • Livelihood restoration (assistance and training): G2 • Special assistance, if applicable: H1	TCN/PIU
B. STRUCTURES				
B1	Loss of structure	Owner of structure	• Cash compensation will be paid at the replacement cost and associated in-direct cost (e.g. registration tax, etc.) evaluated by TCN. • Shifting allowance: F1 • Special assistance, if applicable: H1	TCN/PIU
B2	Loss of rental Structure	Person renting in a residential or commercial structure with rental	• No compensation for structure • Shifting allowance: F1 • Special assistance, if applicable: H1	TCN/PIU

Item	Type of loss	Entitled Persons	Entitlements	Responsibility
		agreement or receipt of payment		
B3	Loss of rental Structure	Owner of structure	• Cash compensation will be paid at the replacement cost and associated in-direct cost (e.g. registration tax, etc.) evaluated by TCN.	TCN/PIU
C. CROPS AND TREES				
C1	Loss of crops and tress	Owner Farmer	• Cash compensation for loss of crops and trees during the construction stage will be paid at the market value of crops based on the harmonized compensation rate in South-west area in Nigeria	TCN/PIU
D. OTHER PRIVATE PROPERTIES OR SECONDARY STRUCTURES				
D1	Other property or secondary structure (i.e. shed, outdoor latrine, rice store, animal barn etc.)	Owners of structures (regardless if the land is owned or not)	• Cash compensation will be paid at the replacement cost and associated in-direct cost (e.g. registration tax, etc.) evaluated by TCN.	TCN/PIU
E. LOSS OF INCOME				
E1	Job loss due to relocation of business to another area or business operator decides not to re-establish	Business owner	• 1 month income assistance • Shifting allowance : F1 • Livelihood restoration (assistance and training):G1	TCN/PIU
F. REHABILITATION ASSISTANCE				
F1	Loss of residential/commercial structures	Relocating APs/ APs reorganizing or rebuilding on same plot	• Moving cost will be paid for assistance at the value evaluated by TCN based on the quantity and size of items need to be moved.	TCN/PIU
G. LIVELIHOOD RESTORATION (ASSISTANCE & TRAINING to PAPs)				
G1	Effects on livelihood	All affected commercial owners/operators of businesses/ workers of businesses /	• Professional assistance and advice to reestablish and develop the business • Vocational or skilled training for business owners or their family members • Priority is given for PAPs for the position of construction workers	TCN/PIU TCN/PIU and contractor TCN/PIU and contractor

Item	Type of loss	Entitled Persons	Entitlements	Responsibility
G2	Effects on livelihood	All affected owners/operators in agricultural land	• For farmers who have remaining land or farmers who cultivate on new lands will be assisted to increase productivity (i.e. increasing cropping intensity, use of high yielding seeds, diversification and introduction of new seeds or crops etc) and assistance to access existing subsidies. • Introducing new livelihood opportunities for farmers or their family members, such as priority for APs for project related employment opportunities during construction period. • Priority is given for PAPs for the position of construction workers • Vocational or skilled training for farmers or their family members	TCN/PIU and retained NGO TCN/PIU and EPC contractor TCN/PIU and EPC contractor
H. SPECIAL ASSISTANCE				
H1	Effects on vulnerable APs	Vulnerable APs including the female - headed households, elderly people and differently able.	• 300 Naira x 30 days per person of special grant for AP household to improve living standards of vulnerable APs (such as linking to national poverty reduction programs conducted by various government institutions) and assistance to in finding suitable land for relocation and shifting. • All women that are part of the resettled households will be informed of the compensation benefits offered to them specifically. • Special help will be given such as opening a bank account, budget management, etc.	TCN/PIU
I. COMMUNITY ASSETS				
I1	Loss of buildings and other structures (schools, shrine, temples, clinics, common wells etc.), infrastructure (local roads, footpaths,	Divisional Secretary of the division, local community or local authority owning or benefiting from community property, infrastructure or resources	• For shrine, amount of compensation will be calculated by TCN with consultation with PAPs based on replacement cost considering size, equipped item, traditional rites • For public assets including well, rebuild a new structure (Not money compensation)	TCN/PIU

Item	Type of loss	Entitled Persons	Entitlements	Responsibility
	bridges, irrigation, water points etc.), common resources			
J. UNANTICIPATED RESETTLEMENT				
J1	Any unanticipated adverse impact due to project intervention	Any unanticipated consequence of the project will be documented and mitigated based on the spirit of the principles agreed upon in this policy framework.		

7-9-4 Valuation Method

Following sections describe valuation methods for the various categories of affected lands and assets in the project area and the methods that were used in determining and valuing the assets. The methods described below are also consistent with the entitlement matrix for Project Affected Persons.

7-9-4-1 Valuation Method for Land

The replacement cost method (Land for land) is the preferred method as recommended by OP 4.12. However, since TCN does not have right to acquire land for replacement in the project area, in consultation with PAPs, this RAP adopted the method of cash compensation for land at market value based on results of market survey. This was done through interviews carried out with residents of the communities and real estate valuers in and around the project area. Entitlement for land compensation only applies for PAPs on communal land, clan or family land and individual land (not those on government land) with evidences of statutory rights or other forms of recognizable rights. During the market survey carried out by TCN, unit rates per square meter for land confirmed at Lot 2 and 3 were ranged from 100 to 300 Naira, and from 9 to 380 Naira, respectively. The unit price for land at Lot 1 was evaluated to be zero Naira. Based on the market survey and reconciliation meeting held on April 2, 2019 at Bureau of Land and Survey involving representatives of TCN RAP consultants for Lot 1, 2 & 3, Government representatives and the project coordinator (TCN), the unit price for land per square meter (m^2) in the project area was evaluated at 200 Naira for urban/semi-urban areas and 100 Naira for rural areas. During the consultation to explain the compensation package and offers compensation to each PAP, negotiations to adjust compensation package will be conducted in case that a PAP claim that replacement cost of the PAP's land is considered being higher than the unit prices mentioned above. The land acquisition process including consultation and negotiation above is described in Section 7-8-4.

7-9-4-2 Valuation Method for Structures

The replacement cost method was used in estimating the value of the house/structure. The replacement cost method is based on the assumption that the capital value of an existing development can be equated to the cost of reinstating the development on the same plot at the current labour, material and other incidental costs. The estimated value represents the cost of the property as if new. In arriving at appropriate rate for structures, the quantity surveyor embarked on market survey of building materials and labour in the project area. Although a few variations exist from one local market to the other, the upper price of materials was adopted to ensure that PAPs suffer no net loss but are made better off in line with the pro-poor objective which OP 4.12 supports.

Types of structures, type of material, level of completion and finishing were considered for the valuation of each structure in the project area.

7-9-4-3 Valuation method for Economic Tree and Crops

Valuation for economic tree and crops was based on the harmonized rate for economic trees in South

West Zone of Nigeria (see Table 7-39). In adopting the rate, market survey in the locality was undertaken to ensure that the rates conform to the appropriate market value of the trees and crops. The South West Harmonized rate is higher than the National Gazette Rate as prescribed in the Land Use Act. The highest value rate in the harmonized gazette which assumed that economic trees to be affected are all of maturity status was used, or maturity of trees were evaluated by the specialist who was invited from Ogun State Ministry of Agriculture. Number of economic trees and crops owned by each PAP were counted and recorded during RAP survey.

Compensation for crops is at full market value of crop yield per hectare or number counts of the quantity of the crops within the affected farm land multiplied by the harmonized rate of government of the South West Zone of Nigeria. The harmonized compensation rates for crops is considered to be equivalent to the compensation for the crop amount harvested for 1 year.

Table 7-39 Harmonized Compensation Rates for Economic Trees and Crops in Southwest Geo-Political Zone

S/N	ECONOMIC TREES/CROPS	A 100%	B 70%	C 30%
1	Cocoa	1,200.00	840.00	360.00
2	Oil Palm	2,200.00	1540.00	660.00
3	Kola nut Tree	2,000.00	1,400.00	600.00
4	Rubber	500.00	350.00	150.00
5	Avocado Pear	900.00	630.00	270.00
6	Local Pear	900.00	630.00	270.00
7	Guava	500.00	350.00	150.00
8	Cashew	700.00	490.00	210.00
9	Bread Fruit	300.00	210.00	90.00
10	Mango	800.00	560.00	240.00
11	Citrus Orange	1,000.00	700.00	300.00
12	Coconut	1,000.00	700.00	300.00
13	Pawpaw	200.00	140.00	60.00
14	Grape Fruit	500.00	350.00	150.00
15	Coffee	500.00	350.00	150.00
16	Banana	250.00	175.00	75.00
17	Plantain	500.00	350.00	150.00
18	Maize	20,000.00/ha	14,000.00/ha	6,000.00/ha
19	Cassava	50.00	35.00	15.00
20	Guinea Corn	1,0.00	7.00	3.00
21	Tobacco	15,000.00/ha	10,500.00/ha	4,500.00/ha
22	Yam	100.00/stand	70.00/stand	30.00/stand
23	Cocoyam	30.00	21.00	9.00
24	Tomatoes	75.00	52.5	22.5
25	Wallnut	500.00	350.00	150.00
26	Pinapple	100.00	70.00	30.00
27	Soft wood	1,500.00	1,050.00	450.00
28	Hard Wood	3,500.00	2,450.00	1,050.00
29	Alligator Pepper	2,500.00/ha	1,750.00/ha	750.00/ha
30	Pepper	75.00	52.5	22.5
31	Mellon	50.00	35.00	15.00
32	Garden Egg	75.00	52.5	22.5
33	Vegetable, Onion and Cabbage	50.00	35.00	15.00
34	Cotton	50.00	35.00	15.00

S/N	ECONOMIC TREES/CROPS	A 100%	B 70%	C 30%
35	Groundnut	50.00	35.00	15.00
36	Beans	75.00	52.5	22.5
37	Beniseed	100.00	70.00	30.00
38	Potatoe	50.00	35.00	15.00
39	Rice	50,000.00/ha	35,000.00/ha	15,000.00/ha
40	Raffia Palm	1,000.00	700.00	300.00
41	Iyere	100.00	70.00	30.00
42	Okro	20.00	14.00	6.00
43	Bamboo	100.00	70.00	30.00
44	Eweran	1,000.00/ha	700.00/ha	300.00/ha
45	Bush Mango (Oro)	500.00	350.00	150.00
46	Agbalumo	500.00	350.00	150.00
47	Pinapple (improved sp)	200.00	140.00	60.00
48	Cowpea	75.00	52.5	22.5
49	Locust Bean	800.00	560.00	240.00
50	Sugarcane	20.00	14.00	6.00
51	Orogbo (Bitter Cola)	500.00	350.00	150.00
52	Bitter Leaf	50.00	35.00	15.00
53	Aidon/Igisogba	60.00	42.00	18.00
54	Afon	75.00	52.5	22.5
55	Ori (Shear butter)	80.00	56.00	24.00
56	Idi	65.00	45.5	19.5
57	Eru	50.00	35.00	15.00
58	Teak	1,500.00	1,050.00	450.00
59	Melina	800.00	560.00	240.00
60	Dongoyaro	400.00	280.00	120.00

Source: Resolution on National Technical Development Forum (NTDF) on Land Administration

NOTES ON APPLICATION OF THE RATES The rates for these are in three grades – A, B, C

Grade A: For matured trees and crops in agricultural plantation or around homesteads regarded as 100%

Grade B: Applicable to trees and crops at medium stage of maturity representing 70% of grade A

Grade C: For immature trees or crops or those at the nursery stage and this represents 30% of grade A

7-9-4-4 Valuation Method for Business Loss

Some commercial structures were located in the project area. The structures include a shop selling daily items, fishponds for catfish aquafarming, a brick factory, etc., but all of them are not large-scale enterprise commercial structures, they are more like structures for family businesses. Their structures will be compensated as mentioned in Section 7-9-4-2. If business loss is happened due to the relocation of their structures, the amount of business loss will be considered when needed, e.g. the number of fish in the fishpond will be counted and multiplied by the market price of the fish around the area.

7-9-4-5 Valuation Method for Shrines, archaeological structures and sacred properties

Since the value of cultural properties cannot be market determined, the approach to compensation taken in this project was based on wide consultation with custodians of traditions (Baales) and those associated with the affected cultural properties. It was agreed that 200,000 Naira per community shrine and 50,000 Naira per individual shrine, 50,000 Naira per earthen grave, 100,000 Naira per cemented grave and

150,000 Naira per marble grave.

7-10 Livelihood Restoration Program

7-10-1 Livelihood and Income Restoration Strategy

TCN is encouraged to use the guidelines such as the World Bank OP 4.12 and involve the affected communities, local leaders, NGOs and other stakeholders to gather opinions in order to assess livelihood restoration procedures.

The World Bank (WB)'s OP, 4.12 paragraph (6c), states the following:

> *''Displaced persons should be offered support after displacement, for a transition period, based on a reasonable estimate of the time likely to be needed to restore their livelihood and standards of living; and provided with development assistance, such as land preparation, credit facilities, training, in addition to the compensation they receive."*

Additionally, WB OP 4.12, paragraph (2c), requires that displaced individuals be given assistance for their efforts to improve their living standards or to at least restore them to the highest standard between pre-displacement or standards prevailing prior to the beginning of the project implementation.

It is recommended that TCN hire a consultant or partner with an NGO to coordinate the restoration programme.

It is recommended to inform the PAPs of the project as early as possible and at least three months before the start of the construction. In all cases, PAPs shall be advised to construct new structures at locations near the previous ones within the affected community to reduce disruption of community life, established spatial organization and services.

Also worthy of mentioning is the fact that many communities along the ROW have experienced workers that can be hired during the construction phase. Local experienced workers and entrepreneurs with necessary experience and capacity should be given priority work opportunities, if applicable. Also, as suggested through consultations, EPC contractors should liaise with village chiefs to maximise local hiring as well as the purchase of relevant local materials and services.

7-10-2 Income Restoration and Improvement

Different restoration packages will be required for each of the various categories of PAPs and will depend on the type and magnitude of loss suffered the vulnerability level of the PAPs' household, the indicated preferences associated to their family characteristics and other relevant circumstances.

The support for income restoration and improvement will include; compensation for land, practical training courses on improved agricultural techniques; improvement of land for farming, agroforestry and other relevant techniques support; a moving allocation; special support for vulnerable groups, and non-financial component. Details are described in the following sections.

7-10-2-1 Land Base

The households that will lose a piece of land will receive sufficient compensation to be able to buy a new land, off-set loss of crops and rehabilitate the land to similar production level.

Further investigations paired with experience on similar projects indicate that in most cases it would be difficult for the TCN to find and propose replacement land for different reasons (risk of speculation, administrative burden, lack of trust from PAPs, etc.) and PAPs requested cash compensation rather than land-to-land compensation. It is thus preferable to pay cash compensation to the PAPs to provide them with an opportunity to purchase new land and condition it themselves and continue farming.

However, to minimize negative impact to PAP's livelihood, adequate compensation level and implementation conditions are essential. PAPs need to be given the conditions summarized below:

- Sufficient time to find and evaluate their option and possible replacement land and organize the resettlement;
- Support for all legal aspects of the transaction;
- All "transaction costs" such as registration fees, transfer taxes, or customary tributes are to be compensated; and
- Adequate control of PAPs' use of compensations by project authorities through different mechanisms like progressive verification of land purchase.

7-10-2-2 Trees and Crops

Trees will be destroyed during the construction of the transmission line since no trees taller than the height specified by TCN (generally 4 meters height) are being kept in the wayleave. Compensation to households will be allocated according to the prescribed rates up to economic trees and crops within the ROW no matter they are taller than 4 meters or not.

PAPs whose crops are to be negatively impacted by the project should be provided seedlings and seeds for their gardens and crops on their replacement land.

Furthermore, compensation should cover cost of improvement (fertilized, tilled, weeded, fenced, etc.) to reach the productive condition of the original plot. Affected households will be paid as land relocation assistance for agricultural land by the project to do this work as much as possible, by themselves.

Additionally, technical assistance will be provided for at least a two-year period to help the impacted households improve their situation. Project Implementation Unit is encouraged to engage an experienced NGO agronomist who will also ensure coordination with governmental agricultural departments for the coordination and efficiency of the work. This specialist will assess concerns, needs and the most relevant aspects of livelihood improvement with PAPs and local administration as well as it will propose improvement and support activities.

This help can include:

- Practical training courses on improved agricultural techniques;
- Improved crop varieties;
- Fertilization;
- Small scale irrigation;
- Animal traction and related equipment;
- Post-harvest grain conservation; and
- Agroforestry, other relevant techniques.

7-10-2-3 Structures

Structures including houses that are located in the wayleave will have to be displaced. In that case the PAPs indicated adequate compensation that they would not have problem to obtain an available land to relocate their houses during the survey campaign.

Those structures should therefore be rebuilt on new land where the risk of spatial disruption of household activities is the lowest. All necessary steps will be taken by the TCN and the PIU or consultants in charge of compensation to make sure that the PAPs find a suitable land for reconstruction and enough time for reconstruction is allowed and proper compensation is paid.

Each of these household will receive additional compensation to cover the following expenses:

- A moving allocation to pay for moving their goods and belongings
- An income support for of the household to mitigate the inconvenience and time constraints related to the resettlement.
- Cost for land administration, taxes and other charges associated with land acquisition.

7-10-2-4 Vulnerable Groups

A special focus must be given to the livelihood improvement of vulnerable groups prior to commencement of the construction of the project. Vulnerable groups include low income families, women, child (under 18 years heading a household) or handicap headed households.

Vulnerable households will be consulted at the onset of the operation to evaluate their concerns and needs. Special help that could be provided include:

- Support to open bank account and financial management (e.g. how to use compensation properly);
- Help for administrative transactions (land titling);
- Relocation logistics and other support for the physically resettled households such as:
  - Transport assistance;
  - Reconstruction advise (on materials, type of structures, etc.) to ensure the quality of construction;
- Psychological support (information, counselling, discussion);
- Special transitional funds specific to vulnerable households (the funds are financial aid for vulnerable households to recover their livelihood. The necessity of the funds was not identified

during the stakeholder consultation process but it is planned to be established by TCN when needed).

Members of affected households should also benefit from the proposed training programs. Household members within vulnerable households are to be given priority for the allocation of project related employment and other benefits.

Given the current place of females in rural communities, when cash compensations is the only acceptable option, the following possible mitigation measures should also be examined and implemented when feasible:

- Awareness programs on issues directed towards authorities, local administrators and communities;
- Assistance of the PIU to inform and assist vulnerable people and groups;
- Seeking full consent of females in the households and explaining to them the proposed compensation options;
- Payment of large amounts of cash compensation (larger than N 200,000) through carefully distributed instalments (it can be over several months) to mitigate the potential for cash misuse;
- Careful monitoring.

Some handicapped headed households were identified in the project area. Two of these handicapped PAPs are cripples and another two have sight problem. These four handicapped headed households should be given necessary compensation and support for resettlement.

7-10-2-5 Non-Financial Components

As a part of non-financial components, professional assistance and advice will be given to all PAPs to reestablish and develop the business. Also vocational or skilled training will be provided for business owners or their family members. To provide these assistances, a professional expert or NGO may be retained by the TCN.

Priority should be given to all able bodied members of resettled households during the labour recruitment process. This applies to the employment and contract opportunities such as clearing of the corridor, porterage for movement of construction materials to transmission pylon development and other sites, construction of access roads and construction camps, reconstruction of community buildings and houses, provision of services and goods to the workers; administration of the compensation program, monitoring activities, etc.

Furthermore, all the affected households and communities should be given all the wood that is cut on their parcel for their own use or sale. The materials salvaged from the affected structures should also be left to the affected households and communities.

All goods and services (sand, cement, food, etc.) should be bought locally when possible. This applies to all contractors and specific provisions to that effect must be included in the construction Terms of

Reference.

7-11 Implementation Budget and Schedule

7-11-1 Land Acquisition and Resettlement Budget

The land acquisition, resettlement, Livelihood Restoration Strategies (LRS) implementation and monitoring budget is summarized in Table 7-40 below. This includes all costs involved in the execution of all RAP and LRS activities except for the compensation for the land and crops/economic trees within access road and work camp that will be designed during the construction period, and the cost will be included in contractors' cost. Also, it should be noted that the budget below is still under the evaluation process by RAP consultants. The total budget shared by TCN is 5,863,913,658.54 Naira (ca. USD 19,158,108 when currency conversion factor is 306.08 Naira/USD).

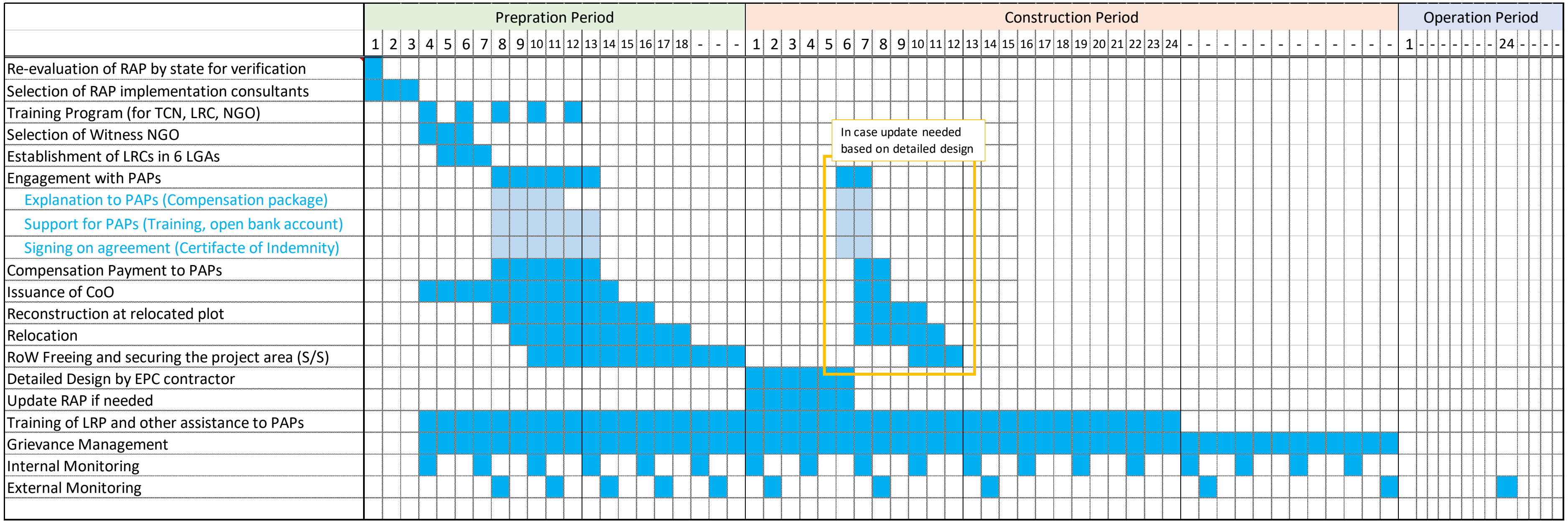
Table 7-40 Land Acquisition and Resettlement Budget

		Lot 1	Lot 2	Lot 3	Remark
(a)	Crops	386,027,143.00	396,993,628.50	400,905,574.24	
(b)	Structures	201,817,797.00	1,679,918,207.82	2,146,630,564.12	
(c)	(a) + (b)	587,844,940.00	2,076,911,836.32	2,547,536,138.36	
	Sub-Total	**587,844,940.00**	**2,076,911,836.32**	**2,547,536,138.36**	
(d)	Support to vulnerable groups	11,201,182.83	6,132,145.40	16,236,000.00	
(e)	Security, bank charges, stamp duty and other logistics, for compensation payment for Crops	9,650,678.58	9,924,840.71	10,022,639.36	2.5% of (a)
(f)	Security, bank charges, stamp duty and other logistics, for compensation payment for Structures	5,045,444.93	41,997,955.20	53,665,764.10	2.5% of (b)
(g)	Demolition and salvage of structures	10,090,889.85	83,995,910.39	107,331,528.21	5.0% of (b)
(h)	Contingency for structures and crops	29,392,247.00	103,845,591.82	127,376,806.92	5.0% of (c)
(i)	Livelihood restoration and training & support, etc.	13,777,454.87	11,933,663.71	NA	
	Sub-total	**79,157,898.05**	**257,830,107.23**	**314,632,738.58**	
	TOTAL AMOUNT of EACH LOT	**667,002,838.05**	**2,334,741,943.55**	**2,862,168,876.94**	
	GRAND TOTAL AMOUNT			**5,863,913,658.54**	

7-11-2 Land Acquisition and Resettlement Schedule

The implementation schedule for this land acquisition and resettlement is shown in Table 7-41 below. The cash compensation shall be made before commencement of relocation and construction, and non-financial compensation shall be started before commencement of relocation and construction and will be kept being provided during construction period.

Table 7-41 Land Acquisition and Resettlement Schedule (Plan)



7-12 Monitoring and Evaluation

The purpose of resettlement monitoring is to ensure that measures developed for compensating the losses were effective in restoring PAPs living standards and income levels. Monitoring will be implemented by the PIU.

Throughout the project lifecycle, monitoring and evaluation activities will be reviewed and revised in case that the previously produced procedures, tools and forms are inefficient.

Monitoring and Evaluation (M&E) procedures establish the effectiveness of all land and asset acquisition and resettlement activities, in addition to the measures designed to mitigate adverse social impacts. The procedures include internal tracking efforts as well as independent external monitoring.

The purpose of resettlement monitoring for the Project will be to verify that:

- Actions and commitments described in the RAP are implemented;
- Eligible PAPs receive their full compensation prior to the start of the rehabilitation activities on the corridor;
- RAP actions and compensation measures have helped the people who sought cash compensation in restoring their lost incomes and in sustaining/improving pre-project living standards;
- Complaints and grievances lodged by PAPs are followed up and, where necessary, appropriate corrective actions are taken; and
- If necessary, changes in RAP procedure are made to improve delivery of entitlements to PAPs.

PIU monitoring and evaluation activities and programs shall be adequately funded and staffed. PIU monitoring will be verified by the witness NGO to ensure provision of complete and objective information.

7-12-1 General

7-12-1-1 Monitoring Framework

The monitoring and evaluation framework consists of three elements:

- PIU monitoring;
- External monitoring undertaken by the Witness NGO; and
- RAP Completion Audit by an individual third party (e.g. another Witness NCO).

Indicators have been established in order to measure RAP activities, results, objectives and goals. There are five categories of indicators for performance monitoring. The first three (3) indicators (input, output and process indicators) are for Internal Performance Monitoring. These are mostly used for medium term measures to ensure that the RAP is relevant, effective and efficient. The last two indicators (outcome and impact indicators) are for Impact monitoring. These are mostly used for assessing the results long term measures.

Table 7-42 RAP Monitoring Framework

COMPONENT ACTIVITY	TYPE OF INFORMATION/ DATA COLLECTED	SOURCE OF INFORMATION/ DATA COLLECTIONS METHODS	RESPONSIBILITY FOR DATA COLLECTION, ANALYSES AND REPORTING	FREQUENCY/ AUDIENCE OF REPORTING
Internal Performance Monitoring	- Measurement of input, process, output and outcome indicators against proposed timeline - budget including compensation disbursement	Quarterly narrative status and compensation disbursement reports	PIU team, including public relations representatives	Quarterly or as required by TCN Environmental Committee and JICA
Impact Monitoring	- Progress of land acquisition and resettlement - Implementation of income restoration assistance - Restoration of income and living standard - Results of public consultation - Details of grievance redress	Annual quantitative and qualitative surveys. Regular public meetings and other consultation with PAPs; review of grievance mechanism outputs.	PIU team, including public affairs representatives, RIC, Witness NGO	Quarterly as required by JICA

The main mechanism to alert management of any delays and problems and will help TCN measure the extent to which the main objectives of the resettlement plan have been achieved.

RAP monitoring and evaluation activities will be adequately funded, implemented by qualified specialists and integrated into the overall PIU budget and activities.

PIU monitoring and evaluation activities will be supplemented and verified by monitoring efforts of the witness NGO.

The establishment of appropriate indicators in the RAP is essential since what is measured is what will be considered important. Indicators will be created for PAPs as a whole, for key stakeholder groups, and for special categories of affected groups such as women.

The most important indicators for the RAP are the near term concern outputs, processes and outcomes since they define whether the planned level of effort is being made and whether early implementation experience is being used to modify/redesign RAP features. Over the medium to long term, outcome and impact indicators are critical since they are the ultimate measure of the RAP’s effectiveness in restoring people’s livelihoods.

Monitoring indicators may have to be defined or re-defined during the course of project in response to changes to project-related conditions. Consequently, implementation and mitigation measures may have to be adopted to incorporate these changes into the M&E plan.

7-12-1-2 Indicators

Input Indicators

These cover the human and financial resources that are utilized in the RAP activities.

Output Indicators

Include activities and services produced with the inputs, which can be a database of land acquisition, compensation payments made for the loss of assets etc.

Process Indicators

Process indicators represent the change in the quality and quantity of access and coverage of the activities and services. Examples of process indicators in the RAP include:

- The creation of grievance mechanisms;
- The establishment of stakeholder channels so that they can participate in RAP implementation; and
- Information and dissemination activities.

Outcome Indicators

Outcome indicators refer to the delivery of mitigation activities and measures to compensate physical and economic losses created by the project (e.g. restoration and compensation of agricultural production and overall income levels, changes in PAPs and community attitudes towards the project, use of compensation payments for income generating activities).

Impact Indicators

Impact indicators define the change in medium and long-term measurable results in behaviour and attitudes, living standards, and conditions. Impact indicators aim to assess whether restoration activities of the RAP are effective in maintaining and even improving social and economic conditions of PAPs.

In addition to quantitative indicators, impact monitoring will be supplemented by the use of qualitative indicators to assess client satisfaction and the satisfaction of the affected people with the choices that they have made in re-establishing themselves.

Tracking this data will allow the PIU in determining the following types of information:

- The extent to which the quality of life and livelihood has been restored;
- The success of the resettlement; and
- Whether PAPs have experienced any hardship as a result of the project.

7-12-2 Internal Monitoring

Internal monitoring measures the progress of activities defined in the RAP. The PIU will be responsible for this process with support from appointed experts, as necessary.

It is the responsibility of the PIU to conduct regular internal monitoring of the resettlement efforts and performance of the operation through LRC, which will be responsible for implementing resettlement activities and manage grievances. The monitoring shall be a systematic evaluation of the activities of the operation in relation to the specified criteria of the condition of approval. The internal monitoring will be carried out quarterly. The RIC will collect necessary information to evaluate the progress of compensation and report it to the PIU, then PIU prepare the quarterly internal monitoring report and submit it to TCN management and other relevant organizations including JICA.

7-12-3 External Monitoring

External monitoring activities will verify the process defined in the RAP.

The witness NGO shall be established to periodically carry out external monitoring and evaluation of the implementation of the RAP. The external monitoring will be carried out quarterly until land acquisition will be completed, and semi-annually or annually after that as shown in Table 7-41.

The following parameters will be monitored and evaluated through PIU report review and sites visits:

- Public consultation and awareness efforts of compensation distribution;
- PAPs should be fully informed and consulted about all resettlement activities, including land acquisition, leasing land and relocation activities;
- The witness NGO representative should attend some public meetings to monitor consultation procedures, problems and issues which arise during the meetings, and proposed solutions;
- Levels of PAPs' satisfaction with various aspects of resettlement and compensation will be monitored and recorded;
- Operation of grievance redress mechanism, redress results, and effectiveness of grievance resolution will be monitored;
- Standards of Living - throughout resettlement implementation process, the trends of living standards of PAPs will be observed and surveyed, and any potential problems in restoration of living standards will be recorded and reported.

The witness NGO should have qualified and experienced staff and their terms of reference acceptable to the financing requirements of JICA.

In addition to verifying the information furnished in the internal supervision and monitoring reports, the independent monitoring unit shall visit a sample of 10% of PAP in each relevant district, six (6) months after the RAP has been implemented to:

- Determine whether the procedures for PAPs participation and delivery of compensation and other rehabilitation entitlements have been done in accordance with the Policy Framework and the respective RAP;

- Assess if the RAP objective or, enhancement or at least restoration of living standards and income levels of PAPs have been met;
- Gather qualitative indications of the social and economic impact of project implementation on the PAPs; and
- Suggest modification in the implementation procedures of the RAP, as the case may be, to achieve the principles and objectives of this RAP.

Both internal and external monitoring will be assessed with RAP Completion Audit.

RAP Completion Audit

A RAP completion audit will be undertaken by a third party (e.g. an individual consultant) when previous monitoring has indicated that there is no significant outstanding issue regarding livelihood restoration and resettlement. It is expected that this final audit will be performed 3 years after the resettlement, at the latest.

The RAP completion audit will be undertaken by an independent consultant as required. It will provide final indication that the livelihood restoration is sustainable and no further interventions are required.

Therefore, the independent audit will assess compliance programs resettlement / compensation against the provisions described in the RAP, the Nigerian legal framework applicable and the requirements of World Bank/JICA. The evaluation report will be made public by the PIU and LRC meeting through public announcement by using appropriate media (e.g. TCN’s web site, newspaper, radio, etc.).

7-13 Grievance Mechanism

During implementation of the project activities, it is possible that disputes/disagreements between TCN and the PAPs will occur especially in terms of compensation, boundaries, ownership of crops or land, etc.

The practice of grievance arbitration over resettlement issues in Nigeria is conducted within the framework of the Land Use Act (LUA) of 1978, reviewed under Cap 202, 1990. Two stages have been identified in the grievance procedure: customary mediation by Local Resettlement Committee and judiciary hearings.

Procedures for grievances will be clearly explained during community meetings. The aggrieved person shall first report the matter to the Village Head (Baale) or RAP Implementation Consultant (RIC) for resolution. Issues that can be resolved by Customary Chiefdom and Village Chief at this level include, ownership tussle, management of deceased property, boundary issues, etc. The type of issues to report to the RIC may include perceived wrong valuation, incorrect PAP data, inadequacy of compensation received, etc.

In case that the issue is not resolved by Baale and/or RIC at this stage, it can then be escalated to customary mediation and if still no acceptable resolution is achieved, the parties may choose to go to court in accordance with laws of the Federal Republic of Nigeria. Figure 7-26 illustrates this mechanism.

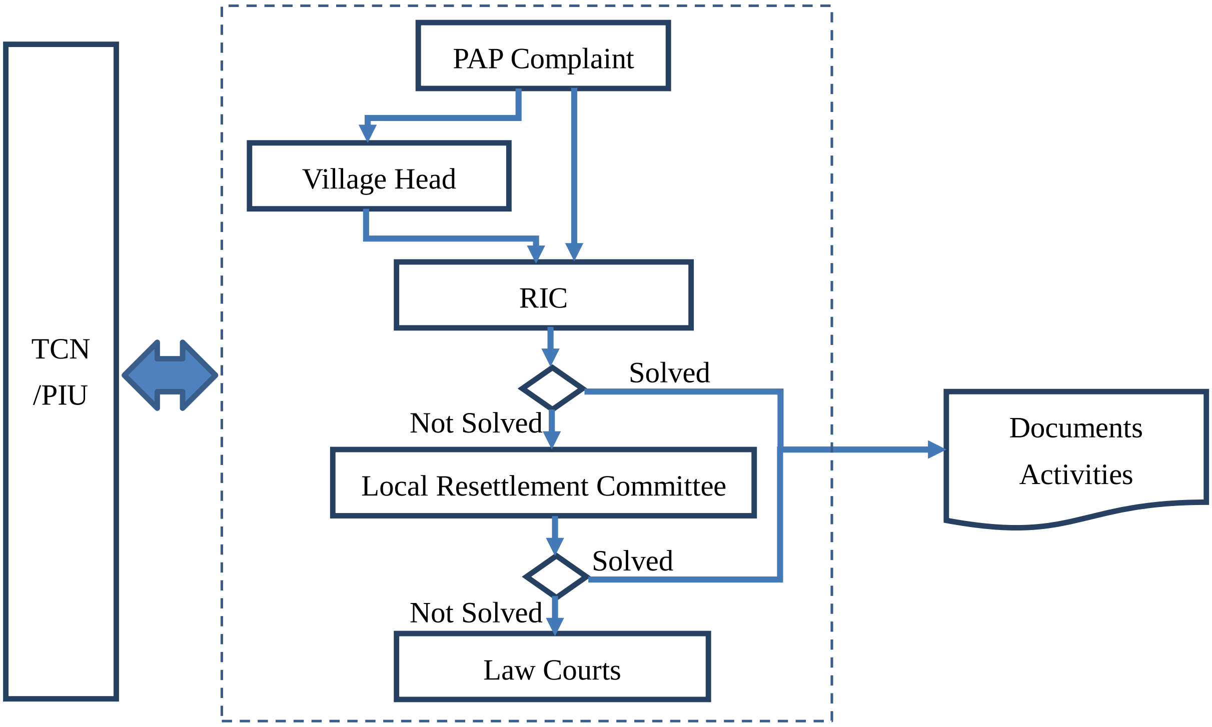


Figure 7-26 Grievance Resolution Procedure

7-13-1 Local Resettlement Committee

At the village levels, a series of customary avenues exists to deal with dispute resolutions. Those avenues should be employed, when and where it is relevant as a "court of first appeal".

Such customary avenues should provide a first culturally and amicable grievance procedure that will facilitate formal and/or informal grievance resolution for grievances.

A Local Resettlement Committee shall be set up by the PIU in each LGA to address complaints related to RAP implementation. This committee will be assisted by the PIU who will act as TCN representative. The Committee will consist of:

- Respected person (e.g. a retired senior citizen, Iman/Alfa or Church Priest, can act as Chairperson of LRC)
- Customary chiefdom (i.e. Oba) from the area crossing the project area
- All LCDA chairman from the area crossing the project area
- DSS officer (Department of security service, Divisional Police Office)
- Women leader and Youth leader at least one for each LGA as necessary
- Witness NGO

PAPs' complaints should first be lodged verbally or in writing through this process.

It is expected that the committee will deal with the grievances they receive within three days of receipt of the complaint. If the complaint cannot be resolved at this level, or if the plaintiff is not satisfied with the settlement proposed, the plaintiff should then be referred to the official legal procedures.

7-13-2 Courts of Law

The judicial process in accordance with applicable laws will be followed and the law courts will pass binding judgment on the matter.

7-14 Stakeholder Engagement

7-14-1 Objective

General objective of stakeholder engagement of this study were to:

- Inform stakeholders on the proposed infrastructures and activities and seek their informed opinion about the socio-environmental risks and opportunities potentially associated with the project as well as take the measures and actions in order to manage the anticipated impacts;
- Obtain feedback from stakeholders on issues of concern and expectations in order to optimize the project;
- Generate a social and institutional dialogue in order to assess and strengthen the project's social acceptability; and
- Help to consolidate, through the ESIA and RAP process, the efforts made by the TCN in order to establish lasting relationships with affected communities and other stakeholders.

7-14-2 Target Stakeholder

Target stakeholder groups of this study included:

- Concerned agencies and organizations at National and State levels;
- State level (Ogun and Lagos) agencies;
- LGA-level agencies;
- Customary authorities in communities affected by the line; -Obas, Ba'ales and Village Heads crossed by the line route;
- Representatives of women group, youth group and occupational group in communities affected by the line;
- Vulnerable people including elderlies, single women and physically handicapped persons;
- Industrial and commercial actors affected by the line, including relevant TCN departments, and JICA; and
- Security agencies, national civil security and defense corps, department of security service, and the Nigerian Police.

7-14-3 Summary of Consultations

Table 7-43 LOT 1 Stakeholder Engagement Meetings

Stakeholder Engagement	Engagement Activity	Stakeholders	Number of Participants	Venue	Date/Time	Specific Discussion Areas
STAGE 1 : SCOPING						
Government Agencies – Federal, State and Local Government Authority Regulatory Authorities.	Meeting with Federal, State and Local Council Officials.	Federal Ministry of Environment, Abuja.	9	Abuja & Ogun State	May 30, 2017 June 28, 2017 July 11, 2017 (12pm)	• Registration of the Project; • Scope of data collection and ToR approval; • Issues concerning site verification; • EIA process and scope of the EIA; • Approval for one season waiver; • Approval for the transmission lines; • Initial consultation/ sensitization on the project.
		Ogun States	25 32 28	Abeokuta, Ogun State	May 11, 2017 June 29, 2017 July 27, 2017	
		Ifo LGA Ewekoro Obafemi-Owode	6	LGA Secretariate	July 20, 2017 (11am-1pm)	
STAGE 2: Line Route survey/ESIA Study						
Baseline Data Collection: Community Engagement, engagement with local groups and traditional leaders.	Meeting with Traditional Rulers, women leaders , Youth leaders and Project Affected Persons (PAPs)	The head and chiefs of host communities. (75communities) women leaders, youth leaders &PAPs	About 500 persons	Palace of Oba/ Palace of Baale	December 18 -23, 2017 and January 22 – 24, 2018 (between 10am -5pm)	• Formal presentation of the project Background information; • Discussion of community concern; and • The need for a grievance mechanism throughout the project life.
Government Agencies – Federal, State and Local Government Authority Regulatory Authorities.	Meeting with Local Government Officials and Project Affected Communities at the Secretariate.	Ifo LGA; Ewekoro LGA Obafemi-Owode LGA and concern parties TCN & Ogun	78 142 60	LGA Secretariate LGA Secretariate Palace of Oba-Eerin in Oba LCDA Line route for	Dec. 12, 2017 Dec. 13, 2017 Dec. 23, 2017 (10am-1pm)	• Formal Presentation of the project background information. • Engagement with affected communities; • Potential positive impacts (provision of electricity and employment of opportunities for local people; and • Community development in general.

Stakeholder Engagement	Engagement Activity	Stakeholders	Number of Participants	Venue	Date/Time	Specific Discussion Areas
	Line route inspection	State ministries	10	Lot 1	Oct.25,2017	• Line route optimization
Local communities	Meetings with persons in the project affected area	Communities (women group meetings were also separately held)	71 communities	All communities in Lot 1	July – December 2017	• Data collection and consultations for ESIA and RAP
Others		JICA consultants & TCN team	20	Ogun state Lagos State	March 2,2018 March 6,2018 (11am-5pm)	• Issues pertaining to hotspots on the lines • Issues pertaining to ESIA/RAP review
		Nigeria Conservation Foundation	12	NCF Head office Lekki- Lagos State	March 7,2018 (11am-12pm)	• Engagement with Nigeria Conservation Foundation to obtain their view on the project and review the report.

Table 7-44 LOT 2 Stakeholder Engagement Meetings

Stakeholder Engagement	Engagement Activity	Stakeholders	Number of Participants	Venue	Date/Time	Specific Discussion Areas
STAGE 1: SCOPING						
Government Agencies – Federal, State and Local Government Authority Regulatory Authorities.	Meeting with State and Local Council Officials.	Federal Ministry of Environment, Abuja.	6	Environment House, Abuja	May 10, 2017 July 11, 2017	• Registration of the Project; • Scope of data collection and ToR approval; • Issues concerning site visitation; • EIA process and scope of the EIA; • Approval for one season waiver; and • Approval for the substation and the lines.
		Ogun States	35	Governor's office Secretariat	May 3,2017 Every last Thursday of the Month	
		Sagamu, Ewekoro, Owode	7	Each Secretariat	November 19 -30, 2017	

Stakeholder Engagement	Engagement Activity	Stakeholders	Number of Participants	Venue	Date/Time	Specific Discussion Areas
		Obafemi & Ifo LGA			January 10, 2018	
STAGE 2: Line Route survey/ESIA/RAP Studies						
Baseline Data Collection: Community Engagement, engagement with local groups and traditional leaders.	Meeting with Traditional Rulers and Youths.	The head and chiefs of host communities. (78 communities)	129	Each host community as in Table 4.11.3	December 18 -23, 2017	• Formal presentation of the project; • Discussion of community concern; and • The need for a grievance mechanism throughout the project life.
Government Agencies – Federal, State and Local Government Authority Regulatory Authorities.	Meeting with Local Government Officials.	Sagamu South; Sagamu West and Ofada/Mokoloki LCDAs and others	155	Sagamu South LCDA Secretariat, Ejio Town Hall and Ofada/Mokoloki LCDA Secretariat	December 15-16, 2017	• Engagement with affected communities; • Potential positive impacts (provision of electricity and employment of opportunities for local people; and • Community development in general.
		Federal Ministry of Environment, Abuja.	18	Redemption Camp	July 11, 2017	• Issues pertaining to appropriate location of the Substations
		Transmission Company of Nigeria, Abuja.	10	Redemption Camp	December 20, 2017	• Engagement with Redeem Officials to take decision on the appropriate substation location
Local communities	Meetings with persons in the project affected area	Communities (women group meetings were also separately held)	78 communities	All communities in Lot 2	July – December 2017	• Data collection and consultations for ESIA and RAP
Non-Governmental Agency (NGO) –		Nigerian Conservation Foundation (NCF)	12	NCF Office, Lekki, Lagos	March 7, 2018	• Discussion on potential impacts of proposed projects on biodiversity • NCF shows their interest for the collaboration of TCN`s project if there is any opportunity

Table 7-45 LOT 3 Stakeholder Engagement Meetings

Stakeholder Engagement	Engagement Activity	Stakeholders	Number of Participants	Venue	Date/Time	Specific Discussion Areas
STAGE 1: SCOPING						
Government Agencies – Federal, State and Local Government Authority Regulatory Authorities.	Meeting with State and Local Council Officials.	Federal Ministry of Environmental and the Federal Agencies, Lagos State agencies, Badagry LGA	42	Lagos	May 30, 2017 June 28, 2017 July 11, 2017	• Registration of the Project; • Scope of data collection and ToR approval; • Issues concerning site visitation; • EIA process and scope of the EIA; • Approval for one season waiver; and • Approval for the substation and the lines.
		Ogun State Agencies, Ewekoro LGA, Ifo LGA, Ado Odo/ Ota LGA	21	Abeokuta	May 11, 2017 June 29, 2017 July 27, 2017	
		Affected Communities	52	Baale’s Palaces in respective communities	March 24-27, 2017	
STAGE 2: Line Route survey/ESIA/RAP Studies						
Baseline Data Collection: Community Engagement, engagement with local groups and traditional leaders.	Meeting with Traditional Rulers and Youths.	The head and chiefs of host communities.	67	Baale’s Palaces in respective communities and hotspots in the communities and substations	December 18 -23, 2017	• Formal presentation of the project; • Discussion of community concern; and • The need for a grievance mechanism throughout the project life.
Government Agencies – Federal, State and Local Government Authority Regulatory Authorities.	Meeting with Local Government Officials.	Sagamu South; Sagamu West and Ofada/Mokoloki LCDAs and others	27	TCN Office Hotspots along the line and substations	September 15-16, 2017	• Engagement with affected communities; • Potential positive impacts (provision of electricity and employment of opportunities for local people; and • Community development in general.
		Federal Ministry of Environment, Abuja.	7	Along the line and substations	December 18-23, 2017	• Issues pertaining to appropriate location of the Substations
Local communities	Meetings with persons in the project affected area	Communities (17% of participants were women)	77 communities	All communities in Lot 3	July – December 2017	• Data collection and consultations for ESIA and RAP

7-14-4 Key Outcome of Consultations

Key outcomes from consultations with relevant national and state agencies are listed:

- The communities understood the objectives and requirements of the project and pledged support and cooperation
- The relevant agencies are aware of the project and the ESIA process (team, objectives and schedules
- The requirements of Ogun State and Lagos State Laws and Regulations relevant to the project were highlighted by the agencies and understood by TCN and its consultants;
- The Ogun State Governor established a committee to provide support for the project to speed up processes of this study especially in terms of access to the communities, information dissemination to the communities and the state as a whole as regards the state master plan and to speed up approvals by the state government, while Lagos State Governor provided a high ranking cabinet member (Commissioner for Energy) to coordinate Lagos State support for the project, specifically providing state land for Badagry Substation.

Key outcomes from consultations with affected communities are summarized in Table 7-46 below.

Table 7-46 Key Outcome from Community Consultations

Topic	Comments or Recommendation	Stakeholder Commented or Recommended	Actions to Address Comments
General Comments	Compensation should be paid directly to PAPs and not through any third party. PAPs request that they be paid in cash instead of building houses for them to decide the new location by themselves and control the cost and quality to avoid trust issues	Communities	Although the OP 4.12 discourages cash for land, the Land Use Act allows it. TCN also prefer cash compensation as a policy. Hence, cash payment will be adopted to respect request of the affected people.
	Will PAPs be permitted to be identified by proxy in case of recorded absentees?		A 2nd party can only be captured as PAP upon receiving a consent (written or phone confirmation) from the 1st PAP that authorizes the second party to act as PAP, and also substantiated by the witnessing of the community leaders that the person representing an absentee PAP is known by them
	Who is the rightful claimant eligible for entitlement for land that has been leased out for crop farming?		The land owner is eligible for his land, while the farmer on the land is entitled to compensation for his/her crops

Topic	Comments or Recommendation	Stakeholder Commented or Recommended	Actions to Address Comments
	How evaluation will be done to owners of fallow lands in terms of compensation entitlement?		Owners of fallow land are not entitled for compensation, except they hold some statutory rights
	Will the project create employment opportunity to engage the youths who are not gainfully employed?		The project will try to create employment directly and indirectly
	Will the project consider compensating land owners with statutory rights only or all owners of land irrespective title holding?		Land owners without statutory rights are only entitled to compensation for the value of improvement on the land (e.g. structures, etc.).
Social Infrastructure	There is a general concern regarding the provision of basic social infrastructure and amenities such as health facilities, schools, and potable water supply. These facilities are grossly inadequate in the affected communities	Affected Community Leaders	The participants were informed that the project will attract development to the communities.
Health and Safety	Concern on the likely problem for the neighbouring communities and the fear that the project would not generate additional problems like vibration, noise, EMF and gaseous emission	Affected Communities (Community Leader, Women Leader Youth Leader)	The interests and concerns of the community will be put into consideration. Their project will be executed with the highest standard and in a way that their safety and health will not be jeopardized.
	Concern on health hazard and EMF effect		
	Hoped that the substations would be built in line with the highest safety standards and would create the minimum disruption to communities		
Yafin Village	The corridor crossed two shrines, which cannot be moved and also proposed site for Baale's Palace. Need to avoid them	Baale of Yafin	The line has been re-aligned and the sacred sites were avoided
Tohun Village	The corridor crossed the middle of the small community of Tohun	Baale of Tohun	The line was adjusted, to pass at the Southern side of the community, thereby minimizing houses affected
Igbele Village	The corridor affects palm oil factory and its plantations, which should be avoided considering people driving livelihood from the factory as workers	Community members	The line was adjusted to avoid the factory and its palm plantations.

7-15 Actions to be Taken for RAP Implementation

(1) Establishment of Organizations for RAP Implementation

For implementation of the RAP, it is recommended that TCN will initiate the following:

- Selection of RAP Implementation Consultant (RIC),
- Establishment of Local Resettlement Committees (LRCs) in all LGA crossing the Project area, and
- Selection of Witness NGO that will have key roles for RAP implementation.

To ensure the appropriate implementation of roles and responsibilities of each organization, RIC will provide training to TCN, LRC and Witness NGO.

(2) PAPs Engagement

Based on the results collected during the study carried out to prepare the RAP, TCN will prepare compensation package for each PAP and explain and offer the compensation. Once the PAP accepts the compensation offer, TCN will provide full payment of compensation. At the same time, Certificate of Indemnity will be issued by PAPs.

(3) Local Consultation and Information Management

During the RAP implementation period, many types of information will be generated and these will need to be reported/shared to relevant organizations such as TCN PIU, JICA, RIC, LRC, Witness NGO etc. in a timely manner. Since the extent of the Project area is wide and the number of PAPs exceed eight thousand, data template and management protocol must be prepared by TCN PIU and RIC prior to the commencement of the RAP implementation.

(4) Livelihood Restoration

TCN is responsible for assisting PAPs’ livelihood rehabilitation/improvement program.

(5) Monitoring

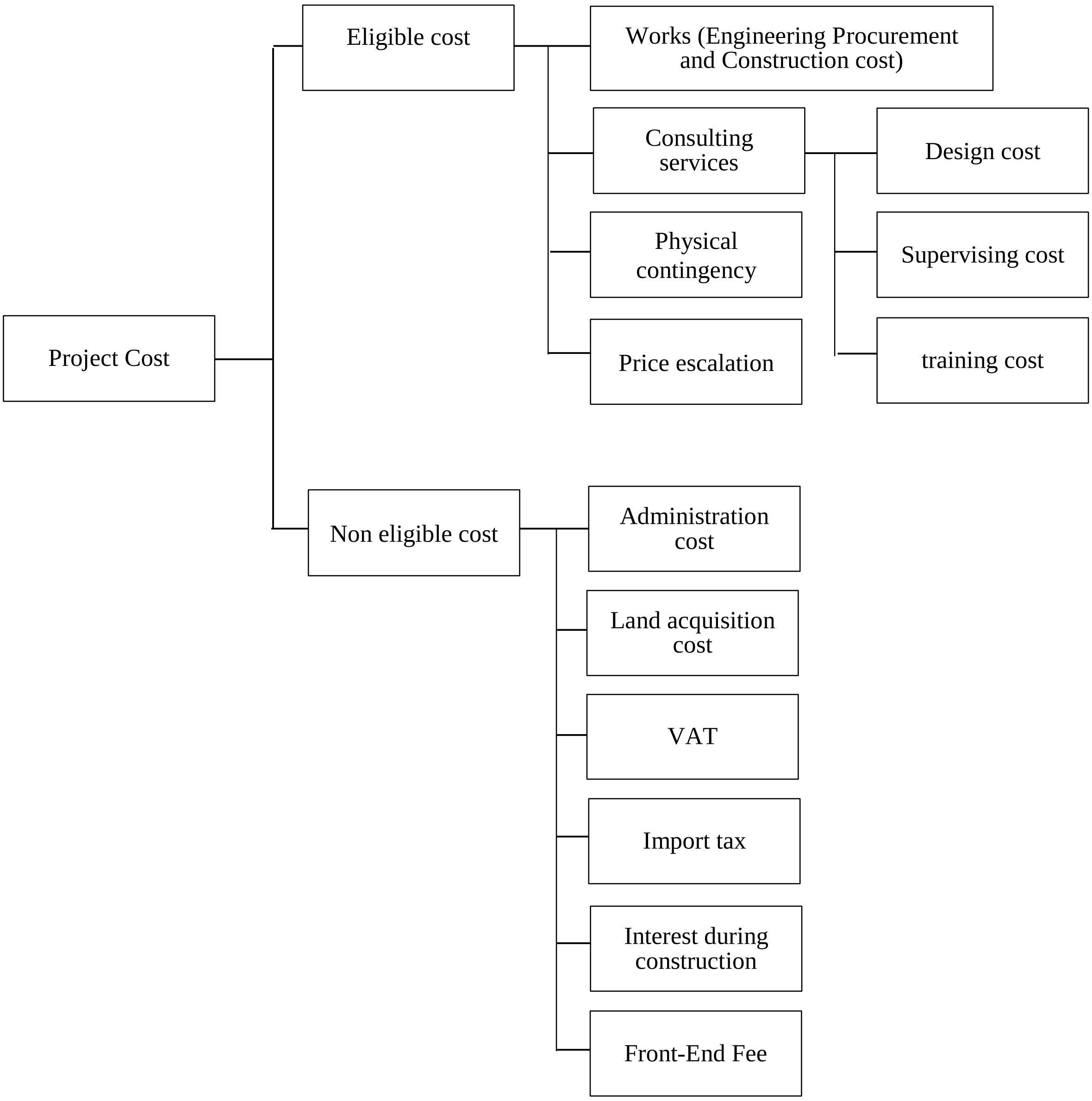
TCN will formulate not only an internal monitoring mechanism, but an external monitoring mechanism. Through the monitoring mechanisms, PAPs’ livelihood rehabilitation/ improvement mentioned above will be also assessed.

Chapter 8   Cost Estimation

Chapter 8 Cost Estimation of the Project

8-1 Components of project cost

The general components of the project cost are indicated in Figure 8-1.



Source: JICA Study team

Figure 8-1 General structure of the project cost

8-2 Cost estimation precondition

The cost estimation was conducted based on the following:

(1) Exchange rate

1) JPY/USD USD 1 = 110.4 JPY

2) NGN/USD USD 1 = 306.8 NGN

3) JPY/NGN NGN 1 = 0.360 JPY

(2) Price escalation ratio

1) Foreign Currency (FC) 1.72%/year

2) Local Currency (LC) 4.64%/year

(3) Physical contingency

Construction: 8%/year

Consultant: 10%/year

(4) Cost estimation year and month

May, 2020

(5) Interest during construction

Construction: 1.45%/year

Consultant: 0.01%/year

(6) Front-end fee

0%

(7) VAT

5%

(8) Import tax

3.5%

(9) Others

Interest during construction shall be included in the Non eligible cost.

8-3 Project implementation schedule

The Project implementation schedule is shown as Figure below.

Source: JICA Study team

Figure 8-2 Project implementation schedule

8-4 Estimated project cost

The project cost comprises the works cost, consultant (design, supervision and training) cost, physical contingency, project administrative cost, interest during construction, etc. Each cost is then broken down into foreign currency and local currency portions. Table 8-1 shows the cost estimate for the project.

Table 8-1 Project cost estimate

Unit: Mill. JPY

No.	Item		Contents	Amount
[1]	Works			
		(1)	Engineering	21,968*
		(2)	Procurement	
		(3)	Construction	
[2]	Consulting services			
		(1)	Design	1,387
		(2)	Supervisiont	
		(3)	Traning	
[3]	Physical contingency			1,841
	Price escalation			1,044
[4]	Administration cost			1,436
[5]	Land acquisition			2,479
[6]	VAT			1,312
[7]	Import tax			814
[8]	Interest during construction			1,299
[9]	Front-End Fee			0
[10]	Total			33,581

*: Works (Construction) was calculated applying an LL-ACSR as conductor.
Source: JICA Study Team

Each item was calculated based on the following policy:

(1) The Works cost

The estimate of the works cost was based on the actual construction work prices obtained in Nigeria were adopted as a general rule. As for equipment considered to be procured from Japan, cost estimates were obtained from Japanese manufacturers.

The breakdown of the Works is shown in Table 8-2.

Table 8-2 Breakdown of the Works cost

Item	Foreign Currency (Mill. JPY)	Local Currency (Mill. NGN)	Total (Mill. JPY)	Remark
(1) Construction of substation and transmission equipment	**19,866**	**5,844**	**21,968**	**Base Cost**
Lot 1	4,104	5,844	6,207	
Lot 2	4,917	0	4,917	
Lot 3	6,394	0	6,394	
Lot 4	4,451	0	4,451	
(2) Price Escalation	**838**	**575**	**1,044**	
(3) Physical Contingency	**1,656**	**513**	**1,841**	
Total	**22,360**	**6,930**	**24,854**	

Source: JICA Study Team

(2) Consulting services cost

In principle, 3,246,000 JPY/MM for the Japanese consultant and 1,896,848 NGN/MM for a local

Consultants were applied and calculated based on the work schedule, before finally adding price escalation and physical contingency were added. The cost is under discussion with TCN, with a proposed consulting cost by TCN of 555 Mill. JPY

A breakdown of the Consulting services cost is shown in Table 8-3.

Table 8-3 Breakdown of Consulting services cost

Item	Foreign Currency (Mill. JPY)	Local Currency (Mill. NGN)	Total (Mill. JPY)	Remark
Design, supervision and training	781	1,152	1,196	**Base cost**
Price escalation	24	116	66	
Physical Contingency	80	127	126	
Total	885	1,395	1,387	

Source: JICA Study Team

(3) Physical contingency cost

8% of the physical contingency was calculated as the subtotal of the works and 10% for consulting services.

(4) Administrative cost

5% of the consulting service cost and the land acquisition cost was applied.

(5) Land acquisition cost

2, 479 Mill. JPY will be required to acquire and pay compensation for the land for the project sites.

(6) VAT cost

Value-Added Tax (VAT) shall be borne by the Nigeria side, 5% of the works cost and the cosulting service cost.

(7) Import tax

Import tax shall be borne by the Nigeria side, 3.5% of foreign currency portion of the works cost and the cosulting service cost.

(8) Interest during construction cost (Tentative)

1.45% of the works cost and 0.01% of the consulting service cost are tentatively applied as the interest rate during the construction, compound interest calculation is apllied.

8-5 Work scope

The work scope were planned as Table 8-4.

Table 8-4 Work scope

Pkg No.	Package Name	Description		QTY		ID
Lot 1	Transmission lines construction	330 kV double circuit transmission lines (110.1 km)	Lot 1-1a: Ejio (Arigbajo) S/S-Likosi (Ogijo) S/S line with turn-in at Likosi (Ogijo) S/S as below - Omotosho P/S line (4 circuits) - Egbin P/S via Paras Energy P/S line (2 circuits) - MAKOGI (MFM) S/S line (2 circuits)	48.8	km	EJ-LI
			Lot 1-1b: Ejio (Arigbajo) S/S-Ajegunle (New Agbara) S/S line with turn in/out Ikeja West S/S-Sakete S/S line	29.6	km	EJ-AJ
			Lot 1-1c: Ejio (Arigbajo) S/S-Olorunsogo P/S line with turn in existing Ejio (Arigbajo) S/S-Olorunsogo P/S line and turning in/out Ikeja West S/S-Ayede S/S line	13.9	km	EJ-OL
			Lot 1-1d: MAKOGI (MFM) S/S-turn in/out Likosi (Ogijo) S/S-Ikeja West S/S line (Parallel Double Circuit Tower, length 5.4 km)	10.81 in Double circuit	km	MA-(IK-LI)
		132 kV double circuit transmission lines (105.4 km)	Lot 1-2a: Likosi (Ogijo) S/S-turn in/out Ikorodu S/S-Shagamu S/S line (4-Circuit Tower, length 2.21 km)	4.82 in Double circuit	km	LI-(IK-SH)
			Lot 1-2b: Likosi (Ogijo) S/S-Abule Oba (Redeem) S/S line	7.78	km	LI-AO
			Lot 1-2c: Ejio (Arigbajo) S/S-New Abeokuta S/S line (4-Circuit Tower, length 6.0 km)	36.5 in Double circuit	km	EJ-NA
			Lot 1-2d: Ajegunle (New Agbara) S/S-Badagry S/S line	36.2	km	AJ-BA
			Lot 1-2e: Ajegunle (New Agbara) S/S-Agbara S/S line	21.7	km	AJ-AG
Lot 2	Substations Construction (1)	Lot 2a New construction of 330/132/33kV substation at Likosi(Ogijo)	330/132/33 kV 300 MVA transformer	2	No	-
			132/33 kV 100 MVA transformer	2	No	-
			330 bay - Ejio (Arigbajo) S/S-Likosi (Ogijo) S/S line (2 bays) - Omotosho P/S line (4 bays) - Egbin P/S via Paras Energy P/S line (2 bays) - MAKOGI (MFM) S/S line (2 bays)	10	No	-
			132 kV bay - Ikorodu S/S-Shagamu S/S line line (4 bays) - Likosi (Ogijo) S/S-Abule Oba (Redeem) S/S line (2 bays)	6	No	-
			33 kV bay	6	No	-
		Lot 2b New construction of 132/33kV substation at Abule Oba (Redeem)	132/33 kV 60 MVA transformer	2	No	-
			132 kV bay - Ajegunle (New Agbara) S/S-Badagry S/S line (2 bays)	2	No	-
			33 kV bay	6	No	-
Lot 3	Substations Construction (2)	Lot 3a New construction of 330/132/33kV substation at Ejio(Arigbajo)	330/132/33 kV 150 MVA transformer	2	No	-
			132/33 kV 60 MVA transformer	2	No	-
			330 kV bay - Ejio (Arigbajo) S/S-Likosi (Ogijo) S/S line (2 bays) - Ejio (Arigbajo) S/S-Ajegunle (New Agbara) S/S line (2 bays) - Ejio (Arigbajo) S/S-Olorunsogo P/S line with turn in existing Ejio (Arigbajo) S/S-Olorunsogo P/S line (4 bays) - Turning in/out Ikeja West S/S-Ayede S/S line (2 bays)	10	No	-
			132 kV bay - Ejio (Arigbajo) S/S-New Abeokuta S/S line (2 bays)	2	No	-
			33 kV bay	6	No	-
		Lot 3b New construction of 330/132/33kV substation at Makogi(MFM)	330/132/33 kV 150 MVA transformer	2	No	-
			132/33 kV 60 MVA transformer	2	No	-
			330 kV bay - MAKOGI (MFM) S/S-turn in/out Likosi (Ogijo) S/S-Ikeja West S/S line (4 bays)	4	No	-
			132 kV bay	0	No	-

Pkg No.	Package Name	Description		QTY		ID
			33 kV bay	6	No	-
		Lot 3c Expansion of 330 kV line bay at Olorunsogo power station	330 kV bay - Ejio (Arigbajo) S/S-Olorunsogo P/S line (2 bays)	2	No	-
		Lot 3d Expansion of 132 kV line bay at New Abeokuta	132 kV bay - Ejio (Arigbajo) S/S-New Abeokuta S/S line (2 bays)	2	No	-
Lot 4	Substations Construction (3)	Lot 4a New Construction of 330/132/33kV substation at Ajegunle (New Agbara)	330/132/33 kV 150 MVA transformer	2	No	-
			132/33 kV 60 MVA transformer	2	No	-
			330 kV bay - Ejio (Arigbajo) S/S-Ajegunle (New Agbara) S/S line (2 bays) - Turn in/out Ikeja West S/S-Sakete S/S line (2 bays)	4	No	-
			132 kV bay - Ajegunle (New Agbara) S/S-Badagry S/S line (2 bays) - Ajegunle (New Agbara) S/S-Agbara S/S line (2 bays)	4	No	-
			33 kV bay	6	No	-
		Lot 4b New construction of 132/33kV substation at Badagry	132/33 kV 60 MVA transformer	2	No	-
			132 kV bay - Ajegunle (New Agbara) S/S-Badagry S/S line (2 bays)	2	No	-
			33 kV bay	6	No	-
		Lot 4c Expansion of 132 kV line bay at Agbara	132 kV bay - Ajegunle (New Agbara) S/S-Agbara S/S line (2 bays)	2	No	-

Source: JICA Study team

8-6 Consulting services implementation plan

Consulting services shall be utilized to facilitate and streamline the project; coordinated among the implementing agency, EPC contractor, JICA and overseas/local stakeholders. Hence, the selection of the consultant who possesses sufficient qualification and experiences should be carried out in conformity with JICA consultant selection guidelines fairly and promptly. The consulting services shall include the followings:

- Preparation of the Employer’s Requirements
- Tender Assistance
- Construction supervision
- Facilitation of implementation of Environmental Management Plan (EMP), Environmental Monitoring Plan (EMoP) and Resettlement Action Plan (RAP)
- Technology transfer

Chapter 9 Project Evaluation

Chapter 9 Project Evaluation

9-1 Preconditions

Preconditions for the Project include securing a budget, land acquisition and compensation etc. in line with the Project implementation schedule. Also, after the detailed design, TCN has to consider modifying the evaluation for the environmental impact and a resettlement action plan, if any changes occur.

In line with the Project implementation, there are two particular preconditions for environment social consideration and coordination with the power sector.

(1) Environment social consideration

Regarding the land acquisition required for this project, TCN has prepared a resettlement action plan (RAP) following consultation with affected people. Based on the RAP, there are plans to pay appropriate compensation according to the compensation policy before relocation and after sufficient explanation to the affected residents, land acquisition is expected to proceed as planned.

(2) Power sector

The precondition of power sector is as followings.

- Realization of Power generation plan

  The power generation plan of applied by power-flow analysis of this Project are based on the Master Plan Study on National Power Development in Nigeria which was formulated by JICA. In addition, The plan is also considered the actual power generation on 2018 and power generation forecast in Lagos and Ogun. Therefore it is expected that the power generation plan is high possibility.

- Expansion of power distribution capacity

  This Project increases transmission capacity, the increase result in increase of customer. The increase of customer is profitable for private power distribution company, therefore it is assumed that the company invests distribution facilities to expand the power distribution capacity as customer increases. Therefore it is expected that the expansion of power distribution capacity is high possibility.

- Realization of power demand plan

  The power demand plan applied by power-flow analysis of this Project is considered the Transmission Expansion Plan (TEP) by support of World Bank (WB) on 2016 which TCN formulated the demand forecast based on the actual demand of each distribution substation. In addition, the demand of this Project is also considered the actual demand on 2018 and demand forecast in Lagos and Ogun. Therefore it is expected that the realization of power demand plan is high possibility.

9-2 Necessary Inputs by Recipient Country to Achieve the Overall Project Plan

(1) Prior to Starting the Construction Work

- Prior to starting the construction work, TCN shall have completed the following items promptly. Also, to facilitate the smooth implementation of the Project, TCN shall promptly complete the cutting of trees, removal of buried objects, ground leveling and so on in the Project site.

  - Compensation procedures for persons conducting activities within the corridor of transmission routes and plots for the substation of the Project
  - Implementation of resettlement based on the Resettlement Action Plan

- In addition, prior to starting construction work, TCN shall have completed the same procedures as above for access roads.

- Prior to starting the construction work, to ensure the Project equipment and materials are delivered promptly to the Project sites before installation work, TCN shall have completed the preliminary procedures necessary for tax exemption and customs clearance.

- Prior to starting the construction work, as part of operation and maintenance, TCN shall have completed the minor repairs for existing equipment directly related to the Project due to deterioration.

- Prior to starting the construction work, TCN shall have completed the reconnection, etc. of power distribution systems to maintain power supply during the rehabilitation of existing substations.

- Prior to starting the construction work, operation of the New Abeokuta substation shall have started.

(2) During the Construction Work

- During the construction work, TCN shall conduct the scheduled power outages required for the Project in conformity with the schedule agreed between TCN and the Consultant and in a timely manner.

- During the construction work, TCN shall conduct environmental and social impact monitoring based on the Monitoring Form prepared during the Preparatory Survey carefully.

- During the construction work, the Government of Nigeria shall allocate the budget required for the Project, including the cost covered by the Nigerian side, promptly.

(3) After the Installation Work of the Project and Commencement of Operation

- After the installation work of the Project, TCN shall conduct the commissioning required for the function test or other related issues of the equipment of the Project promptly.

- After the installation work of the Project, TCN shall register the existing SCADA system at the

Osogbo National Control Center (NCC) so that the signals from the substations of the Project are properly displayed.

- After the installation work of the Project, TCN shall hold discussions with DisCo, the concession operator and other related parties so that the equipment of the Project is connected to the distribution system and the effects of the Project are promptly felt.

9-3 External Conditions

The following are considered external conditions of the Project to achieve and sustain the effects.

(1) Overall Goal

As mentioned in Chapter 2, Economic Recovery and Growth Plan 2017-2020: ERGP is considered the upper-level plan of the Project and "To secure sufficient and stable supply of electricity" is set as the key and most pressing issue to underpin economic development. If Nigerian Government policy is as described in ERGP, it will not be possible to maintain consistency between the upper-level plan and the Project. In addition, a stable political situation in Nigeria is essential to facilitate ERGP implementation.

- The electric power development policy shall remain unchanged.
- The government and economy shall remain stable.

(2) Project Objectives

The Project aims to improve the power supply conditions in the southwest of Nigeria, which is the center of the country's economic activity. Since the equipment on the transmission system functions as a network, as well as the Project equipment, other equipment related to the transmission system shall be kept in a sound conditions by daily maintenance work. Moreover, the security of the transmission facility shall be secured, since the power supply cannot continue if destroyed by wars or vandalism.

- Sustainable operation and maintenance shall be properly maintained.
- Security of the facilities shall be maintained.

(3) Expected Outcomes

One of the expected effects of the Project involves actually increasing the power supply to the consumers, as achieved through a distribution network connected to the transmission system. Conversely, power for the transmission system is supplied via the generation equipment. Therefore, to boost the actual power supply to consumers, the generation equipment located on the upper side and the distribution network located on the lower side of the transmission system shall remain in a stable operational condition. In addition, since the equipment of the Project shall also remain in a stable operational condition, the equipment of the Project shall be properly maintained in conformity with the maintenance schedule.

- Power generation facilities in the upper stream and power distribution facilities in the lower stream shall operate properly.

- Operation and maintenance shall be properly and appropriately maintained.

9-4 Economic Evaluation

9-4-1 Objective and Methods

(1) Objective

In this economic analysis, economic viability of the Project is assessed from viewpoints of the national economy of Nigeria and a cost-benefit analysis is conducted to evaluate the magnitude of the economic benefits brought by implementing the Project through comparison with costs, i.e., value of resources used for the Project implementation shown in economic costs.

(2) Methods

Methods applied for the economic analysis are described below:

1) Indicators estimated in this analysis to show economic viability of the Project include economic internal rate of return (EIRR), benefit-cost ratio (B/C) and net present value (NPV).
2) Period for the economic evaluation is set as 31 years, from 2019 to 2049.
3) A cut-off rate of 10%, with which the EIRR of the Project is compared to appraise the economic viability of the investment, is conservatively applied in this analysis. Recently, the conventional cut-off rate of 12% has been used less frequently in favor of lower rates instead. The economic analysis for the "Electricity Transmission Project for the Federal Republic of Nigeria", assisted by the World Bank (WB), for example, applies a cut-off rate of 7% though the EIRR of the project is estimated as high as 46.7%.
4) Economic benefit of the Project counted in this analysis is derived from the increased power supply. Without implementation of the Project and related small rehabilitation works, electricity has to be supplied via existing facilities and equipment, with which future power supply will have to be limited to avoid overloads or power outages. With implementation of the Project and the related rehabilitation works, sufficient electric power will possibly be supplied to meet the demand in the target area. The difference between the power that can be supplied by existing facilities/equipment only and that demanded is estimated to calculate the economic benefit of the Project. The difference in the transmitted and distributed electricity (kWh) to customers through facilities/equipment constructed by the Project and the rehabilitation works is multiplied by the "willingness to pay" for the electricity (USD/kWh) to estimate the economic benefit.

   As the Project excludes the generation and distribution sub-sectors, the economic benefit is computed based on the proportion of the transmission tariff to the end-user tariff. According to the end-user tariff by DisCo defined Multi-year Tariff Order (MYTO) and the volumes of electricity supplied to respective DisCo, the weighted average customer tariff is calculated as

USD 0.188/kWh, while the transmission tariff is defined as USD 0.0170/kWh in MYTO. The share of the transmission tariff to the end-user tariff is assumed as 9%. Out of the total economic benefit of power supply, 9% is regarded as the Project benefit.

5) "Willingness to pay" for electricity in Nigeria is assumed as USD 0.20/kWh. Based on a recent survey of 835 households conducted in 2012, the WB estimated the "Willingness to pay" in Nigeria at USD 0.16/kWh at 2012 prices, which is converted to USD 0.18/kWh at 2016 prices by an appraisal mission of the WB in 2018. Meanwhile, the WB also introduced information indicating that the cost of self-generation had reached USD 0.20-0.30/kWh[1]. "Nigeria Power Baseline Report" issued by the Advisory Power Team in the Office of Vice President in August 2015 shows estimates of private generation cost at NGN 62-94/kWh, which can be converted to USD 0.30-0.45/kWh applying the exchange rate at the time. Considering that more than 40% of the electricity is used by commercial and industrial sectors in 2015 and the current self-generation cost is estimated to far exceed USD 0.20/kWh, the "willingness to pay" for electricity in this analysis is set conservatively as USD 0.20/kWh.

6) The average of the technical loss in power distribution sub-sector for 2018-2020 is assumed to be 12.5%, referring to the "Nigeria Power Baseline Report", while the loss rate is presumed to decrease by 0.25% per year during 2021-2030 and remain at 10% after 2030. Losses other than technical losses are not considered as the economic benefit occurs once the electricity is distributed to the consumers, even if the tariffs are not collected, which does not eliminate the need to improve revenue collection in the distribution sector.

7) As certain rehabilitation works are necessary for the transmission network to allow the required electricity to be transmitted to the distribution networks, the costs of the rehabilitation works are also added as costs of attaining the economic benefits.

8) O&M costs the transmission lines and substations are estimated at 1% and 1.5% of the construction costs, respectively, assuming 50% of foreign and local currency portions. Through a comparison of the costs for facilities/equipment O&M and budgeted or forecast operation expenditures required for transmission service provision (TSP), additional O&M cost of USD 4,825/GWh is estimated as other operation costs

9) Tax and duties, namely VAT and import tax, are removed to convert the financial costs to the economic ones. Standard Conversion Factor (SCF) applicable for converting the financial costs of the local currency portion to economic costs is set as 0.95 referring to the Consultancy Service Report of "WAPP North Core 330 kV Project" (December 2008).

10) Service life of the transmission facilities/equipment is assumed to be 35 years, while the residual values of the facilities/equipment at the end of the evaluation period are counted as negative costs in the final year. The overall land acquisition cost is also counted as a negative cost in the last year of the evaluation period.

[1] Project Appraisal Document for "Electricity Transmission Project" (January, 2018)

9-4-2 Results of the Economic Evaluation

(1) Estimated Indicators to Show the Economic Validity

The estimated economic internal rate of return (EIRR), benefit-cost ratio (B/C) and net present value (NPV) are shown in Table 9-1. The Project is economically viable and to be implemented to develop the national economy efficiently, as the EIRR exceeds the cut-off rate of 10%, the B/C surpasses 1.0 and the NPV is positive.

Table 9-1 Estimated Indicators on the Economic Validity of the Project

Economic Internal Rate of Return (EIRR)	13.8%
Benefit-cost Ratio (B/C)	1.25
Net present Value (NPV, at discount rate of 10%, USD million)	88

Source: JICA Study Team

(2) Results of Sensitivity Analysis

The EIRRs, B/Cs and NPVs given a 24% increase in investment and O&M costs and a 19% decrease in benefits are shown in Table 9-2. The Project would remain economically feasible, even if a 24% increase in costs or 19% decrease in benefit were to happen.

Table 9-2 Results of the Sensitivity Analysis

Case	EIRR	B/C	NPV
24% increase in costs	10.1%	1.00	USD 2.0 million
19% decrease in benefit	10.2%	1.01	USD 3.2 million

Source: JICA Study Team

The results of the economic analysis and the economic benefit and cost streams of the Project during the period of economic analysis are given in Table 9-3 for reference.

Table 9-3 Result of the Economic Analysis and Benefit-cost Stream in Base Case

Indicators on Economic Viability

EIRR	13.8%
B/C	1.25
NPV (10% Discount, USD million)	88

Discount Rate 10%

Year	Cost Bebefit Stream (UDS million at constant prices of 2018)					Discounted Benefit and Costs				
	Economic Benefit	Costs			Balance	Economic Benefit	Costs			Balance
		Initial Investment	Rehabili-tation	O&M			Initial Investment	Rehabili-tation	O&M	
2019	0.0	3.5	0.0	0.0	-3.5	0.0	3.2	0.0	0.0	-3.2
2020	0.0	8.3	0.0	0.0	-8.3	0.0	6.8	0.0	0.0	-6.9
2021	0.0	55.7	0.0	0.7	-56.4	0.0	41.9	0.0	0.5	-42.4
2022	0.0	88.9	0.0	1.8	-90.7	0.0	60.7	0.0	1.2	-61.9
2023	0.0	67.3	0.0	2.7	-70.0	0.0	41.8	0.0	1.7	-43.5
2024	0.0	28.7	23.9	3.5	-56.1	0.0	16.2	13.5	2.0	-31.7
2025	45.2	6.2	38.4	28.8	-28.2	23.2	3.2	19.7	14.8	-14.5
2026	90.6	0.0	0.0	28.8	61.9	42.3	0.0	0.0	13.4	28.9
2027	90.9	0.0	0.0	28.8	62.1	38.5	0.0	0.0	12.2	26.4
2028	91.1	0.0	0.0	28.8	62.4	35.1	0.0	0.0	11.1	24.1
2029	91.4	0.0	0.0	28.8	62.6	32.0	0.0	0.0	10.1	22.0
2030	91.7	0.0	0.0	28.8	62.9	29.2	0.0	0.0	9.2	20.0
2031	91.7	0.0	0.0	28.8	62.9	26.5	0.0	0.0	8.3	18.2
2032	91.7	0.0	0.0	28.8	62.9	24.1	0.0	0.0	7.6	16.6
2033	91.7	0.0	0.0	28.8	62.9	21.9	0.0	0.0	6.9	15.1
2034	91.7	0.0	0.0	28.8	62.9	19.9	0.0	0.0	6.3	13.7
2035	91.7	0.0	0.0	28.8	62.9	18.1	0.0	0.0	5.7	12.4
2036	91.7	0.0	0.0	28.8	62.9	16.5	0.0	0.0	5.2	11.3
2037	91.7	0.0	0.0	28.8	62.9	15.0	0.0	0.0	4.7	10.3
2038	91.7	0.0	0.0	28.8	62.9	13.6	0.0	0.0	4.3	9.4
2039	91.7	0.0	0.0	28.8	62.9	12.4	0.0	0.0	3.9	8.5
2040	91.7	0.0	0.0	28.8	62.9	11.3	0.0	0.0	3.5	7.7
2041	91.7	0.0	0.0	28.8	62.9	10.2	0.0	0.0	3.2	7.0
2042	91.7	0.0	0.0	28.8	62.9	9.3	0.0	0.0	2.9	6.4
2043	91.7	0.0	0.0	28.8	62.9	8.5	0.0	0.0	2.7	5.8
2044	91.7	0.0	0.0	28.8	62.9	7.7	0.0	0.0	2.4	5.3
2045	91.7	0.0	0.0	28.8	62.9	7.0	0.0	0.0	2.2	4.8
2046	91.7	0.0	0.0	28.8	62.9	6.4	0.0	0.0	2.0	4.4
2047	91.7	0.0	0.0	28.8	62.9	5.8	0.0	0.0	1.8	4.0
2048	91.7	0.0	0.0	28.8	62.9	5.3	0.0	0.0	1.6	3.6
2049	91.7	-34.7	-17.1	28.8	114.7	4.8	-1.8	-0.9	1.5	6.0
Total	2,242.4	223.9	45.2	727.6	1,245.7	444.7	171.9	32.3	152.8	87.7

Source: JICA Study Team

9-5 Financial Evaluation

9-5-1 Objective and Methods

(1) Objective

In this financial analysis, financial soundness of the Project is assessed by comparing the investment and O&M costs and revenues for the power transmitting entity.

(2) Methods

Methods applied for the financial analysis are described below:

1) Indicators estimated in this analysis to show financial feasibility of the Project include financial rate of return (FIRR), benefit-cost ratio and net present value (NPV).

2) Period for the financial analysis is set as 31 years, from 2019 to 2049, as for the economic evaluation.

3) A cut-off rate of 9%, with which the FIRR of the Project is compared to appraise financial feasibility of the investment, is adopted in this analysis. According to the WB database, the average real interest rate, i.e., the lending interest rate of the banks for financing private sector needs and adjusted by the GDP deflator, was 8.6% for 2011-2017 in Nigeria.

4) Increased revenue for the transmission company from implementing the Project is calculated as financial benefit by multiplying the incremental transmitted power estimated corresponding to the increased power supply with the transmission tariff provided in MYTO 2015. The increase in electricity transmitted through facilities/equipment developed by the Project and related rehabilitation works is calculated based on difference in the volumes between electricity transmitted only via existing facilities/equipment and transmitted to meet the demand in the target area.

5) Transmission tariff for 2018 provided in MYTO 2015 effective since February 2016 is applied to estimate the revenue. The prices and charges are converted to USD based on the exchange rates applicable when setting the tariff.

6) As the transmission charge, defined as Transmission Use of System (TUOS) Charge, includes that for the System Operator (SO) and the Market Operator (MO), etc., Transmission Service Provider (TSP) Charge, which excludes the portions for SO, MO and others, is applied to estimate the increased transmission revenue for consistency with the cost estimation, which only includes investment and O&M costs of the transmission facilities/equipment to be constructed by the Project and the rehabilitation required to supply to meet the electricity demand of the target area..

7) Investment and O&M costs of the Project and supplemental rehabilitation works to enable the required electricity to meet the demand are also counted as costs corresponding to the revenue increase. O&M costs and other operation costs are estimated in the same way as done in the economic analysis except conversion of the financial costs to the economic ones.

8) As done in the economic analysis, service life of the facilities/equipment is set as 35 years and their residual values at the end of the analytical period are counted as negative costs in the final year thereof. The entire land acquisition cost is also counted as negative in the final year of the evaluation period.

9-5-2 Results of the Financial Analysis

(1) Estimated Indicators to Show Financial Feasibility

As shown in Table 9-4, the Project is financially feasible and to be implemented as the FIRR exceeds the cut-off rate of 9%, the B/C surpasses 1.0 and the NPV is positive.

Table 9-4 Estimated Indicators on the Financial Validity of the Project

Financial Internal Rate of Return (FIRR)	14.4%
Benefit-cost Ratio (B/C)	1.37
Net present Value (NPV, at discount rate of 9%, USD million)	154

Source: JICA Study Team

(2) Results of the Sensitivity Analysis

Financial indicators in the following cases are estimated as part of the sensitivity analysis.

1) Increase in the investment and O&M costs by 36%

2) Decrease in the revenue of TSP Charge by 26%.

Results of the sensitivity analysis are shown in Table 9-5. The Project would remain financially feasible, even the two cases.

Table 9-5 Results of the Sensitivity Analysis

Case	FIRR	B/C	NPV
36% increase in costs	9.1%	1.01	USD 3.3 million
26% decrease in revenue	9.2%	1.01	USD 5.1 million

Source: JICA Study Team

The results of the financial analysis and revenues and costs of the Project during the period of financial analysis are given in Table 9-6 for reference.

Table 9-6 Result of the Financial Analysis and Revenue and Cost in Base Case

Indicators on Financial Viability

FIRR	14.4%
B/C	1.37
NPV (9% Discount, USD million)	154

Discount Rate	9%

Cost Bebefit Stream (UDS million at constant prices of 2018)						Discounted Revenue and Costs				
Year	Increased Revenur	Costs			Balance	Economic Benefit	Costs			Balance
		Initial Investment	Rehabili-tation	O&M			Initial Investment	Rehabili-tation	O&M	
2019	0.0	3.6	0.0	0.0	-3.6	0.0	3.3	0.0	0.0	-3.3
2020	0.0	8.8	0.0	0.1	-8.9	0.0	7.4	0.0	0.0	-7.5
2021	0.0	60.3	0.0	0.8	-61.1	0.0	46.6	0.0	0.6	-47.2
2022	0.0	96.4	0.0	2.0	-98.4	0.0	68.3	0.0	1.4	-69.7
2023	0.0	72.9	0.0	3.0	-75.9	0.0	47.4	0.0	1.9	-49.3
2024	0.0	31.2	25.8	3.8	-60.7	0.0	18.6	15.4	2.3	-36.2
2025	51.4	6.7	42.0	31.7	-29.1	28.1	3.7	23.0	17.4	-15.9
2026	102.8	0.0	0.0	31.7	71.0	51.6	0.0	0.0	15.9	35.6
2027	102.8	0.0	0.0	31.7	71.0	47.3	0.0	0.0	14.6	32.7
2028	102.8	0.0	0.0	31.7	71.0	43.4	0.0	0.0	13.4	30.0
2029	102.8	0.0	0.0	31.7	71.0	39.8	0.0	0.0	12.3	27.5
2030	102.8	0.0	0.0	31.7	71.0	36.5	0.0	0.0	11.3	25.3
2031	102.8	0.0	0.0	31.7	71.0	33.5	0.0	0.0	10.4	23.2
2032	102.8	0.0	0.0	31.7	71.0	30.8	0.0	0.0	9.5	21.3
2033	102.8	0.0	0.0	31.7	71.0	28.2	0.0	0.0	8.7	19.5
2034	102.8	0.0	0.0	31.7	71.0	25.9	0.0	0.0	8.0	17.9
2035	102.8	0.0	0.0	31.7	71.0	23.7	0.0	0.0	7.3	16.4
2036	102.8	0.0	0.0	31.7	71.0	21.8	0.0	0.0	6.7	15.1
2037	102.8	0.0	0.0	31.7	71.0	20.0	0.0	0.0	6.2	13.8
2038	102.8	0.0	0.0	31.7	71.0	18.3	0.0	0.0	5.7	12.7
2039	102.8	0.0	0.0	31.7	71.0	16.8	0.0	0.0	5.2	11.6
2040	102.8	0.0	0.0	31.7	71.0	15.4	0.0	0.0	4.8	10.7
2041	102.8	0.0	0.0	31.7	71.0	14.2	0.0	0.0	4.4	9.8
2042	102.8	0.0	0.0	31.7	71.0	13.0	0.0	0.0	4.0	9.0
2043	102.8	0.0	0.0	31.7	71.0	11.9	0.0	0.0	3.7	8.2
2044	102.8	0.0	0.0	31.7	71.0	10.9	0.0	0.0	3.4	7.6
2045	102.8	0.0	0.0	31.7	71.0	10.0	0.0	0.0	3.1	6.9
2046	102.8	0.0	0.0	31.7	71.0	9.2	0.0	0.0	2.8	6.4
2047	102.8	0.0	0.0	31.7	71.0	8.4	0.0	0.0	2.6	5.8
2048	102.8	0.0	0.0	31.7	71.0	7.7	0.0	0.0	2.4	5.4
2049	102.8	-72.7	-18.6	31.7	162.4	7.1	-5.0	-1.3	2.2	11.2
Total	2,517.7	207.3	49.1	803.2	1,458.2	573.8	190.3	37.1	192.2	154.3

Source: JICA Study Team

9-6 Project Evaluation

9-6-1 Relevance

As shown below, the relevance of this Project is considered high, as it will help achieve Nigeria's transmission plan and power policies and benefit public facilities and residents, including impoverished people in the target area.

(1) Relevance in Terms of Technical Aspects

In Nigeria, although the development of power sources proceeds based on abundant national hydropower resources, it is having difficulty reconciling its costly power distribution network with the growing demand for power. The Project is intended to strengthen transformation equipment in the Lagos and Ogun areas, where power shortages have emerged due to inadequate transmission capacity.

The Project components have been specified on the system plan in 2025 as the target evaluation year while securing consistency with the Master Plan Study on National Power Development in Nigeria which was formulated by JICA.

The degree of contribution for Project components concerning 330 and 132 kV transmission lines, 330/132/33 kV substations and 132/33 kV substations is shown according to the Project target evaluation year (2025) in Table 9-7. Increase of transmission capacity through the Project components is approximately 2,886 MW.

Table 9-7 Degree of Contribution of the Project Component to Lagos and Ogun Areas in the Project Target Year (2025)

Item	Average flow per 1 cct [MW]	increase of transmission capacity through the Project components [MW]	Degree of contribution
330 kV transmission lines	Approx. 322 MW	Approx. 2,886 MW	41%
132 kV transmission lines	Approx. 57 MW		46%

Source: JICA Study Team

(2) Benefit in the Project Area

Electric power is imperative as a form of energy to underpin self-reliant and sustainable socioeconomic growth of a nation. Particularly when spearheading the country's economic activity, development projects are one of the key forms of economic infrastructure development to establish a secure and efficient power distribution network.

The Project aims to improve electric power distribution in the Lagos and Ogun States in Nigeria in response to serious power system problems caused by supply capacity shortages, due, in turn, to recent rapid economic growth. Enhancing the current insufficient supply capacity of power distribution facilities represents a fundamental solution to the loss of opportunity gain due to disrupted supply and is thus highly beneficial.

(3) Operation and Maintenance Capabilities

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

The transmission and substation facilities planned under this project have already been installed and gone into operation in Nigeria. As Nigeria has already introduced them and the skills required for operation methods, system protection functionality and other O&M issues do not significantly exceed the technical levels for equipment used in the country, although the internal structure of the switchgear and other equipment to be introduced may differ from traditional units. As such, manufacturing technicians will be used for O&M technology transfers, offering guidance on initial and standard operations based on the characteristics, features and specifications of the equipment. Assuming that the technology transfer of differing operation methods for each delivering manufacturer proceeds smoothly, there should be no issues in terms of O&M capabilities on the Nigerian side for the delivered equipment.

Low-Loss (LL) conductors introduced in the Project constitute a new technology for TCN. LL conductors can be LL-ACSR or LL-TACSR conductors, which do not entail different installation methods of support hardware from ACSR conductors conventionally adopted by TCN and the technical level is such that the technology can be transferred during the installation works period of the Project. In addition, since key work processes such as stringing and tension line work are the same as for conventional conductor types, the new technology will not exceed the technical levels of TCN. Accordingly, assuming that the technology transfer regarding the differing methods of fitting support hardware goes smoothly, there should be no issues in terms of O&M capabilities on the Nigerian side.

(4) Project to Contribute to Upper-Level Plans

Concerning upper-level plans, the “Master Plan Study on National Power Development in Nigeria” and “Transmission Expansion Plan (TEP)” are the Grid Development Plan and consistency between this and the network plan of the Project, with 2025 as the target year, has been secured following dialog during the preparatory survey. Henceforth, assuming TCN advances the development of power distribution equipment based on plans made consistent through the preparatory survey, it is anticipated that the Project will manifest the effectiveness described later and certainly contribute to the upper-level plan.

(5) Consistency with Japan’s ODA policy

In the “ODA policy to the country of Nigeria”, Japan has prioritized maintaining relations with Nigeria from the perspective of stabilizing efforts to secure energy resources and promote trade and investment by Japanese companies and set out the following ODA policies:

Basic policy (Goal): Promoting sustainable economic and social development

Priority fields (Medium Target):

- ✓ Consolidation of core infrastructure
- ✓ Promotion of social development centered on urban areas

The Project is intended to help reinforce and rehabilitate power distribution facilities as part of the key socioeconomic infrastructure in the metropolitan area that supports the national society and economy and complies entirely with the assistance goal of “wide-area infrastructure development (electric power)” as stipulated in the “ODA policy to the country of Nigeria,”

As shown above, the Project is deemed consistent with the Government of Japan’s ODA policy for Nigeria and highly relevant as a Japanese Loan Project.

9-6-2 Effectiveness

The following impacts are expected from implementing the Project:

(1) Quantitative

The Project aims to improve the transmission network in Lagos and Ogun areas and comprises 330 kV transmission lines, a 132 kV transmission line, 330/132/33 kV substations and 132/33 kV substations.

The actual load-to-capacity rate of the equipment is defined as the utilization rate of the equipment and that figure for the Project in the target years is applied as the evaluation indicator of the Project.

< Operation Indicators of the Project >

Components	Equipment	Unit Capacity [MVA]	Number of Units and circuits	Capacity [MVA]	Length [km]	Load [MVA]	The target year of the Project evaluation 2025 [%]
Lot 1 330 kV Line	-	777	2	1554	110.1	322	21%
Lot 1 132 kV Line	-	125	2	250	105.4	57	23%
Lot 2a 330/132/33kV substation_Likosi (Ogijo)	330/132/33 kV Transformer	270	2	540	-	494	91%
	132/33 kV Transformer	60	2	120	-	86	72%
Lot 2b 132/33kV substation_Abule Oba (Redeem)	132/33 kV Transformer	60	2	120	-	81.4	68%
Lot 3a 330/132/33kV substation_Ejio (Arigbajo)	330/132/33 kV Transformer	120	2	240	-	241.4	101%
	132/33 kV Transformer	60	2	120	-	121.2	101%
Lot 3b 330/132/33kV substation_Makogi (MFM)	330/132/33 kV Transformer	120	2	240	-	110.6	46%
	132/33 kV Transformer	60	2	120	-	108.4	90%
Lot 4a 330/132/33kV substation_Ajegunle (New Agbara)	330/132/33 kV Transformer	120	3	360	-	314.4	87%
	132/33 kV Transformer	60	2	120	-	111.8	93%
Lot 4b 132/33kV substation_Badagry	132/33 kV Transformer	60	2	120	-	88.4	74%

Source: JICA Study Team

(2) Qualitative Impacts

Effect Item	Project Countermeasures (Loan Project)	Extent of Project Effects and Improvement (Current Conditions and Problems)
1. Accumulation of technology for enhancing flexibility of equipment planning and system	➢ Introduction of Low-Loss (LL) conductors	➢ By introducing Low-Loss (LL) conductors, technology concerning power transmission planning utilizing such technology will be accumulated.

Effect Item	Project Countermeasures (Loan Project)	Extent of Project Effects and Improvement (Current Conditions and Problems)
operation		
2. Promotion of utilization of 330 kV transmission lines for power supply in the metropolitan area	➢ Construction of 330/132/33 kV Key substations -Likosi (Ogijo) -MFM -Ajegunle (New Agbara) -Ejio (Arigbajo)	There are plans to construct a 330 kV transmission line with the objective of reinforcing the power supply in Nigeria and 330/132/33 kV substation capacity will be greatly strengthened concerning supply to Lagos-Ogun area, which consumes a large proportion of national power.
3. Realization of a project consistent with the "Master Plan Study on National Power Development in Nigeria" and "Transmission Expansion Plan (TEP)"	➢ Review of the Transmission Expansion Plan (TEP) ➢ Compilation and implementation of Project components in line with the above review	In the preparatory survey of the Project, a system plan was compiled based on review of the TCN's Transmission Expansion Plan (TEP) with the objective of resolving fundamental power supply development issues in the southwest power system in Nigeria. This specifically entails effectively utilizing 330 kV transmission lines and introducing Low-Loss overhead conductors. Since the components have been selected based on the same, not only will Project implementation improve power supply in the areas around the Project equipment, it will also improve the composition of the Southwest power system allowing it to respond to optimum power transformation and transmission plans from a long-term perspective.

Source: JICA Study Team

(3) Estimated Greenhouse Gas Emission Reductions

The Project aims to improve the transmission system in Southwest Nigeria. The project will also ensure 330 kV transmission lines are used effectively and elicit reduced transmission losses on the power system in the southwest area, meaning energy utilization can be rationalized. Since the reduction in transmission loss results in a reduction in primary energy such as fossil fuel consumed by power generation equipment, it will help reduce emissions of greenhouse gases (GHG) such as carbon dioxide.

The input data and calculation results of the amount of GHG reduction based on the result of power flow analysis from transmission loss reduction with/without projects are shown in Table 9-8.

Table 9-8 Reduction in GHG

Data	Value	Unit
Emission reduction	20,170	tCO_2/year
Baseline emission	62,577	tCO_2/year
Amount of electricity to the transmission system in the year 2025	5,431,901	MWh/year
Transmission loss rate of the baseline transmission system in the year 2025	1.99	%
CO_2 emission factor of electricity	0.5791	tCO_2/MWh
Project emission	42,407	tCO_2/year
Annual electricity loss of the project transmission system	73,229	MWh/year
CO_2 emission factor of electricity	0.5791	tCO_2/MWh

Source: JICA Study Team