Federal Ministry of Power (FMP)
National Power Training Institute of Nigeria (NAPTIN)
The Federal Republic of Nigeria

DATA COLLECTION SURVEY
ON
PERFORMANCE IMPROVEMENT
OF DISTRIBUTION COMPANIES
IN THE FEDERAL REPUBLIC OF NIGERIA

FINAL REPORT

OCTOBER 2021

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

YACHIYO ENGINEERING CO., LTD.

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SUMMARY

1. Objective of the Survey

The objective of the Data Collection Survey on Performance Improvement of Distribution Companies (the Survey) is to formulate JICA assistance programs and projects to help boost the profitability in business of Distribution Companies (DisCo), such as developing distribution infrastructure and capacity to help ease distribution losses.

2. Current Status and Issues in the Power Sector

(1) Electric Power Sector Reform Act (EPSRA)

The Electric Power Sector Reform Act (EPSRA) (No. 6 of 2005) is the basic law on power sector reform. Under the EPSRA, the power sector in Nigeria was unbundled by function into generation, transmission, and distribution, and privatized power generation and distribution. The objective of the power sector reform in Nigeria was to improve efficiency through privatization and to reduce the financial burden on the government. In Nigeria's EPSRA and related regulations, there is no framework that can mitigate capital investment risk and credit risk of power producers, the electricity tariff optimization framework is not progressing as planned even though it is legislated, and there is no guarantee of stable fuel supply for independent power producers. These are the issues that need to be addressed.

(2) Power Sector Recovery Program (PSRP)

The power sector reform in Nigeria started with the formulation of the National Electric Power Policy in 2001 and continued with the enactment of the EPSRA in 2005. This has resulted in insufficient flow of funds to the power sector as a whole and has prevented the development of infrastructure conducive to power sector recovery. Against this backdrop, the Federal Government of Nigeria and NERC has formulated and implemented the PSRP with the support of the World Bank in 2017 to clean up and normalize the accumulated debt of the power sector.

The PSRP is a program comprising a series of action plans on policy, regulation, operations and governance. It was aimed to reset the entire power industry in Nigeria over a five-year period from 2017 to 2021 by restoring solvency to the electricity sector, improving sector transparency and power supply services, resolving issues including consumer complaints, loss and electricity theft and also revising electricity tariffs to a cost-recoverable level.

(3) Challenges of the power sector

The abovementioned challenges in the power sector are caused by all the segments of generation, transmission and distribution, which are closely interconnected. Non-payment of consumers impedes the financial liquidity of the entire sector, causing problems of the distribution sector to spread out and affect the whole power sector.

Table 1 Problems of each power sector segment

Subsector	Problem
Consumers	Since consumers have strong complaints and dissatisfaction about the "terrible quality of electricity supply" and "high distrust on the business way and attitude of DisCos", they are unwilling to pay their electricity tariff.
DisCo	DisCo suffers from a lack of funding due to high distribution losses, which are mainly attributed to non-payment from consumers. Commercial losses are high because of the low installation rate of electricity meters caused by insufficient investment, which, in turn, entails deteriorating customer management capability. Insufficient investment funding prevented DisCo from conducting proper maintenance, whereupon its distribution assets deteriorated and generated high technical losses. High technical, commercial and collection losses hinder efforts to supply sufficient electricity to meet demand.
TCN	Insufficient investment funding prevented TCN from conducting proper maintenance, whereupon its transmission assets deteriorated and generated high technical losses. High technical losses hinder efforts to supply sufficient electricity to meet demand.
GenCo Gas company	The Nigerian Gas Company (NGC) is unable to fully collect its gas tariff, thus NGC limits the gas supply to GenCos. Accordingly, GenCos cannot receive sufficient gas for their power generation and it is difficult for them to generate electricity fully utilizing their installed capacity.

3. Challenges of the power distribution field (Technical)

(1) Number of forced (fault) outages

Annual trends in terms of the number of faults of high-voltage distribution feeders (33, 11kV) are shown in Table 2. The frequency of faults of high-voltage distribution feeders (33, 11kV) varies from several hundred to 3,000 per company per year, depending on the DisCo and year.

For the major DisCos (Abuja, Ikeja and Eko), the frequency of faults per high-voltage distribution feeder is calculated from the data in Table 2, with faults occurring 2.7 to 4.2 times per year. The calculation results show that equipment reliability is low, even at the high-voltage distribution feeder level.

Table 2 The transition in the number of faults of high-voltage distribution feeders (times/year)

HV (33KV,11KV) faults (Frequency/Year)					
DisCo	2015	2016	2017	2018	2019
Abuja	988	1,674	1,981	1,265	207
Benin	1,270	1,665	1,489	1,464	1,411
Eko	922	1,019	957	1,088	1,143
Enugu	3,270	3,192	3,870	3,296	278
Ibadan	2,820	2,355	1,366	1,443	1,537
Ikeja	754	699	753	904	949
Jos	319	493	590	642	983
Kaduna	734	957	906	1,120	1,137
Kano	287	405	954	1,497	1,282
Port Hurcourt	356	470	299	213	183
Yola	274	262	292	314	308

Source: NERC

(2) Long fault restoration time

In the capital area and urban centers, on average, 80% of faults are resolved in under eight hours. 10% of the faults are cleared in eight to 24 hours and only about 5% require a 48-hour recovery time. The reason why the recovery time of 48 hours is required is due to the strategic inventory shortage of repair

equipment/materials and the constraint of equipment supply.

Power outages caused by faults occur frequently in power distribution equipment and once a power outage occurs, restoring the supply takes a long time.

Table 3 Rate of faults cleared within eight hours

Rate of Faults cleared within 8 hours (2019)			
DisCo	Total of fault	Cleared within 8 hrs.	Rate (%)
Abuja	207	182	88
Benin	1,411	755	53
Eko	1,143	603	53
Enugu	278	224	80
Ibadan	1,537	1,480	96
Ikeja	949	507	53
Jos	983	793	81
Kaduna	1,137	929	82
Kano	1,282	1,062	83
Port Harcourt	183	45	25
Yola	308	294	95

Source: NERC

(3) Defective facilities

The current situation of distribution facilities sees some cases where first aid and repair points are outstanding. Presumably, there are certain circumstances in which first aid and repairs remain incomplete due to financial difficulties, despite the fact they are aware of the problems.

The technical factor precluding progress in first aid and repairs is the fact that although maintenance work must be carried out while power has been cut off, the distribution line is not installed with any switchgears that can isolate the work section appropriately. Accordingly, it is considered difficult to initiate power outages for maintenance work.

The followings are examples of facilities with problems from a maintenance perspective that emerged during the site inspection. Figure 1 shows poles with a large inclination, as well as the conductors shown in Figure 2, which have large sag. Many such sagged conductors are seen in all 33kV, 11kV and 415V lines. Since the wires are bare conductors, they are considered prone to short-circuit and broken conductor faults due to strong winds.

Figure 1 Tilted poles

Figure 2 Large sag of conductors

4. Challenges of the power distribution field (Non-technical)

(1) Low rate of Installation of meters

The installation rate of customer meters in Nigeria is very low, at 40% of the weighted average for all DisCos. Even though Abuja and Benin DisCos have the highest installation rates, even their meter installation rates are less than 55%. The meter installation rates of Kaduna, Kano and Yola DisCos, which have the lowest installation rate, are only about 20%. Since 2018, when a Meter Asset Provider (MAP) Regulation was established and implemented, customer meter installation rates have not substantially increased. On the contrary, the installation rate largely decreased in Port Harcourt and Benin DisCos. Clearly, measures to promote customer meter installation, such as the enactment and implementation of the MAP Regulation, have not elicited the expected results. It seem that a significant portion of bills are issued to customers without meters (so-called estimated bill).

(2) Financial deficit

As the financial statements for the three DisCos (Abuja, Ikeja, Eko) in Chapter 3 show that DisCos are not being managed sustainably for business operations as private companies. Although Abuja DisCo is expected to post a net profit of NGN 124 billion in 2019, the company is not in a sound financial position, considering that it has payables of NGN 60 billion to NBET and the Market Operator during this period and has posted NGN 165 billion of the fee revenue out of the revenue shortfall approved by NERC to date.

(3) High rate of ATC&C Loss

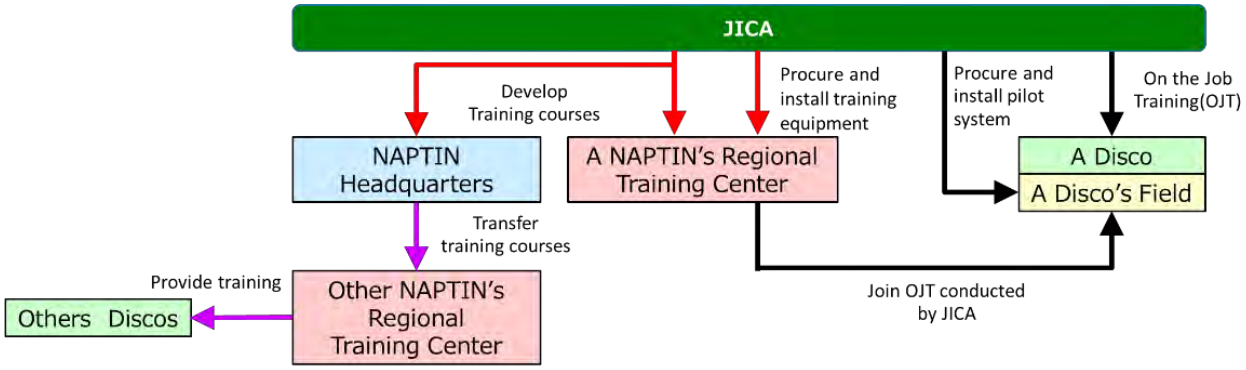
The reason for the revenue shortfall is the fact that electricity tariffs are insufficient to cover actual costs and the losses in the distribution sector (distribution losses) are high. The technical and commercial losses (defined as 1 - as billed power/received power) for DisCos overall are close to 32% and the collection loss is about 26% (defined as 1 - the amount of fee collected/billed), resulting in an aggregate distribution sector loss of nearly 50% ATC&C loss, (defined as (1- technical and commercial loss) multiplied by (1- collection loss)), reaching 49%. In other words, DisCos have only been able to collect around half the electricity tariff corresponding to the amount of power received from TCN.

5. Considerations on assistance measures by JICA (Technical)

Since it is difficult to implement financial cooperation projects such as concessional loan and grant aid to DisCo, which has already been privatized, the Team considered on assistance measures by JICA how JICA by focusing on technical cooperation.

(1) System for implementing technical cooperation projects, and counterpart organizations

In order to directly express the effects of the project efforts, the project will be conducted under the implementation system shown in Figure 3.



Source: Prepared by the survey team

Figure 3 Scheme for technical cooperation activities

(2) Measures to improve the power supply reliability

In order to achieve the project goal of "improving supply reliability", the issue in the distribution sector that can be expected to have significant improvement effects is extracted. Table 4 shows the extracted issue alongside the related efforts and evaluation indexes.

Table 4 Issue and evaluation indexes expected to be improvable

Issue	Efforts	Evaluation indexes
Low supply reliability	Reducing the fault recovery time	Fault recovery time
	Implementing preventive maintenance of facilities	Number of faults

(3) Reducing the fault recovery time

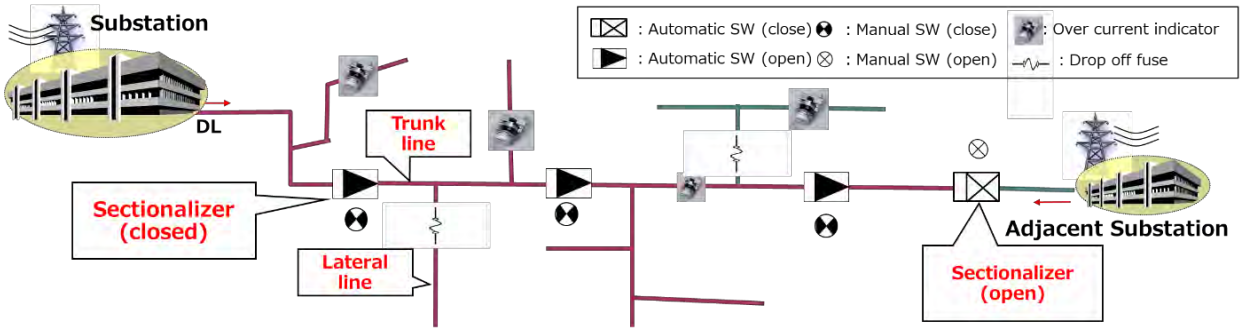
Table 5 shows the specific activities for reducing the fault recovery time. The distribution system in Nigeria will be drastically modified to a configuration suitable for reducing the fault recovery time. The expected system configuration is shown in Figure 4. The expected system is equipped with automatic sectionalizing switches, a manual sectionalizing switch, drop-off fuses, fault current indicators, etc. for minimizing the fault section. And by appropriately combining these equipment components, a distribution system configuration suitable for the actual situation in Nigeria will be resolved. As this equipment is rarely installed in the current distribution system in Nigeria, AEDC takes an average of 6 hours to recover from a fault.

As part of the activity, first, the system configuration shown in Figure 4 will be constructed as the pilot project in the DisCo. In parallel with the introduction of this equipment, the introduction of a fault-detection device that can quickly determine the fault point will expedite the fault point location and restoration work to sound sections. The degree to which the recovery time is shortened by conducting system operations that integrate these technologies will then be verified. In the above activities, this technology will be established by preparing a standard work manual in line with the implementation of on-site technical guidance as technology transfer. At the same time, that technical capabilities are expected to be maintained through technical training on practice by NAPTIN.

In order to deploy this technology throughout Nigeria, NAPTIN will work with the DisCos to develop training courses that are directly linked to practice. Since the training at NAPTIN is expected to be simulated on-the-job training using full-scale facilities, the development of training courses using the simulated distribution facilities to be constructed at NAPTIN is planned. The improvements attained in the technologies and skills of the DisCo engineers and technicians will lead to much faster responses to feeder faults.

Table 5 Summary of activities to reduce the fault recovery time

Counterpart	Method	Activities
DisCos	Pilot project	Construct and operate a reliable distribution system Evaluate the effect of the applied distribution system
	Technical transfer	Improve the method for locating a fault point and restoring the fault
	Capacity development	Develop/improve the standard work procedure manuals such as the operation manuals, design standards, installation manuals, etc. Dispatch technical staff to NAPTIN (participation in training)
NAPTIN	Technical transfer	Develop training courses that incorporate the contents of the technical transfer to the DisCos Conduct training for the 11 DisCos using the developed training courses
	Procurement of facilities	Procure and install a simulated distribution network for training (both overhead and underground lines and a mock substation)



Source: Prepared by the survey team

Figure 4 Example of a system configuration to which sectionalizing switchgears are applied

(4) Implementation of preventive maintenance for facilities

Table 6 shows the specific activities for preventive maintenance of the facilities (substation / distribution). Distribution facility faults and personal injuries often occur in Nigeria due to aging facilities and inadequate maintenance. To solve this problem, it will be necessary to prevent distribution facilities faults and eliminate dangerous parts by carrying out reliable maintenance work without fail. To meet this condition, the project will conduct the following activities.

The activities for the DisCos include the following: improving work implementation methods, on-site guidance aimed at the accumulation and analysis of data and know-how related to patrol/inspection work, and developing/improving the work manuals.

NAPTIN, meanwhile, will develop training courses that reflect the activities at the DisCos. In developing the courses, NAPTIN should cooperate with the DisCos and keep in mind that the training content should reflect the key points of their practical work. In addition, a simulated substation used in the abovementioned training will be constructed on the premises of the NAPTIN headquarters in Abuja. This simulated substation will be used to conduct on-the-job training on substation maintenance work (patrol, inspection, equipment testing, etc.).

Furthermore, the measuring instruments required for other distribution line maintenance work will be procured.

Table 6 Summary of activities to introduce preventive maintenance

Counterpart	Method	Activities
DisCo	Technical transfer	Develop inspection/patrol manuals Develop work procedures to accumulate and analyze maintenance data
	Capacity development	Execute operation and maintenance works in compliance with the manuals and standard work procedures Detect facility defects using the deterioration data accumulated Improve inspection work by introducing deterioration-detection devices Manage the loading of the distribution transformers using the distribution line metering system
NAPTIN	Technical transfer	Develop training courses on standardized work procedures, data analysis to detect deterioration of equipment, maintenance planning, etc.

		Carry out the training developed through the project for the DisCos
	Facility construction	Procure and install simulated facilities for training (distribution facilities, injection substation, etc.)

6. Recommendations to NAPTIN (Non-technical)

(1) Development and improvement of training courses through dialogs with the DisCos through the Association of Nigerian Electricity Distributors (ANED)

AEDC's plan for its training course for customer care/attention includes modules on "how to understand customers' emotions" and "how to communicate with irritating customers." The difference in the practicability of the two training courses is quite obvious compared to the same kind of trainings by NAPTIN.

It will be necessary for NATIN to fully take the DisCos' needs into account through ANED-mediated consultations and discussions with the DisCos.

(2) Making Training Courses More Practical by Introducing Case Studies and Exercises

To raise the bill collection rate or improve customer relations, it is often necessary to flexibly respond to the actual situations. While lectures on theories and principles are important, more practical training focused on the introduction of case studies and exercises is essential. Such training will enable trainees to actually raise their bill collection rates and improve their customer relations after the training courses in their workplaces.

(3) More Effective Utilization of External Resources

Many of the lecturers and staff members in charge of training course development seem to lack experience in bill collection or customer service. To make utmost use of the capacity for the development of training courses and implementation of the training, NAPTIN should more effectively use external persons who have tangible experience in raising bill collection rates and improving customer relations.

(4) Enhancement of Training Management (Improvement in the Development of Curriculums and Training Materials, the Management Training Portal Site, etc.)

The Training Portal Site will be an important information source for prospective trainees. However, there are discrepancies between the content of the Training Portal Site and content on the Training Calendar on NAPTIN's website. It would be more efficient to develop and improve the curriculum and training materials by module, and then to combine the curriculum and training materials thus developed and improved. NAPTIN will need to enhance its training management, i.e., its management of curriculum / training material development and improvement, and its management of the Training Portal Site itself.

7. Recommendations to AEDC (Non-technical)

(1) Conducting Training for OJT Trainers and Developing an Off-JT Taring Course for Bill Collection

AEDC conducts only simple OJT regarding bill collection, the most essential element of the business management of AEDC. OJT is critically important to raise the bill collection rate, and training for the OJT trainer is an immediate need for AEDC. Judging from the current capacity of AEDC, it is recommended that AEDC dispatch a prospective OJT trainer to Train-the-Trainers for training conducted by an external organization, such as NAPTIN. It is also recommended that AEDC jointly develop an Off-the-Job-Training (Off-JT) course with an external organization. A combination of OJT and Off-JT would be effective in raising the bill collection rate.

(2) Realizing the Plan for the Training on Customer Services

AEDC's plan for the training on customer services can be evaluated as practical and useful for improving customer relations. Training courses should be developed and implemented based of the existing plan. Two types of training courses will be required: one for training the AEDC trainers and another conducted by the AEDC trainers for training the AEDC customer service staff. With these two types of training, AEDC can improve customer relations in all areas of its franchise.

(3) Effective Use of External Resources for the Improvement of Training on Bill Collection and Customer Services

AEDC has few sufficient staff members with abundant experience in developing, conducting, or improving training. It will be essential for AEDC to have good partners to work with in the development and implementation of the training to raise the bill collection rate and improve customer relations. NAPTIN may be the best candidate partner.

(4) Developing a System for Responding to Customers through Interaction between the Customer Service Section and the Sections Assigned to Problem Solving and Troubleshooting

As it may take substantial time to solve such problems, the customer service staff needs to explain the countermeasures being taken by the sections in charge of solving the problems and preempting future problems. The customer service staff should be supported with real-time information provided by those section. The development of a coordinated system that enables real-time information exchange between the customer service section and the sections in charge of solving the problems and preempting future problems is a recommended approach to improving customer relations.

Contents

Photo of the current situation in the survey area (1 of 2)

View of NAPTIN headquarters

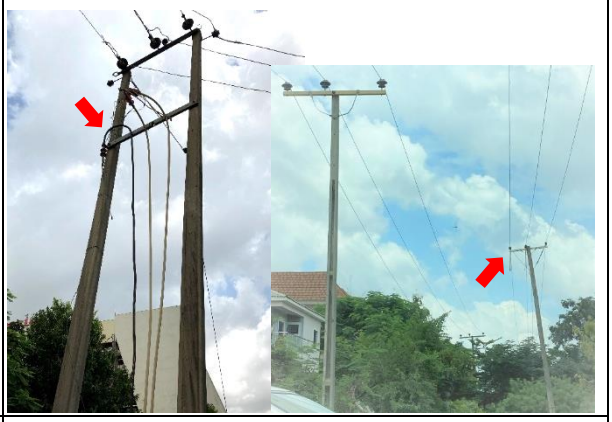
NAPTIN has nine training centers, including the headquarters, and the NAPTIN headquarters in Abuja was built in 2015, and with the support of AFD, training rooms, accommodations, and a simulated substation will be added.

Classrooms at NAPTIN Headquarters

Each of NAPTIN's training centers has a training room, a library, and some of the training centers have accommodation facilities. The headquarters in Abuja has three training rooms that can accommodate 30 people, and can accept up to 90 trainees at a time.

Defective equipment on existing 33kV distribution lines (1)

The weak arm is bending and the insulator is coming off the arm and approaching the pole (left).
Loose wires and sloping insulators are seen (right).

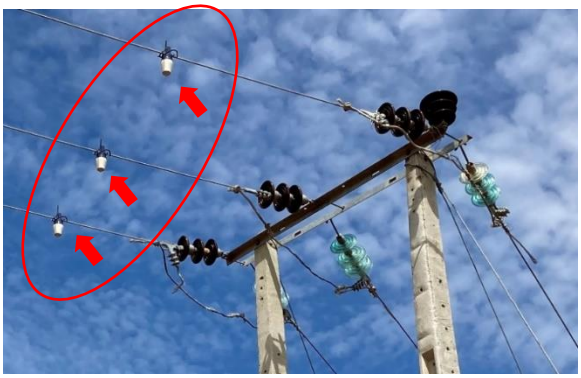


Defective equipment on existing 33kV distribution lines (2)

Equipment that is no longer in use has been discarded and abandoned on site (left), and an 11kV pole of a 33kV and 11kV concurrent line is tilted toward the 33kV side (right).

Accidental restoration of an 11kV distribution line

A corroded wooden arm broke off, causing the wire to contact the pole, resulting in a ground fault. The entire distribution line was blacked out, short-circuit grounding equipment was installed on both sides of the working pole, and the broken wooden arm was replaced with an FRP arm.



Installation of Fault Current Indicator (FCI) on existing 33kV distribution lines

The FCI system has been installed at five locations per feeder as a pilot under the jurisdiction of AEDC, and the effect of the FCI system has been significant, with AEDC officials reporting an 80% reduction in the time to search for accident points compared to before the system was installed.

Photo of the current situation in the survey area (2 of 2)

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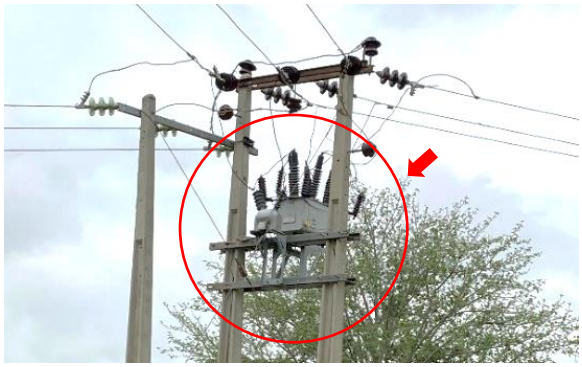
<td>  </td>
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<td>Installation of auto reclosers for existing 33kV distribution lines
A total of 60 units have been installed for 91 33kV feeder lines. Fifteen of them are out of order. In addition to the purpose of protecting the distribution lines, the purpose of the reclosers is to prevent the TCN circuit breakers from being overloaded. Sctional switchgear is rarely installed on 11kV feeders.</td>
<td>Existing 33/11kV Substation
11kV circuit breaker panel of B33 Substation (Injection Substation) located in the center of Abuja. 20 11kV feeders are available, but only 12 of them are in use.</td>
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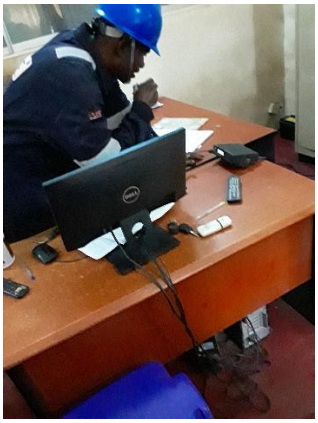
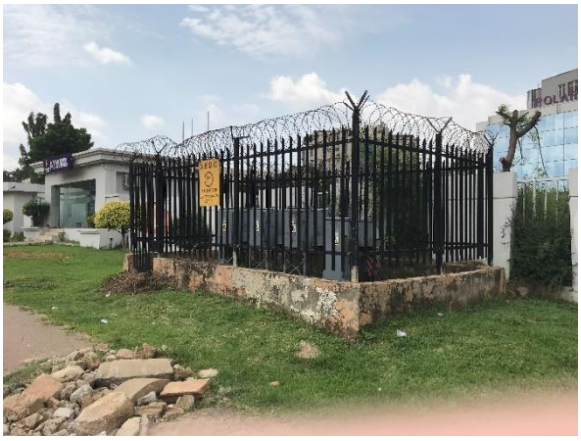
<td>  </td>
<td>  </td>
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<td>Communication with the power feeder command station
Communication between the substation and the power feeder control station for power distribution is done by radio and is manually operated by the substation operator.</td>
<td>Ring Main Unit
Ring main units have been installed in some underground distribution areas in Abuja city, but many of the cables have been disconnected and are not in use.</td>
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<td>Proposed Site for Construction of Simulated Substation
An AFD-supported simulated substation is planned to be constructed on a vacant lot (on the left or right side of the road) within the NAPTIN headquarters site in Abuja.</td>
<td>Electricity meter for training
Electricity meters and prepaid input terminals used for training at NAPTIN headquarters in Abuja.</td>
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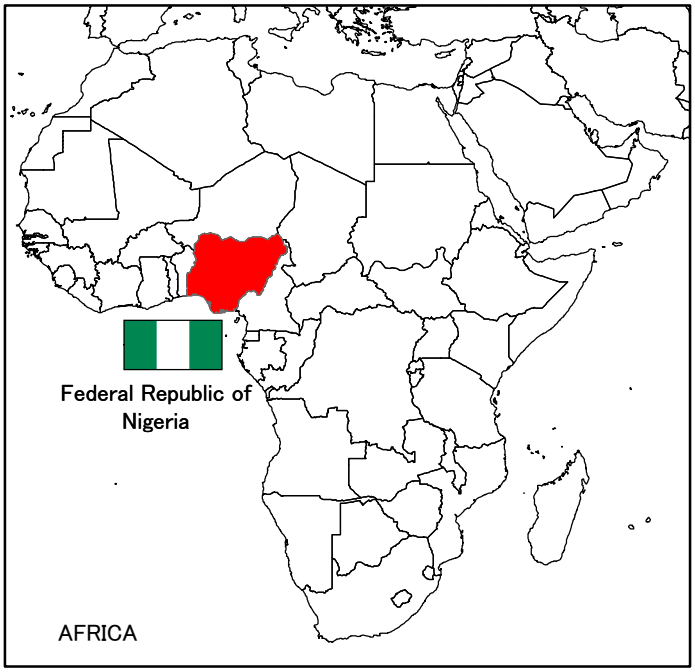

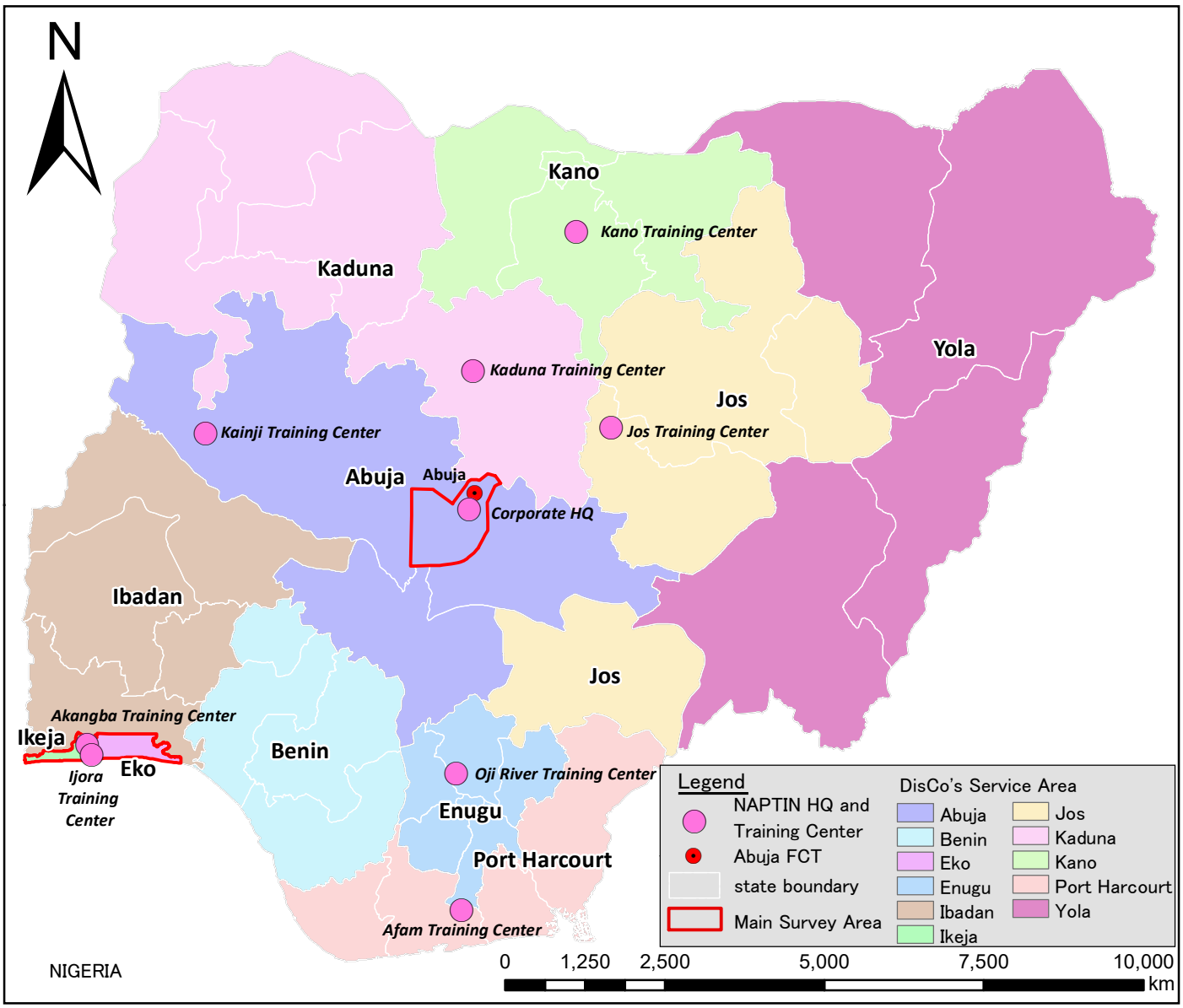

Location Map and DisCo's service area

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Abbreviations

AEDC	Abuja Electricity Distribution Plc.
AFD	*Agence Française de Développement*
AfDB	African Development Bank
AMI	Advanced Metering Infrastructure
AMR	Automated Meter Reading
ANED	Association of Nigerian Electricity Distributors
ATC&C Loss	Aggregated Technical and Commercial Loss
BPE	Bureau of Public Enterprises
DisCo	Distribution Company
DISREP	Nigeria Distribution Sector Recovery Program
DMC	Distribution Metering Code
DSO	Distribution substation operator
EKEDC	Eko Electricity Distribution Plc.
EPSRA	Electric Power Sector Reform Act
ERGP	Economic Recovery and Growth Plan 2017-2020
EU	European Union
FCI	Fault Current Indicator
FCT	Federal Capital Territory
FMF	Federal Ministry of Finance
FMP	Federal Ministry of Power
GenCo	Power Generation Company
GIZ	*Deutsche Gesellschaft für Internationale Zusammenarbeit*
IKEDC	Ikeja Electric Plc.
IPP	Independent Power Producer
LMMA	Local Meter Manufacturer/Assembler
MAP Regulations	Meter Asset Provider Regulations
MPA	Meter Procurement Agreement
MSA	Metering Service Agreement
MSC	Meter Service Charge
MYTO	Multi Year Tariff Order
NAPTIN	National Power Training Institute of Nigeria
NBET	Nigerian Bulk Electricity Trading Plc.
NEPA	National Electric Power Authority
NERC	Nigerian Electricity Regulatory Commission
NESI	Nigerian Electricity Supply Industry
NGC	Nigerian Gas Company
NMMP	National Mass Metering Programme
PHCN	Power Holding Company of Nigeria

PHED	Port Harcourt Electricity Distribution Plc.
PIP	Performance Improvement Plan
PPA	Power Purchase Agreement
PSRO	Nigeria Power Sector Recovery Operation
PSRP	Power Sector Recovery Programme 2017-2021
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
TCN	Transmission Company of Nigeria
TEM Stage	Transitional Electricity Market Stage
WB	World Bank

Chapter 1 Outline of the Survey

1-1 Background of the Survey

Nigeria is Africa's most populous nation, recording 196 million people in 2018 (according to the World Bank) as well as the biggest nominal GDP in the continent, having overtaken South Africa in 2018. According to the Economic Recovery and Growth Plan 2017-2020 (ERGP), the economy was set to grow at an average real growth rate of 4.62% during the period 2017 to 2020. This economic growth has also seen potential demand for electricity soar. However, chronic insufficiencies of electricity supply have resulted in frequent power outages, both scheduled and unforeseen, and impeded economic development.

To solve the problem of serious power shortages, ERGP, formulated by the Federal Government of Nigeria (FGN), prioritized power sector recovery and set a target of boosting available generation capacity to 10GW by 2020. However, distribution companies (DisCos) suffer an extraordinarily high level of unpaid bills from their customers, limiting power sector liquidity to a considerable extent and explaining the sector-wide operational difficulties.

In response, FGN formulated the Power Sector Recovery Programme 2017-2021 (PSRP). PSRP stipulates the required interventions by the FGN and relevant organizations as well as action plans to intervene and reset the power sector - particularly the distribution sub-sector - by solving the main challenge, i.e. reducing distribution loss and boosting DisCos performance.

Despite the urgent need to strengthen the distribution sub-sector, donors cannot directly support DisCos, since they were privatized in 2013. Instead, donors are expected to immediately help improve DisCos performance by strengthening the National Power Training Institute of Nigeria (NAPTIN), which offers training opportunities for the power sector and financial assistance schemes applicable to privatized DisCos.

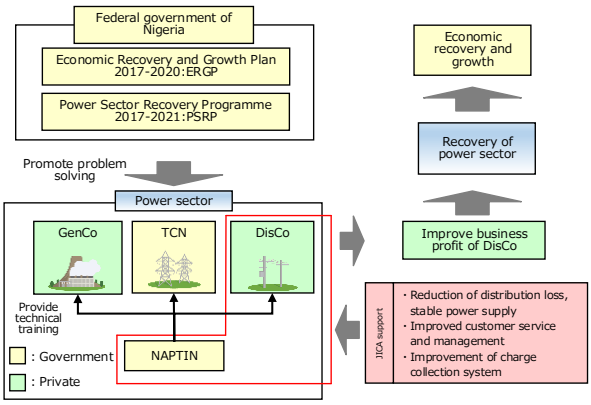
1-2 Outline of the Survey

1-2-1 Objective of the Survey

The objective of the Data Collection Survey on Performance Improvement of Distribution Companies (the Survey) is to formulate JICA assistance programs and projects to help boost the profitability of DisCos' business, such as developing distribution infrastructure and capacity to help ease distribution losses.

Figure 1-2.1 shows the context of this survey within the power sector of Nigeria. To achieve its purpose, the following works will be conducted:

- ✓ To collect information related to NAPTIN and DisCos
- ✓ To clarify the challenges by discussing with relevant organizations
- ✓ To propose measures to improve NAPTIN's capability and what potential exists to help improve DisCos performance
- ✓ To propose measures that will effectively boost the economy and profitability; taking the assistance of other donors into account.



Source: JICA Survey Team

Figure 1-2.1 Positioning of this survey within the Nigerian power sector

1-2-2 Survey Site

The Federal Capital Territory of Abuja (hereinafter referred to as "FCT") and Lagos State are assumed to be the main survey areas. FCT has NAPTIN headquarters and Lagos has two training centres and there are corresponding DisCos (Abuja Electricity Distribution Company: AEDC, Ikeja Electricity Distribution Company: IKEDC, Eko Electricity Distribution Company: EKEDC).

NAPTIN training centres are also located all over the country (one each for Rivers, Enugu, Niger, Plateau, Kaduna and Kano). Since functions and levels presumably differ depending on each of these training centres and the corresponding distribution companies, we will also interview relevant parties and analyze related reports for the training centres in each region.

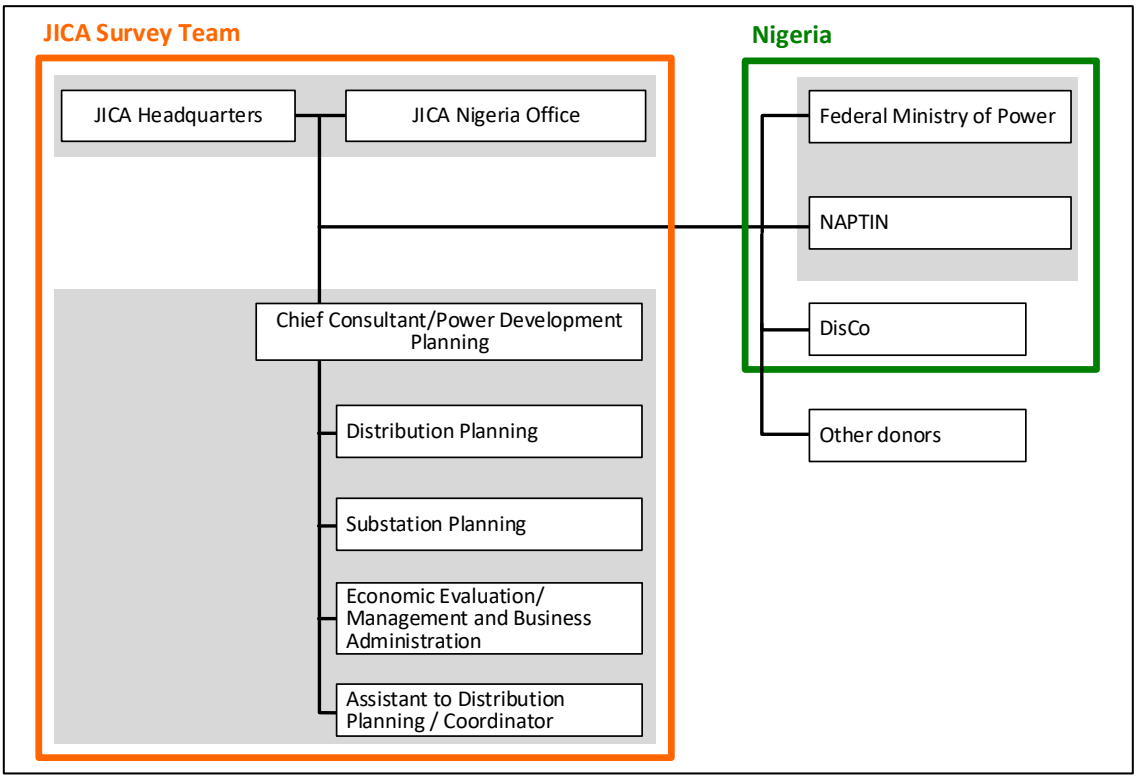
1-3 Structure and Survey Schedule

1-3-1 Structure of the Survey

To conduct a proper survey, the Study team explained the background, purpose and flow and requested nomination of counterpart members. The Study team requested that TANESCO and the Ministry of Energy nominate the counterpart and accompany the survey when it was launched. The Tanzanian side responded flexibly to the requests made by the Study team.

Since the survey scope covers wide-ranging power demand forecasting, which also encompasses system and equipment planning, TANESCO formed a counterpart team, led by the Investment Department as team leader and with the Distribution and Customer Services and Transmission departments as team members. The survey took place with considerable support from the counterpart team and the Dodoma regional office.

The actual structure of this survey is shown in Figure 1-3.1 Structure of the survey.



Source: JICA Survey Team

Figure 1-3.1 Structure of the survey

1-3-2 Survey Schedule

The Survey will be conducted as shown in Table 1-3.1. It will be divided into three stages: First Work in Japan, First Field Survey in Nigeria: an explanation of the Draft Final Report (DF/R) and Second Work in Japan.

Table 1-3.1 Survey Schedule

Item \ Year	2020						2021				
	Apr.	May.	Jun.	Jul.	Aug.	…	Jul.	Aug.	Sep.	Oct.	Nov.
First Work in Japan (Preparation of Interim Report)	□	□	□	□	□	□	□	□			
First Field Survey in Nigeria									■		
Second Work in Japan (Submission of the Final Report to JICA)										□ ▼	

Remarks: □ Conducted in Japan ■ Conducted in Nigeria ▼ Submission to JICA

Chapter 2 Current Status and Issues in the Power Sector

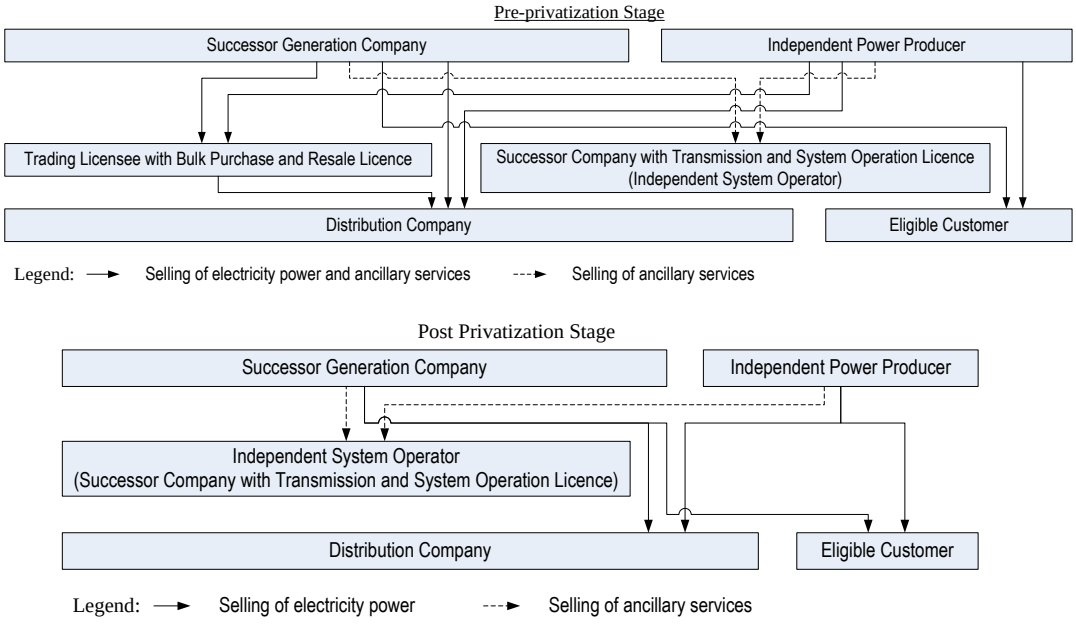
2-1 Electric Power Policy

2-1-1 Electric Power Sector Reform Act (EPSRA)

The Electric Power Sector Reform Act (EPSRA) (No. 6 of 2005) is the basic law covering power sector reform. It comprises 12 parts, which are listed in Table 2-1.1.

Table 2-1.1 Structure of the Electric Power Sector Reform Act and Summary of Provisions in Each Part

Parts	Summary of Provisions
PART 1	**<Establishment of Power Holding Company of Nigeria (PHCN) and Successor Companies and Transfer of Assets and Liabilities of National Electric Power Authority (NEPA)>** Procedures are provided to transfer assets, liabilities and employees of NEPA to PHCN and successor companies and to privatize successor companies.
PART 2	**<Establishing Competitive Market>** A mechanism of competition in the Power Sector before and after privatization, trading between and rights and roles of generation, transmission and distribution sub-sectors are defined. The major provisions are as follows: * Mechanism of competition and structure of the electricity market before and after privatization (see Figure 2-1.1) * Proposals, approval and application of the Market Rules * Contents of the Market Rules (National grid operation by the system operator, payment settlement and directions by system operator) * Enforcement and amendments of Market Rules (approved by NERC), dispute resolution and penalties * Market studies * Directives from the relevant minister concerning eligible customers * Determination of power tariffs during the transition stage



Note 1: The current electricity market is at the pre-privatization stage

Note 2: Ancillary services are those for adjusting instant power output required to balance supply and demand and ensure an adequate frequency.

Source: Prepared by the Survey Team

Figure 2-1.1 Structure of The Electricity Market Before and After Privatization

Parts	Summary of Provisions
Part 3	**<Establishment of the Nigerian Electricity Regulatory Commission (NERC)>** Establishment of NERC is provided with provisions on purpose, functions, powers, basic structure, operational funding, accounting, selection of commissioner and Chairperson of NERC.
Part 4	**<Licensing of Operators of the Power Sector and Electricity Tariffs>** Provisions are given for licensing (Applications, terms and conditions, renewals, modifications, cancellations and executive orders) of the power sector operators (Generation, transmission, system operation, distribution and electricity trading) by NERC and for electricity tariffs (Setting methodology and modification procedures).
Part 5	**<Land Expropriation and Easement>** Provisions are given for land expropriation (Expropriation procedure) and easement of licensees (for generation, transmission and distribution).
Part 6	**<Consumer Protection and Customer Service Standards>** Consumer protection standards for customer services by licensees are provided as follows: * Complaint handling standards and procedures * Rules for dealing with special needs (e.g. persons with disabilities) * Rules on procedures and methods for dealing with people unable to pay their electricity bills * Rules for applying to receive electricity * Rules for disconnecting non-payers/contract violators * Rules and regulations on information to be communicated to consumers and channels of communication * Performance standards of power providers (NERC's rules covering all aspects of power supply services) * Rules to streamline the use of electricity by consumers * Establishment of other operational standards, rules and manuals deemed necessary by NERC
Part 7	**<Competition and Market Power>** Provisions are given regarding competition and market power (NERC's responsibility to prevent abuses of market power and penalties in case of abuse of market power).
Part 8	**<Power Consumer Assistance Fund>** Provisions are given to establish and manage the Power Consumer Assistance Fund as follows: * Establishment and management of a Power Consumer Assistance Fund by NERC * Purpose of the Fund (to relieve underprivileged power consumers) * Composition of the Fund (consumer contributions, federal subsidies) * Determination of consumer contribution amounts by NERC * Method of consumer contributions * Payment of subsidies from the Fund to DisCos
Part 9	**<Rural Electrification>** Provisions are given to establish the Rural Electrification Agency (REA) and compose and manage the Rural Electrification Fund (REF) as follows: * Establishing REA and its composition/structure * Reporting on REA's account audit results to the relevant minister * Formulating a rural electrification policy and plan by the relevant minister and submission to the President * Reporting to the President on a quarterly basis and periodic evaluation by the minister on how the rural electrification policy is progressing and plan regarding expansion of the main grid, development of independent and mini-grid systems and renewable energy development * Composition of funding sources for REF (Surplus of NERC's operating fund; fines collected by NERC, donation from international and national organizations; contributions from eligible customers; interest and earnings via REF investment, monies appropriated by the National Assembly and fixed rate of electricity licensee sales determined by NERC) * Purpose of the REF (to promote, support and facilitate entry into rural electrification, provide equitable access to electricity, maximize the socio-economic benefits of rural electrification, promotion of grid expansion and off-grid electrification and promotion of innovation in rural electrification, rather than just subsidized consumption * Establishment of objective and transparent geographical distribution criteria for REF by REA in consultation with responsible ministers (Need for financial support; results from previous REF supports, consideration of local matching funds) * Establishment of open, competitive and transparent criteria for selecting REF-supported activities (Technical, economic and financial relevance, support for local development taking priorities of local communities and commitment of local residents and investors into account)

Parts	Summary of Provisions
	* Criteria for selecting activities to be supported by REF and determining the amount of such support (Remaining resources available from REF and other objective criteria set by the REA, such as cost per connection of support activities, tariff levels and quality of service)
Part 10	**<Offences and Penalties>** Provisions are given for offences and penalties in case of failure or refusal to respond or submit information in the manner or time prescribed in the Act as follows: * Willful misrepresentation * Failure or refusal to respond or provide information in the manner or time prescribed or providing false or incomplete answers or information * Delaying or obstructing an inspector or police officer from executing their authority or duties * Refusal to provide or non-provision of information to inspectors or police officers without a valid reason
Part 11	**<General>** General provisions are given regarding the appointment of inspectors and establishment of regulations by NERC, prohibition of use or disclosure of information obtained by an inspector, etc. for personal gain * Inspection by NERC (Appointment and duties of inspectors, permission for inspectors and police officers to enter the premises of a licensee or a person suspected of violating laws or regulations, permission to inspect records, accounting books, documents and dispatch of inspectors to offices, facilities, equipment and premises worked in, used or owned by or under the control of a licensee on the basis of a search warrant issued by a magistrate having jurisdiction over such premises; seizure of documents and goods based on a search warrant) * Establishment of regulations by NERC in accordance with the laws (Supervisory matters and methods by NERC, powers and obligations of licensees, procedures for performance and submission of information/documents by licensees, modification and revocation of licenses, determination of power business operational standards, content and method of providing information by the licensees, method of electricity billing, charges and billing payable by licensee/eligible customer/consumer, investment and assets of licensees, customer-related matters (such as complaint handling procedures, practices concerning customers struggling to pay bills, connection and disconnection procedures, formulation, revision and approval of financing policies for the licensees, regulation of rural electrification projects and investments, procedures for addressing licensee mergers, acquisitions, affiliate relationships and transactions, procedures for market power monitoring, mitigation and enforcement, etc.), fines and penalties for violations of laws and regulations on the part of licensees and consumers and public announcement of rules enacted by NERC * Prohibition of use or disclosure of confidential information obtained by inspectors, police officers, commissioners, or NERC employees in the performance of their duties or by any other person having indirectly obtained such information from said inspectors, police officers, commissioners, or NERC employees for personal gain (Personal financial status; commercial secrets, etc.) except for the purpose of legal proceedings and information required for law enforcement
Part 12	**<Consequential and Transitional Provisions>** Provisions are given on the initial transfer date and contingent on the remaining validity of rules, ordinances and notifications under revoked acts. * Continuance of validity of rules, ordinances and notifications under the Electricity Act or the NEPE Act until the rules, ordinances and notifications are enforced by NERC under this Act; * Continuance of validity of licenses/certificates/authorities under the Electricity Act or NEPA Act until their expiry; * Continuance of validity of the tariffs, prices and charges until new tariffs, prices and charges are set; * Continuance of ownership and occupancy of land and water rights under the Electricity Act or the NEPA Act; * Invalidity of provisions under the Utility Charges Commission; * Repeal of Electricity Act and NEPA Act.
Part 13	**<Interpretation (definition of words and phrases and the name of this Act)>**

Source: Electric Power Sector Reform Act

While the objective of power sector reform in developed countries is to improve efficiency through deregulation and the introduction of competition, the main objective in developing countries is to reduce the financial burden on the government. The objective of the power sector reform in Nigeria was to improve efficiency through privatization and to reduce the financial burden on the government. In developing

countries, large-scale capital investment is necessary to meet the ever increasing demand for electricity. In addition, the financial structure of electric power companies is fragile, and there is the problem of credit risk. Furthermore, electricity tariffs need to be set at a level that will allow power producers to continue their business at a reasonable profit. In Nigeria's EPSRA and related regulations, there is no framework that can mitigate capital investment risk[1] and credit risk of power producers, the electricity tariff optimization framework is not progressing as planned even though it is legislated, and there is no guarantee of stable fuel supply for independent power producers. These are the issues that need to be addressed.

2-1-2 Power Sector Recovery Program (PSRP)

The PSRP is a program comprising a series of action plans on policy, regulation, operations and governance. It was designed to reset the entire power industry in Nigeria over a five-year period from 2017 to 2021 by restoring solvency to the electricity sector, improving sector transparency and power supply services, resolving issues including consumer complaints, loss and electricity theft and also revising electricity rates to a cost-recoverable level.

(1) Background

Nigeria’s power sector reform began with the formulation of its National Power Policy in 2001 and was followed by the enactment of its Electric Power Sector Reform Act of 2005. Nigeria’s power sector is being reformed in four stages. In 2015, although an NERC directive advanced reform to the second stage, cost-recoverable electricity rates have still not been established to date and DisCos’ collection rate remains quite low. Consequently, the overall power sector lacks sufficient funds and the infrastructure remains underdeveloped. Against this backdrop, the Federal Government and NERC formulated the PSRP in 2017, supported by the World Bank, as part of efforts to reset the power sector.

Stage 1 (Interim Period stage): Based on the Electric Power Sector Reform Act, a holding company, Power Holding Company of Nigeria (PHCN), was established and the National Electric Power Authority (NEPA) was unbundled into 18 successor companies, six generation companies (GenCo), the Transmission Company of Nigeria (TCN) and 11 distribution companies (DisCo). In addition, in 2013, all DisCos and five GenCos were privatized (although the government holds a 51% stake in one) and the remaining one, which owns hydropower plants (Kainji, Juba and Shiroro), is operated through a concession to a private company.

Stage 2 (Transitional Electricity Market stage): NBET (Nigeria Bulk Electric Trading Plc.), a power wholesaler, began activities and is purchasing electricity from GenCos and Independent Power Producers (IPP), which it subsequently sells to DisCos and eligible customers[2] under contracts. Since 2011 until now (October 2021) the electricity market is remained at this stage.

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[1] The Partial Risk Guarantee provided by the World Bank Group for the Azura-Edo IPP (450 MW, gas-fired) in 2015 is the first risk mitigation measure for investments in the power sector in Nigeria. The Federal Ministry of Finance of Nigeria signed a Put-Call Option Agreement with the Azura-Edo IPP, under which the government is supposed to purchase the power generation assets in case of default on the part of the Nigerian government.

[2] Eligible Customer is a maximum demand customer who buys electricity not from a distribution company but directly from a generating company, IPP and/or licensed electricity trader.

Stage 3 (Medium-Term Electricity Market stage): NBET withdraws from the market and contracts between GenCos/IPPs and NBET are replaced by direct contracts between GenCos/IPPs and DisCos/eligible customers.

Stage 4 (Long-Term Market stage): at this stage, an electricity spot market emerges, in which electricity is traded based on bilateral contracts between buyers and sellers and supply and demand are balanced in a central spot market.

(2) Objectives

PSRP has the following objectives:

i) Restore the sector's financial viability;
ii) Improve power supply reliability to meet growing demand;
iii) Strengthen the sector's institutional framework and increase transparency;
iv) Implement policies that promote and encourage investor confidence in the sector;
v) Institutionalize a contract-based electricity market.

(3) Approach and Action Plan

The PSRP comprises the four approaches (interventions) and 16 action plans shown in Table 2-1.2.

Table 2-1.2 Approaches and Action Plans stated in the Power Sector Recovery Program

Approach	Component
1. Financial interventions	1) Establish sustainable and appropriate electricity tariffs 2) Develop and implement a plan to finance the deficit (US$3.77 billion) until a cost-recoverable tariff structure is established (2017-2021). 3) Compensate for the accumulated deficit (US$1.38 billion) caused by previous low tariffs (2015-2016). 4) Clear past government agency tariff shortfalls (US$85 million) and prevent of future shortfalls 5) World Bank funding
2. Operational/Technical interventions	6) Ensure baseline generation, transmission and distribution of (4,500 MW on-grid) by 2021. 7) Improve distribution company (DisCo) performance 8) Adequate natural gas supply for power generation
3. Governance interventions	9) Restore sector governance 10) Improve sector transparency 11) Make contracts fully effective 12) Clearly communicate PSRP 13) Establish a PSRP Implementation Monitoring Team and implement monitoring
4. Policy interventions	14) Temporary fiscal and monetary policies aimed at encouraging private sector investments 15) Increase electricity access 16) Economical procurement of power

Source: Power Sector Recovery Program

With regard to the above "2. Operational/Technical interventions" 2) Improve distribution company (DisCo) performance, the following detailed action steps are described:

i) NERC to ensure that each DisCo commences and updates a complete customer database, to identify their customers and commence a metering program.
ii) NERC reviews and approves the Performance Improvement Plan (PIP) for each DisCo.

iii) NERC monitors each DisCo's progress in terms of implementing PIP, refining performance indicators and enforcing compliance with committed investments.
iv) NERC to finalize business continuity regulation after consulting with stakeholders, including investors and management of DisCos.
v) Based on the MYTO targets and baseline, the Bureau of Public Enterprise (BPE) revises Performance Agreements with each DisCo, to clarify the obligations of each party and the consequence(s) of non-compliance with the agreement.
vi) BPE monitors Performance Agreements based on information provided by NERC and assesses compliance.

2-1-3 Power development plan

2-1-3-1 Priority mandates by the Federal Ministry of Power

Ministerial mandates of the Federal Ministry of Power as signed by the Honorable Minister and Permanent Secretary to develop and streamline the Nigerian Electricity Supply Industry (NESI) are shown in Table 2-1.3. FMP periodically monitors the progress of the eight (8) mandates and their targeted deliverables. As indicated in Table 2-1.4, three (3) of the eight mandates relate to grid expansion. As for power generation, FMP intends to increase generation capacity by at least 1,000 MW annually by ensuring the completion of ongoing power generation projects. FMP plans to increase distribution and transmission capacity and reduce their losses by implementing the Siemens Grid and Distribution Enhancement Project and TREP (Transmission Rehabilitation and Expansion Program).

Table 2-1.3 Ministerial mandates of the Federal Ministry of Power

No.	Mandates
1	Implement Federal Government's Power Policy focusing on direct agreements between willing buyers and sellers.
2	Implement the Siemens Grid and Distribution Enhancement Project.
3	Increase distribution and transmission capacity to 11,000 MW by 2023.
4	Increase generation capacity by at least 1,000 MW annually by ensuring the completion of ongoing power generation projects.
5	Complete the Energizing Education Programme to reach 37 Universities and 7 Teaching Hospitals.
6	Complete the Energizing Economies Programme to reach at least 500,000 MSMEs.
7	Actively collaborate with the Private Sector to create numerous well-paying jobs for Nigerian youth.
8	Implement strategy towards realization of the President's June 12 promise to take 100 million Nigerians out of poverty in the next decade.

Source: Federal Ministry of Power (2020.2) "Ministerial Performance Report - Implementation of identified priorities and deliverables of the Federal Ministry of Power"

Table 2-1.4 Mandates related to power development plan

No.	Mandates	Baseline	Target
2	Implement the Siemens Grid and Distribution Enhancement Project.		Phase 1: Increase operational capacity to 7GW by 2021 Phase 2: Increase grid capacity to 11GW, achieve further reduction in ATC&C losses Phase 3: Increase operational capacity to 25GW by 2025
3	Increase distribution and transmission capacity to 11,000	Wheeling capacity as of August 2019 ・Transmission: 8,100MW	Complete Phase 1 and 2 of Siemens Grid and Distribution Enhancement Project

No.	Mandates	Baseline	Target
	MW by 2023.	・Distribution: 5,000MW	and TREP[3].
4	Increase generation capacity by at least 1,000 MW annually by ensuring the completion of ongoing power generation projects.	As of 2019 ・Rated hydro capacity: 1,936MW ・Available hydro capacity: 1,225MW ・Rated thermal capacity: 11,154MW ・Available thermal capacity: 4,202MW	Deliver the following by December 2020 (1) Zungeru (hydro) 700MW (2) Kaduna (thermal) 215MW (3) AfamⅢFast Power (thermal): 240MW (4) Kashimbilla (hydro) 40MW (5) Dadin Kowa (hydro) 40MW Deliver the following by December 2021 (1) 14 solar projects: 1,050MW (2) Jigawa Energy City: 50MW Deliver the following by December 2023 (1) Mambilla(hydro): 3,050MW (2) NBET initiated PPAs: 4,100MW

Source: Federal Ministry of Power (2020.2) "Ministerial Performance Report - Implementation of identified priorities and deliverables of the Federal Ministry of Power"

2-1-3-2 Nigeria Electrification Roadmap

Siemens formulated and proposed the Nigeria Electrification Roadmap (NER, later referred to as "Presidential Power Initiative" (PPI)) to the government of Nigeria to implement the Siemens Grid and the Distribution Enhancement Project, aiming to resolve the challenges facing the Nigerian power sector and expand the grid capacity in phases. NER proposes taking the following steps and projects to expand the grid in three phases, namely 7, 11 and 25GW respectively.

Table 2-1.5 Proposed contents of the Nigeria Electrification Roadmap

Step	Step 1	Step 2	Step 3
Target year	2021	2023	2025
Capacity	7GW	11GW	25GW
Plans	(1) Secure revenue stream through Smart Metering ・Pilot in Abuja, Yola, Eko, Ikeja DisCo (2) Enable power distribution by reinforcing transmission and distribution assets ・Abuja, Yola, Lagos regions (Alagbon substation, Eko DisCo) (3) Enhance power flow through new substations and system studies ・Abuja, Yola, Lagos regions, Eastern Corridor (4) Automation of transmission and distribution network ・Improve and upgrade SCADA for TCN Network ・SCADA and Advanced Distribution management system for DisCos	(1) Increase power production through power plant rehabilitation ・Afam V (2) Embedded power generation ・Abuja Region (40MW) ・Jos Region (Dadin Kowa hydro power, 30MW)	(1) Additional power generation through NNPC (Nigerian National Petroleum Corporation) ・Abuja: 1,350MW ・Kaduna: 900MW ・Kano: 1,350MW ・Lagos (Agura) 450MW (2) Additional power generation to reach 25GW - Nationwide (3) Utilization of flare gas in power generation ・Flare gas cleaning and collection ・AKK pipeline drives electrification in Abuja and rural electrification in Northern regions

Source: Siemens (2018.11) "Electrification Roadmap for Nigeria"

As well as the above proposal, Siemens also proposed vocational education and training for the power

[3] Transmission Rehabilitation and Expansion Program (TREP) is formulated and implemented by the Transmission Company of Nigeria with anticipated donor assistance such as the African Development Bank, the World Bank, JICA, AFD (Agence Française de Développement), etc.
https://tcn.org.ng/repository/projectdocuments/Transmission%20Rehabilitation%20and%20Expansion%20Program%20(TREP).pdf

sector, such as collaboration with the Lagos electricity board to set up the Lagos Energy Academy and establishment of a Vocational Education and Training Center at the Lekki Free Trade Zone as proposed to the Federal Ministry of Industry, Trade and Investment.

In late February 2021, the Federal Government and Siemens AG signed a contract for the pre-engineering phase of the Presidential Power Initiative (PPI). The contract signed for the pre-engineering phase, includes:

- Engineering design
- Finalizing project specifications
- Commissioning works for transmission & distribution systems
- Network development studies
- Power simulation
- Training - support services

2-1-4 Regulations Related to The Power Distribution Sector

(1) Distribution Code

1) Background and History

The power sector in Nigeria was separated by function into generation, transmission and distribution sectors when the Electric Power Sector Reform Act (2005) was enacted. Under the Electric Power Sector Reform Act, distribution companies (DisCo) were established and licensed to distribute electricity to assigned licensed areas for 230V to 33kV networks.

DisCos were also tasked with retailing electrical power to end users.

2) Structure of the Distribution Code

The Distribution Code comprises the following four components:

(a) Distribution Planning & Connection Code: This component stipulates the following:
- Technical and design criteria
- Procedures to be followed by the DisCo in Planning and development of the distribution system
- Connection conditions specifying the connection criteria (Technical, Design & Operational criteria) to be complied with by any user connecting (or seeking connection) with the DisCo.

(b) Distribution Operation Code: This component stipulates the following:
- Day-to-day operating procedures
- Principles governing the development, operation and maintenance of an effective, well-coordinated and functional Distribution Network for the electricity sector in Nigeria

(c) Construction and Maintenance Code: Containing guidelines as to how the distribution system should be constructed and maintained.

(d) Data Registration Code: Containing the schedule and templates for data to be interchanged

among DisCos and users.

3) Application of the Distribution Code

The Distribution Code applies to all DisCos and distribution network users in the country. DisCos dictate how the Distribution Code is developed and implemented and both DisCos and users must mandatorily comply with its provisions. Users must also provide all required information and reasonable rights of access, service and facilities necessary to implement the Distribution Code.
Here, users are defined as follows:

(a) Directly connected generators
(b) Directly connected power customers
(c) Interconnected distribution network operators
(d) Energy retailers or marketers

4) Role of the Distribution Companies

Under the terms and conditions of the license, the role of the distribution companies is as follows:

(a) Provide connections and deliver electric energy to users in accordance with the technical and safety parameters specified in the Distribution Code and other industry regulations.
(b) Procure ancillary services on behalf of the transmission and system operator and recover the costs involved.
(c) Handle network emergencies and restore the normal network status safely and functionally.
(d) Perform demand forecasting.
(e) Evaluate and accept user connections.
(f) Ensure proper metering at all network connection points.
(g) Supervise compliance with and enforce the Distribution Code and other health and safety regulations for the network.
(h) Develop, monitor and enforce procedures for conducting system tests pertaining to the network to ensure the health and safety of personnel and equipment.
(i) Obtain necessary information from users of the Distribution Network to enable it to perform adequate planning operations and development of the network.
(j) Test and monitor users' equipment/apparatus connected to the network to ensure their compliance with the Distribution Code and other relevant regulations.
(k) Report on scheduled and planned actions and unexpected occurrences such as faults, outages, network upgrading; to network users, connectors and the regulator.
(l) Comply with the Transmission Grid Code and protect the integrity of the Transmission Network.

(2) Metering Code

The Metering Code comprises three parts, namely: i) General Conditions, ii) Grid Metering Code (GMC) and iii) Distribution Metering Code (DMC).

1) Composition of the General Conditions

Part 1: The General Conditions of the Metering Code comprise the sections and sub-sections shown in Table 2-1.6.

Table 2-1.6 Composition of the General Conditions (Part 1) of the Metering Code

No.	Section/Sub-section		
1.	Background		
1.1	Title of the Code	1.2	New Arrangements or The Nigerian Electricity Sector
1.3	Parts of the Metering Code		
2.	Interpretation and Definitions		
2.1	Interpretation	2.2	Definitions
3.	Review Process and Disputes		
3.1	Disputes	3.2	Metering Code Review Panel
3.3	Unforeseen Circumstances	3.4	Illegality and Partial Invalidity

Source: Metering Code

2) Composition of the Grid Metering Code

Part 2: The Grid Metering Code (GMC) of the Metering Code comprises the sections and sub-sections listed in Table 2-1.7. The GMC is targeted for i) the Market Operator, ii) the System Operator, iii) Transmission Service Provider (TSP), iv) Distribution Companies (DisCos), v) Generators directly connected to the Transmission Network, vi) Customers with and without self-generation directly connected to the Transmission Network, whether they qualify or not as Market Participants, vii) Eligible Customers with and without self-generation connected to the MV Distribution Network, provided that they qualify as Participants in the Market, viii) Traders.

Table 2-1.7 Composition of the Grid Metering Code (Part 2) of the Metering Code

No.	Section/Sub-section					
1.	Objectives and Scope					
1.1	Objectives	**1.2**	Scope	**1.3**	Derogations	
2.	Metering Requirements					
2.1	Type of Connection Points	**2.2**	Location of Main and Check Metering Systems			
2.3	Applicable Standards	**2.4**	Characteristics of the Metering System			
2.5	Accuracy of Metering					
3.	Ownership And Associated Obligations					
3.1	Ownership	**3.2**	Proper Order	**3.3**	Metering Information Register	
4.	Certification, Calibration and Testing of Metering System					
4.1	Certification	**4.2**	Initial Calibration	**4.3**	Commissioning Tests	
4.4	Periodic Tests	**4.5**	Other Periodic Tests	**4.6**	Test Failure	
5	Security and Data Access					
5.1	Sealing	**5.2**	Access to Metering Data			

Source: Metering Code

3) Composition of the Distribution Metering Code

Table 2-1.8 shows sections, sub-sections and profiles of Part 3: Distribution Code (DMC) of the Metering Code. The DMC applies to i) Distributors, ii) Customers connected to the LV Distribution Network and iii) Customers connected to the MV Distribution Network, provided that they are not Participants in the Market, iv) Generators connected to the Distribution Network, provided that they

are not Participants in the Market.

Table 2-1.8 Composition of the Distribution Metering Code (Part 3) of the Metering Code

No.	Section/Sub-section/Profile of Provision
1.	**Introduction**
1.1	**Purpose and Scope:** * Purpose of DMC (Specifying technical and operational criteria for distributors to install, verify, operate, maintain, inspect and replace metering systems) * Scope of DMC (Customers connected to low- and medium-voltage distribution networks, etc.) * Obligations of distributors (Own, install, verify, operate, maintain, inspect and replace metering systems, ensure that metering systems meet performance, functional and technical requirements and applicable standards and ensure billing and financial settlement based on the data obtained by meter readings, etc.)
1.2	**Derogations:** Reporting obligations by distributors to NERC and responses by NERC in cases of derogations of metering systems, etc.
2.	**Obligations**
2.1	**Distributors' Obligations of Installation and Replacement of Metering Equipment:** * Installation (Close to connection points), assigning a unique identifier and recording installation date, functionality, unit of measurement, ancillary equipment, site-specific loss adjustment factors, redundancy details and sources of check metering data and initial meter register reading of the metering system * Reporting of meter replacement in accordance with DMC, maintenance of calibration and malfunction records and documents of meter testing prior to installation and providing metering system information to users and NERC, etc.
2.2	**Standards of Metering Systems:** * Standards of medium- and low-voltage metering systems * Service life of metering systems, etc.
2.3	**Alternatives to Standard Metering Systems:** * Install a check meter or arrange another measure for checking by the distributor upon the request of a user * Agreement to pay the costs of the additional features or equipment including the costs of installation, operation, maintenance, repairs and replacement * Prohibition of degradation of the capability of the metering system by additional features or equipment, etc.
2.4	**Technical Requirements and Accuracy of Meters:** * Accuracy of meters, certification of the accuracy and ensuring of the accuracy by the Distributor * Standard application layer (A layer that organizes the functions and roles of communication protocols (Communication procedures/communication rules) into a hierarchical structure and implements the functions required for specific systems and services) protocol and physical protocol for data transfer of prepayment systems, etc.
3.	**Certification and Tests**
3.1	**Certification of New Metering Installations:** * Procedure necessary to procure quality meters (Certification of meter type (model) by NERC, tests of all meters by distributors at meter test stations accredited by NERC in compliance with the relevant standards and accuracy class) * Validity period of the type-test certificate, prior and clear indication of the calibration tests and retention of and submission to NERC when required of test certificates by the distributor for the metering equipment that is in use and that is no longer in use and within the period of five (5) years after the de-commissioning * General requirements for testing and calibration laboratories, directives by NERC on the procedures and required tests (Certification of type tests, routine tests and calibration test and endorsement of manufacturer's certifications, etc.), a pre-defined percentage of meters for sampling testing and calibration reports, etc.
3.2	**Certification of Existing Installations:** * Valid period of meters and metering equipment already installed with calibration or verification tests compatible with the provisions of this Metering Code, NERC's evaluation and certifications in response to the distributor's requirement within the first twelve (12) months of the effective date of this DMC, replacement of uncertified meters or metering equipment by the distributor and obtaining certifications of the meters or metering equipment within eight (8) years of effective date of the Metering Code, etc.

No.	Section/Sub-section/Profile of Provision
3.3	**Re-certification:** * Requirement for re-certification of a metering installation and its components before the expiration of the certificate, expiration of certification of the overall metering installation upon expiration of the individual certification of any one of its components, re-certification by removal and tests, testing online, or replacement of the component and cancellation of certification, etc.
3.4	**Inspection and Periodic Tests:** * Distributor's obligation to conduct periodic inspection, periodical, random, or unannounced inspection and testing of any metering system by distributors to ascertain compliance with the requirements of this DMC, request for inspection and/or testing by users and payment of the cost, inspection and test utilizing an authorized meter test station, user granting access to the meter and distributor disclosing the results of any inspection and/or tests to the requesting party and user, etc.
3.5	**Faulty Metering Equipment:** * Determination of a fault and non-compliance of a metering system with the DMC, Distributor's obligation to conduct urgent repair or replacement within two (2) working days, safe and prudent use of metering equipment to avoid damage, user's obligation to notify any damage to the metering equipment to the distributor, investigation by the distributor to determine which party is responsible for the damage, bearing the cost of repairs or replacement by the responsible party, disputes in determining the responsible party and resolution by the Metering Code Review Panel, distributor's obligation to obtain or estimate data for the period from occurrence of the fault until completion of the repair or replacement and recording of all relevant meter parameters by the distributor to replace a meter in the metering system
4.	**Access and Security**
4.1	**Access to Metering Systems:** * User's granting of access to the Distributor to allow it to fulfil its obligations under the DMC, exemption of prior arrangement by the distributor in cases of routine meter reading, or periodic, random and unannounced inspections, etc.
4.2	**Security of Metering Systems:** * Distributor's obligation to maintain the security of the metering data, obligation of appropriate sealing of the metering system, approval of procedures for sealing and the removal by NERC, protection of the metering system by the distributor (Sealing of all associated links, circuits, data storage and data processing systems, ensuring of security of the metering system and use reasonable endeavors to ensure the security of all metering data), etc.
5.	**Meter Reading and Data Management**
5.1	**Meter Reading:** * Obligation of the distributor to manually read all meters at least once every four (4) months and obligation of the distributor to record the meter reading (Meter identification number, meter reading and the date at the beginning and end of the reading period, cumulative active energy (kWh) of the reading period, cumulative reactive energy (kVArh) and maximum active and reactive power of the billing period and details of any meter alarms recorded during the meter reading period), etc.
5.2	**Remote Metering Equipment:** * Obligation of the distributor to specify the type of equipment for communication with remote meters and obligation of the distributor for tests to verify the meter reading results recorded at each metering point
5.3	**Data Management:** * Obligation of the Distributor to manage data (Maintenance of a metering data registry containing usage data for each user and data required to settle and validate metering data for each metering system, estimation of usage in case of unavailability, inaccuracy and lack of suitability for settlement purposes, adjustments to metering data to account for system losses and energy not accounted for, aggregation of metering data for settlement and loss calculation and reasonable endeavors to maintain the security and confidentiality of the metering data)
5.4	**Data Registration:** * Obligation of the distributor to establish and maintain a register of information of the metering system (Date of installation of the metering system, functionality of the meter and the unit of measurement (e.g. kWh, kVArh, etc.), meter type, type of ancillary equipment, redundancy and sources of check metering data required by this DMC and meter designation as the main meter/check meter, data for each meter following completion of the validation and estimation procedures, billing data for each meter following completion of adjustments for losses and unaccounted-for energy and data covering a period of not less than 12 months and electronically accessible)

No.	Section/Sub-section/Profile of Provision
5.5	**Data Validation and Loss Adjustment Factors:** * Obligation of the distributor (Having data validation procedures and loss adjustment calculation methodology approved by NERC, determination of site-specific loss adjustment factors and maintaining both unadjusted and loss-adjusted values in the metering data registry of each metering system, etc.)
Inherent Powers of NERC: * Power to amend or repeal the provisions of the Metering Code and adopt any provisions of the Metering Code at variance with special circumstances in conformity with the provisions of the Act, with reasons to be recorded in writing	

Source: Metering Code

Appendices of the Metering Code are listed in Table 2-1.9.

Table 2-1.9 Appendices of the Metering Code

Appendix	Title (Latest Version No. 9
Appendix A	1. Certification Tests (Ver. 02)
Appendix B	2. Commissioning Tests (Ver. 02)
Appendix C	3. Sealing Procedures (Ver. 01)
Appendix D	4. Technical Specifications or Meters And Metering Accessories (Ver. 01)
Appendix E	5. GMC Metering Characteristics: Classification of Connection Points and Location of Metering Systems (Ver. 01)
Appendix F	6. Installation Standards (Ver. 01)

Source: Metering Code

(3) Multi-Year Tariff Order (MYTO)

The Multi-Year Tariff was introduced with a proposal by a notice of NERC, namely Notice of Proposed Establishment of a Methodology for a Multi-Year Tariff Order (MYTO), April 26, 2007. The first MYTO, i.e. MYTO (Multi-Year Tariff Order to Determine Charges and Tariff for Generation Transmission and Retail Tariff for the Period from July 2008 to June 2013, issued in June 2008 after holding public consultation meetings.

1) Notice of Proposed Establishment of a Methodology for a Multi-Year Tariff Order (MYTO) (April 26, 2007)

This notice provides the principles and basic methodology for setting the electricity tariff. The outlines of this notice are as follows:

- Tariff Revision
  - * MYTO provides a 15-year tariff path for the electricity industry
  - * Major reviews every 5 years, when all inputs are reviewed with stakeholders
  - * Minor reviews each year in the light of revisions to a limited number of parameters (such as inflation and gas prices)
- Invitation Opinions: The general public, stakeholders and any affected parties are invited to send objections. comments or representations to NERC
- Principles of Tariff Setting: Fair, efficient (at lowest possible cost, encouraging investment) and balanced (between service providers and users) tariff setting
- Methods of Tariff Setting:

* A building block approach is applied and the three blocks, i.e. i) return of capital associated with recouping the capital over the useful lives of assets (depreciation), ii) return on capital to achieve a fair rate of return on capital investment and iii) efficient operating costs and overheads are analyzed and aggregated to compute the tariff during the Transitional and Medium-Term Electricity Market until the move to the Long-Term Electricity Market where electricity retailing is liberalized.
* Tariff setting for power generation subsector to be privatized and liberalized - Pricing through a Power Purchase Agreement (PPA). Before PPAs are concluded, Pricing through Vesting Contracts, which are concluded between generation companies and the bulk trader at a regulated low price to control the market power of generation companies
* Incentivizing the electricity supply industry to achieve an appropriate power supply

- Treatment of Capital Cost in MYTO: Tariff setting for capital incentive electricity supply industry recognizes the capital cost, such as depreciation/reserve replacement, return on capital investment and financing costs as the key factors.
- Treatment of Distribution: Tariff setting considers optimized facility/equipment replacement, optimized capacity of equipment and economic lives of assets and depreciation for competitive equipment replacement to meet increased future demand for the long term.
- Weighted Average Cost of Capital (WACC): Tariff setting considers risks for private companies, cost of assets holding and procurement of capital. A commercial interest rate is applied as the cost of debt. The rate of return on equity is set lower than the commercial interest rate.
- Treatment of Operation Cost:
  * Operation and maintenance costs are assumed to include an allowance for improved performance.
  * Overheads and administration costs per unit of energy supplied are assumed to decline gradually.
  * Commercial losses are presumed to decrease and the revenue collection rate is expected to increase.
- Setting Generation Tariff:
  * One of the pressing issues in the power sector is a shortage of generation capacity due to under-investment and lack of re-investment, resulting in plant availability below 60%. There are plans to increase capacity to 10,000MW by the end of 2007.
  * There are plans to privatize the generation subsector and private sector participation and investment promotion is expected through pricing in a competitive market.
  * In future, electricity wholesale prices will be determined by market trades and be reflected in regulated transmission and distribution charges.
  * Vesting Contracts with regulated prices are applied to control the market powers of generation companies.
  * A wholesale tariff will be set to streamline construction and secure the required operation and maintenance costs.

- Setting Transmission Charges:
  * A connection charge for new generators that covers their costs in connecting to the high-voltage network and extending transmission infrastructure (one-time) will be included in the transmission charge.
  * Transmission charge covers transmission losses, which comprise between 5 and 10% of the energy injected.
  * Transmission charges are calculated according to the volume of transmitted energy.
  * Transmission charges exclude charges to cover transmission losses. Generators effectively pay for the injection of excess energy as well as the contracted volume.
  * Transmission tariffs levied on distribution companies are calculated based on building block methodology.
  * The generators see incentives to locate reasonably close to the Transmission Network and, at places near load centers or at the end of long transmission lines near isolated load centers, where connection costs and transmission losses are lower.
- Pricing of Distribution and Retailing:
  * Most of the cost of distribution networks comprises capital expenditure, like the transmission subsector. Distribution tariffs are set including an estimation of future capital expenditure required according to the forecasted peak demands for each distributor.
  * The Distribution Use of System (DUOS) tariff is calculated, covering the cost of distribution and marketing, according to the building blocks methodology and includes allowances for capital expenditure, network operation and maintenance, losses across distribution networks and metering costs.
  * Distribution and retailing costs include the operating and administration costs of retailing and billing electricity sales.
- Why a Multi-Year Tariff Order?
  * MYTO provides a stable price path going forward, with a review each year according to varying rates of inflation, the cost of input fuel for electricity generation (primarily gas) and exchange rate fluctuations.
  * Major reviews will be undertaken at intervals of under five years if industry participants can demonstrate to NERC changing industry parameter and necessity of urgent review.
  * At the commencement of a major review, NERC has to prepare a consultation paper that indicates the issues to be covered by the review and informs the relevant parties. Relevant electricity suppliers must provide verifiable information on capital expenditure, actual and projected sales, operating costs, fuel costs, tax and other payments, etc.
  * NERC develops its own analyses on important parameters, such as i) forecasts of electricity demands, ii) interest rates, iii) WACC of the industry, iv) appropriate expansion of transmission and distribution networks, v) reasonable reduction of electricity losses, particularly non-technical losses, etc.
  * The tariff path allows a gradual tariff increase in the initial years to avoid a steep change in one

year.

* A long-term tariff path reduces the risks for both consumers and investors in industry.

2) MYTO (July 2008 to June 2013)

MYTO (July 2008 to June 2013) was the first MYTO, which was issued by NERC in June 2007 as Multi-Year Tariff Order to Determine Charges and Tariff for Generation, Transmission and Retail. The MTYO (July 2008 to June 2013) provided the following tariffs and charges for the period from July 2008 to June 2013 (actually to May 2013). Before the first MYTO, the tariff was reviewed in February 2002 from an average of NGN 4.5 to 6.0/kWh.

* Wholesale price for generated electricity sold to the national grid,
* Transmission charge,
* Transmission system operator (TSO) and market operator (MO) charge,
* PHCN Headquarters charge,
* Regulation charge and
* Equal payment and tariff among distributors to maintain a national uniform tariff.

The MYTO (July 2008 to June 2013) set the tariffs following the methodology described in the abovementioned notice and according to the following principles:

Cost recovery/financial viability:

* Tariffs/charges should permit regulated entities to recover efficient costs, including a rational rate of return on investment.

Signal to investors:

* Tariffs/charges should encourage an efficient level and nature of investment in the industry.

Certainty and stability:

* The pricing framework should be certain and stable to promote private sector investment.

Efficient use of the network:

* Efficient pricing should reflect the marginal costs imposed by users on the system and reduce cross subsidies.

Allocation of risk:

* The pricing arrangement should allocate risks efficiently to those tasked with managing them.

Simplicity and cost-effectiveness:

* The tariff/charge structure should be easy to understand and the regulatory system should not be costly to implement.

Incentive for improving performance:

* Tariffs/charges should incentivize operators appropriately to reduce costs and boost the quality

of services.

Transparency/fairness:

* Tariffs/charges should be non-discriminatory and transparent. Access to the monopolized network is a key pre-requisite for effective competition in contestable sectors.

Flexibility/robustness:

* The pricing framework must be able to cater for unseen changes in circumstances.

Social and political objectives:

* The pricing framework needs to provide for achievement of social policy goals, such as user affordability, universal access and specific policies, such as the national uniform tariff.

The tariff calculation during the target MYTO period (July 2008 to June 2013) is shown in Table 2-1.10. The plan was to ensure the tariff of 2012 would reach a level reflecting costs and lower the subsidy to zero, but a cost-reflective tariff was not attained. Although plans included realizing a tariff reflecting costs in July 2021 under an Extraordinary Review of MYTO 2015 (NYTO 2020) published in September 1, 2020, a minor review had become necessary to achieve a tariff reflecting costs due to the sharp depreciation in the Nigerian Naira (NGN).

Table 2-1.10 Tariff Calculation of MYTO (July 2008 to June 2013)

(Unit: NGN thousand)

Operators	Details	2008	2009	2010	2012	2013	
Generation	Wholesale contract costs + PPAs	81,018	123,304	204,243	334,996	395,154	
	Annual License charge (1%)	810	1,233	2,042	3,350	3,952	
	Subtotal	81,828	124,537	206,286	338,346	399,105	54%
Transmission	Total Operational Expenditure	7,206	10,552	16,404	25,436	29,499	
	Return on Capital	4,204	17,828	33,843	46,280	91,352	
	Return of Capital (Depreciation)	6,330	9,794	11,536	17,641	24,203	
	HQ Admin charge	3,037	2,430	1,944	1,555	1,555	
	Regulatory charge	312	609	637	909	1,466	
	Ancillary service charge 1%	177	382	618	894	1,451	
	Subtotal	21,266	41,595	64,981	92,714	149,526	20%
All DisCos	Total Operational Expenditure	13,415	14,891	16,214	17,998	19,798	
	Return on Capital	13,594	35,840	58,297	80,952	147,968	
	Return of Capital (Depreciation)	3,806	4,946	6,191	11,697	16,007	
	HQ Admin charge	4,364	3,491	2,793	2,234	1,787	
	Market Operator charge	77	137	254	451	559	
	Regulatory charge	529	890	1,256	1,700	2,792	
	Subtotal	35,785	60,195	85,006	115,033	188,911	26%
Grand total		138,879	226,327	356,273	546,093	737,543	100%

Average and levelized tariff NGN/KWh	11.20	10.64	9.49	10.00	10.00
NERC adopted Retail Tariff NGN/KWh	6.00	7.00	8.50	10.00	10.00
NERC adopted Regulated costs (nominal) (NGN '000)	74,400	148,854	319,242	546,093	737,543
Subsidy requirement (NGN'000)	64,479	77,472	37,031	0	0
Subsidy N/KWh	5.20	3.64	0.99	0	0

Source: MYTO (July 2008 to June 2013)

3) Historical MYTOs

Past MYTOs issued after MYTO (July 2008 to June 2013) were listed in Table 2-1.11. There have been five major reviews to date. Minor reviews, the information of which was collected by the JICA Survey Team, are shown in the table. To date, values of major parameters for tariff setting, such as the exchange rate or loss reduction target, have deviated from the values presumed in the previous MTYO and tariff, with which actual costs are recovered and adequate returns obtained, meaning the tariff reflecting costs was not attained. Although the inflation rate of the US and Nigeria have largely differed, the presumed exchange rate for many MYTOs remained the same for five years, meaning the tariff reflecting costs has not been realized.

Table 2-1.11 Historical MYTOs

Name of MYTO (Date of Issue)	Effective Period		
	from	~	to
MYTO (27 Jun. 2008)	1 Jul. 2008	~	31 May 2013
MYTO II (31 May 2012)	1 Jun. 2012	~	31 May 2017
MYTO 2.1 (31 Dec. 2014)	1 Jan. 2015	~	31 Dec 2018
Amended MYTO 2.1 (24 Mar. 2015)	1 Apr. 2015	~	31 Dec 2018
MYTO 2015 for each of the Distribution Companies (21 Dec. 2015) for the Transmission Company of Nigeria (21 Dec. 2015)	 1 Feb. 2016 1 Jan. 2016	 ~ ~	 31 Aug. 2020 31 Dec 2024
Extraordinary Review of MYTO 2015 (MYTO 2020) (Suspended Period)	1 Sep. 2020 (28 Sep. 2020)	~ ~	31 Dec 2025 (11 Oct. 2020)
MYTO minor reviews			
2016 - 2018 Minor Review of MYTO 2015 and Minimum Remittance Order for the Year 2019	1 Jul. 2019.	~	31 Dec 2019
December 2019 Minor Review of MYTO 2015 and Minimum Remittance Order for the Year 2020	1 Jan. 2020	~	1 Apr. 2020
Order on the Transition to Cost-reflective Tariffs in Nigerian Electricity Supply Industry (Stop of tariff increase due to COVID-2019)	1 Apr. 2020	~	31 Aug. 2020

Source: NERC (Answer to Questionnaire prepared by JICA Survey Team)

4) Extraordinary Review of MYTO 2015 (MYTO 2020)

On September 1, 2020, NERC approved a wide tariff raise, namely an Extraordinary Review of MYTO 2015 (MYTO 2020). The target period of this MYTO extends until December 2025 and plans including realizing tariff reflecting costs in 2021 onward. Prior to this tariff revision, NERC had carried out various preparatory works, such as holding public consultation meetings. According to newspaper articles, however, demonstrations against the increased tariff called by the opposition party, namely the People's Democratic Party and civil and social organizations occurred throughout urban areas nationwide, because only three months had elapsed since the National Assembly suspended the tariff increase in June 2020. In response, the Federal Government started negotiating with the union and NERC issued an order on September 28, 2020 to suspend the new tariff for two weeks until October 11, 2020. According to the HP of NERC, NERC issued a Revised MYTO 2020 on October 30, 2020, whereby the tariff raise planned for September 2020 was postponed to December 2020.

The new tariffs for September to December 2021 of MYTO 2020 (for January to June of Revised

MYTO 2020) for Abuja DisCo, Eko DisCo and Port Harcourt DisCo (Eko DisCo is selected as a sample with many commercial and industrial maximum demand customers; Port Harcourt DisCo as the opposite example and Abuja DisCo as the intermediate example) are shown in Table 2-1.12. Since this tariff revision, "Residential", "Commercial", "Industrial" and "Special (for agricultural or social use) tariff classes have been abolished and new tariffs set by "Tariff Band", classified by the average daily service hours. The tariff level of each "Tariff Band" differs widely.

Table 2-1.12 New Tariff from September 2020 of MYTO 2020
(Examples of Abuja DisCo. Eko DisCo, Port Harcourt DisCo)

Tariff Band	Service Hours	New Tariff Class	Old Tariff Class	New Tariff (NGN/kWh)					
				Abuja		Eko		Port Harcourt	
				NGN/kWh	Ratio to C	NGN/kWh	Ratio to C	NGN/kWh	Ratio to C
Lifeline	< 50kWh/month	R1	R1	4.00	-	4.00	-	4.00	-
A	Minimum of 20 hours/day	A-Non-MD	R2, C1, D1, A1	49.75	1.09	54.08	1.26	55.20	1.07
		A-MD1	R3, C2, D2, A2, SL	67.70	1.06	56.94	1.08	54.80	1.11
		A-MD2	R4, C3, D3, A3	67.70	1.06	56.94	1.08	52.20	1.06
		A-Bilateral, A-MD3	Customers on Bilateral Contract	53.05	-	-	-	-	-
B	Minimum of 16 hours/day	B-Non-MD	R2, C1, D1, A1	47.72	1.04	49.81	1.16	54.80	1.06
		B-MD1	R3, C2, D2, A2, SL	64.65	1.02	52.81	1.00	52.20	1.06
		B-MD2	R4, C3, D3, A3	64.65	1.02	52.81	1.00	51.70	1.05
C	Minimum of 12 hours/day	C-Non-MD	R2, C1, D1, A1	45.69	1.00	43.01	1.00	51.70	1.00
		C-MD1	R3, C2, D2, A2, SL	63.63	1.00	52.69	1.00	49.20	1.00
		C-MD2	R4, C3, D3, A3	63.63	1.00	52.69	1.00	49.20	1.00
D	Minimum of 8 hours/day	D-Non-MD	R2, C1, D1, A1	37.8	0.83	40.82	0.95	45.90	0.84
		D-MD1	R3, C2, D2, A2, SL	51.11	0.80	47.77	0.91	48.60	0.93
		D-MD2	R4, C3, D3, A3	51.11	0.80	47.77	0.91	48.60	0.94
E	Minimum of 4 hours/day	E-Non-MD	R2, C1, D1, A1	33.08	0.72	36.15	0.84	43.60	0.84
		E-MD1	R3, C2, D2, A2, SL	50.25	0.79	39.63	0.75	47.60	0.97
		E-MD2	R4, C3, D3, A3	50.25	0.79	39.63	0.75	47.60	0.97

Legend:
Non-Maximum Demand Users (Non-MD) of New Tariff Classification
Maximum Demand Users 1 (MD-1) of New Tariff Classification
Maximum Demand Users 2 (MD-2) of New Tariff Classification

(Note) MD: Maximum Demand User, Source: MYTO 2020

Table 2-1.13 Tariff Classes of Conventional MYTO

Old Tariff Class		Description
1. Residential		A customer using his/her premises exclusively as a residence - house, flat or multi-storied house where people reside.
R1	Lifeline (<50kWh)	
R2SP	Single	
R2TP	3-phase	
R3	LV Maximum Demand	
R4	HV Maximum Demand (11/33kV)	
2. Commercial		A customer using his/her premises for any purpose other than exclusively as a residence or a factory for manufacturing goods.
C1S	Single	
C1T	3 -phase	
C2	LV Maximum Demand	
C3	HV Maximum Demand (11/33kV)	
3. Industrial		A customer using his/her premises for manufacturing goods, including welding and ironmongery.
D1S	Single	
D1T	3 -phase	
D2	LV Maximum Demand	

Old Tariff Class		Description
D3	HV Maximum Demand (11/33kV)	
4. Special		Customers such as agriculture (excluding agro-allied enterprises involving processing) water boards, religious houses, Government, teaching hospitals, Government research institutes and educational establishments.
A1S	Single	
A1T	3 -phase	
A2	LV Maximum Demand	
A3	HV Maximum Demand (11/33kV)	
5. Street Lighting		
S1	Single and 3-phase	

Source: MYTO 2015

Old and new tariffs for customers with 12 - 16 hours of average daily serve (Tariff Band C) are compared in Table 2-1.14. The rate of tariff increase for customers with lower demand is generally higher. The rate of tariff increase for customers in the "Residential" and "Special" old tariff classes is higher compared to that of customers in the "Commercial" and "Special" old tariff classes, since the former customers enjoyed a favorable tariff.

Table 2-1.14 Comparison of New and Old Tariffs (examples of Tariff Band C)

Old Tariff Class	Abuja			Eko			Port Harcourt		
	Old Tariff (NGN/kWh)	New Tariff (NGN/kWh)	Increase Rate	Old Tariff (NGN/kWh)	New Tariff (NGN/kWh)	Increase Rate	Old Tariff (NGN/kWh)	New Tariff (NGN/kWh)	Increase Rate
R1	4.00	4.00	0%	4.00	4.00	0%	4.00	4.00	0%
R2SP	24.30	45.69	88%	24.00	43.01	79%	30.23	51.70	71%
R2TP	24.30	45.69	88%	25.79	43.01	67%	30.23	51.70	71%
R3	47.09	63.63	35%	29.00	52.69	82%	48.39	49.20	2%
R4	47.09	63.63	35%	29.00	52.69	82%	50.76	49.20	-3%
C1SP	37.39	45.69	22%	24.00	43.01	79%	38.96	51.70	33%
C1TP	37.39	45.69	22%	30.00	43.01	43%	38.96	51.70	33%
C2	47.09	63.63	35%	36.00	52.69	46%	46.72	49.20	5%
C3	47.09	63.63	35%	36.00	52.69	46%	48.39	49.20	2%
D1SP	36.07	45.69	27%	24.00	43.01	79%	41.81	51.70	24%
D1TP	36.07	45.69	27%	30.00	43.01	43%	41.81	51.70	24%
D2	47.09	63.63	35%	36.00	52.69	46%	46.72	49.20	5%
D3	47.09	63.63	35%	36.00	52.69	46%	48.39	49.20	2%
A1SP	35.74	45.69	28%	24.00	43.01	79%	40.60	51.70	27%
A1TP	35.74	45.69	28%	24.28	43.01	77%	40.60	51.70	27%
A2	35.74	63.63	78%	24.28	52.69	117%	45.58	49.20	8%
A3	35.74	63.63	78%	24.28	52.69	117%	49.07	49.20	0%
S1	26.84	63.63	137%	23.52	52.69	124%	40.62	49.20	21%

Legend: Non-Maximum Demand Users (Non-MD) of New Tariff Classification
Maximum Demand Users 1 (MD-1) of New Tariff Classification
Maximum Demand Users 2 (MD-2) of New Tariff Classification

Source: MYTO2015 and MYTO 2020

The ratios of old and new tariffs of Eko DisCo and Port Harcourt DisCos to those of Abuja DisCo (in case of Tariff Band C") are shown in Table 2-1.15. For old tariffs, those of Eko DisCo are the lowest, followed by Abuja DisCo and Port Harcourt DisCo. For new tariffs, there is less difference between Eko DisCo and Abuja DisCo. A comparison of the new tariff between Abuja DisCo and Port Harcourt DisCo shows that for small demand customers (Non-Maximum Demand Users), the new tariff of Port Harcourt DisCo is slightly higher and that for large demand customer (Maximum Demand Users 1

and 2), the new tariffs of Abuja DisCo are substantially higher.

Table 2-1.15 Old and New Tariff Comparison between DisCos (Examples of "Tariff Band C")

Old Tariff Class	Abuja		Eko		Port Harcourt	
	Old	New	Old	New	Old	New
R1	1.00	1.00	1.00	1.00	1.00	1.00
R2SP	1.00	1.00	0.99	0.94	1.24	1.13
R2TP	1.00	1.00	1.06	0.94	1.24	1.13
R3	1.00	1.00	0.62	0.83	1.03	0.77
R4	1.00	1.00	0.62	0.83	1.08	0.77
C1SP	1.00	1.00	0.64	0.94	1.04	1.13
C1TP	1.00	1.00	0.80	0.94	1.04	1.13
C2	1.00	1.00	0.76	0.83	0.99	0.77
C3	1.00	1.00	0.76	0.83	1.03	0.77
D1S	1.00	1.00	0.67	0.94	1.16	1.13
D1T	1.00	1.00	0.83	0.94	1.16	1.13
D2	1.00	1.00	0.76	0.83	0.99	0.77
D3	1.00	1.00	0.76	0.83	1.03	0.77
A1S	1.00	1.00	0.67	0.94	1.14	1.13
A1T	1.00	1.00	0.68	0.94	1.14	1.13
A2	1.00	1.00	0.68	0.83	1.28	0.77
A3	1.00	1.00	0.68	0.83	1.37	0.77
S1	1.00	1.00	0.88	0.83	1.51	0.77

Legend: Non-Maximum Demand Users (Non-MD) of New Tariff Classification
Maximum Demand Users 1 (MD-1) of New Tariff Classification
Maximum Demand Users 2 (MD-2) of New Tariff Classification

Source: MYTO2015 and MYTO 2020

The calculation basis and results are shown in Table 2-1.16. From July 2021 onward, the tariffs were expected to fully reflect costs, which would mean any tariff shortfall or necessary subsidy being eliminated. As the inflation rate for the latter half of 2020 increased to near 15% and the exchange rate to the US dollar is forecasted at a constant figure of USD 1=NGN 3983.8, it will not be possible to reflect the costs unless minor reviews corresponding to changes in important parameters can be carried out on a timely basis.

Table 2-1.16 Calculation of New Tariff of MYTO 2020

Parameter	Sep.-Dec. 2020	Jan.-Jun. 2021	Jul.-Dec. 2021	Jan.-Dec. 2022
Common				
Nigerian Inflation	12.82%	12.82%	12.82%	12.82%
Exchange Rate (NGN/USD)	383.8	383.8	383.8	383.8
US Inflation	1.00%	1.00%	1.00%	1.00%
Sent out Generation (MWh/h)	4,646	4,974	4,974	5,325
Weighted Generation Price (N/kWh)	25.6	25.6	25.6	25.6
TCN and Admin Charge (N/kWh)	7.8	8.3	8.3	8.2
Abuja DisCo				
Delivered to AEDC (MWh/h)	460	495	495	532
ATC&C Losses	22.33%	19.89%	19.89%	19.89%
End-use Cost-reflective Tariffs (W/kWh)	57.01	57.16	57.16	57.14
End-use Allowed Tariffs (W/kWh)	50.05	50.05	57.16	57.14
Tariff Shortfall (W/kWh)	6.96	7.11	.-	.-

Parameter	Sep.-Dec. 2020	Jan.-Jun. 2021	Jul.-Dec. 2021	Jan.-Dec. 2022
Eko DisCo				
Delivered to EKDC (MWh/h)	440	473	473	509
ATC&C Losses	11.23%	10.09%	10.09%	10.09%
End-use Cost-reflective Tariffs (W/kWh)	49.62	50.73	50.73	50.89
End-use Allowed Tariffs (W/kWh)	47.90	47.90	50.73	50.89
Tariff Shortfall (W/kWh)	1.72	2.83	.-	.-
Port Harcourt DisCo				
Delivered to PHED (MWh/h)	260	280	280	301
ATC&C Losses	29.70%	23.76%	23.76%	23.76%
End-use Cost-reflective Tariffs (W/kWh)	64.82	61 .91	61.91	61.78
End-use Allowed Tariffs (W/kWh)	50.05	50.05	61.91	61.78
Tariff Shortfall (W/kWh)	14.77	11.86	.-	.-

Source: MYTO2015 and MYTO 2020

Since the Nigerian Naira depreciated sharply, the Survey Team asked NERC whether it had approved a Minor Review of MYTO 2020 or not in the first study period in Nigeria. According to NERC, there were Minor Reviews of MYTO 2020 in December 2020 and in August 2021. As the orders of the two Minor Reviews are yet to be provided, the Survey Team remains unaware whether a tariff reflecting costs has been attained to date (October 2021).

(4) Meter Asset Provider (MAP) Regulations

1) MAP Regulations 2008

The Meter Asset Provider (MAP) Regulations 2018 were promulgated on March 8, 2018 and came into force on April 3, 2018. NERC also promulgated the "Order on the Implementation of the Meter Asset Provider Scheme in the Nigerian Electricity Supply Industry" on August 30, 2019, which stipulates the rules required to enforce MAP Regulations 2018.

Objectives: The following are the main objectives in enacting and implementing Meter Asset Provider (MAP) Regulations 2018:

i) Encourage the development of independent and competitive meter services
ii) Eliminate estimated billing practices
iii) Attract private investment to provide metering services
iv) Close the metering gap by accelerating the meter roll-out
v) Enhance revenue assurance

Obligation to Install and Monitor Meters:

* The Distribution Licensee is obligated to ensure MAPs install and monitor meters (eligible customers can have MAP do it themselves).

Application for Obtaining Permission to Install and Monitor Meters:

* Those wishing to conduct meter installation/monitoring activities must submit the following documents to NERC:

i) Application form (completed)
ii) Certificate of incorporation and memorandum and articles of association

iii) Tax clearance certificates
iv) Certified audited financial statements for three consecutive years prior to that in which the application is made
v) Detailed resumes of Applicant's Board of Directors, management and technical staff
vi) A ten-year business plan
vii) Relevant applicant experience in asset finance, metering and other related business

Technology Requirements for MAPs:

* MAPs must deploy technology and back-office systems capable of maintaining and retrieving records of financial, inventory and customer data and monitoring usage of the deployed infrastructure on an online real time basis
* All technology systems deployed by MAPs must be capable of directly interfacing into the vending platforms of Distribution Licensees. Evidence of this must be submitted to NERC at the time of application

Procurement Process of MAP and Grant of Permits:

a) The procurement procedure comprises the following steps: 1) Request for submission of proposals, 2) Request for statement of interest, 3) Preparation and distribution of bidding documents, 4) Bid evaluation and contractor selection and 5) Obtaining Permission from NERC.
b) Distribution Licensees must enter into the first meter service contract within 120 days of April 3, 2018. Subsequent procurement contracts must be completed within 120 days from the commencement of the procurement.
c) Applicants wishing to participate in the meter installation and monitoring certification service must apply to NERC and obtain a "No Objection" to perform the meter installation and monitoring.
d) NERC monitors the progress and results of the bidding process for meter procurement by distribution companies.
e) The recipient of the meter procurement bid must apply to NERC for permission to provide meter installation and monitoring services, which NERC shall approve, subject to criteria and conditions.
f) Upon NERC's approval, the Distribution Licensee shall enter into a Metering Service Agreement with the licensee to provide meter installation and monitoring services.
g) A publication shall be placed by the Distribution Licensee in at least two national newspapers providing information about the successful applicant, the monthly metering service charge and a detailed roll-out plan.
h) The license to provide meter installation and monitoring services is valid for a period of 15 years.

Domestic Procurement Rate of Meters:

* In accordance with Nigerian domestic procurement rules, at least 30% of meters used by meter installation and monitoring companies must be manufactured by a Local Meter

Manufacturer/Assembler (LMMA).

Rights of the Distribution Licensees:

i) Pursuant to the provisions of the Metering Code, Meter Reading, Billing and Collection Regulations, the Distribution Licensee shall have access to customer meters installed by the MAP.
ii) Right to use data from customer meters for monitoring, billing planning and any other related activities.
iii) Right to query data from customer meters for audit purposes and evaluating consistency, accuracy and integrity.
iv) Distribution Licensees must treat cases of unauthorized access and meter tampering in accordance with existing laws and regulations.
v) Distribution Licensees must clearly show metering service charges in customer billing. Metering service charges are determined based on the service procurement process and NERC approval.

Obligations of the Distribution Licensee:

i) Have meters installed in a manner that will achieve the plan established by NERC.
ii) Plan and execute a transparent and competitive procurement process for meter installation and monitoring services.
iii) Establish a secure payment system for MAPs.
iv) Provide relevant information to MAPs in a timely manner to enable them to meet their contractual obligations.
v) Pay service charges to MAPs for meter installation and monitoring services.
vi) Pay applicable metering service charges for customers affected by a prolonged service outage exceeding two weeks.
vii) Ensure that metering service charges collected from customers are ring-fenced in a dedicated account for payment to MAPs.

Rights of the MAPs:

i) Legal ownership of the meter asset until fully amortized through payment of a metering service charge by beneficiary customers.
ii) Right to have the metering service charge paid by customers payable in full.
iii) MAPs can access customer premises to facilitate meter installation and monitoring in compliance with the Metering Code, Meter Reading, Billing and Collection Regulations and any other applicable NERC regulation.
iv) MAPs are granted access to viewing rights to the vending platform associated with meter installation and monitoring.

Obligations of the MAP to the Distribution Licensee:

i) Conformity with all meter specifications and installation standards.
ii) Obtain all necessary certifications and approvals for meters required by regulations and industry.

iii) Engage only certified meter installation and measurement service providers.

Obligations of the MAPs to Customers:

i) Periodically inspect meters to ensure integrity and reading accuracy. Where required, MAPs must arrange for meters to be tested and calibrated in line with the provisions of the Metering Code.
ii) Repair or replace faulty meters within two days of being notified of such faults.
iii) Where a MAP fails to repair or replace a meter within two days of a report by the customer or Distribution Licensee, the customer shall not be liable for payment of the metering service charge for the billing period unless such delays were attributable to inability to access the customer's premises.
iv) If a defective meter cannot be repaired or replaced within two days, the Distribution Licensee and MAP shall agree on an appropriate compensation to the Distribution Licensee for loss of revenue.
v) MAP shall render services to its customers according to the service standards set out in a Service Level Agreement (SLA) with the Distribution Licensee.

MAP Key Performance Indicators (KPIs):

i) A Service Level Agreement shall be executed between the MAP and Distribution Licensee to provide for Key Performance Indicators (KPIs) for the MAP.
ii) The scope and responsibility for meter maintenance activities must be as agreed between the parties under the Metering Service Agreement (MSA)/Service Level Agreement (SLA).
iii) The KPIs agreed between the parties to the SLA shall be filed with NERC. The provisions for the meter reading, billing and collections and the Metering Code shall be the basis for benchmarking.

Rights of the Customer:

i) Customers can have their meter repaired or replaced within two days at no additional cost, unless intentionally damaged by the customer. If there is a dispute over who is responsible for damage of the meter, the customer has a right to fair resolution in line with the Metering Code and other applicable regulations. MAP must provide a meter pending resolution of the dispute.
ii) If it is established that the customer willfully damaged the meter, the MAP shall replace the meter based on an upfront payment by the customer or other mutually agreed terms of payment.
iii) If the MAP is unable to provide a replacement meter within a billing period, an average of the last three months' billing/vending shall be applied to determine the customer's energy consumption.
iv) If a customer relocates within the franchise area, the customer shall apply to the Distribution Licensee to transfer services, including applicable credits for energy.

Obligations of the Customer:

i) Customers must provide access to their premises to the Distribution Licensee/MAP to install the meter. If the customer disallows entry, the distribution company shall deny the power supply service.

ii) The customer must ensure that meters are secure and shall not tamper with or remove them.

iii) Upon the installation of a meter by a MAP, the Customer has an obligation to pay metering service charges. The customer has an obligation to pay for metering service charges through the Distribution Licensee at the time of payment for energy unless financed upfront in full by the customer. Metering service charges will be made over the life of the meter until fully amortized (except for lump-sum prepayment).

iv) If a customer fails to pay for metering service charge in any given month or months, the metering service charge will be deferred and continue until the cumulative payment is zero.

v) Customer meters are associated with feeders and distribution transformers and must not be moved by customers.

Customer Financing of Meters:

i) If a customer elects to pay for a meter upfront, they shall not be liable to pay subsequent metering service charges.

ii) The metering service charges paid by the customer are determined in the process of procuring meter installation and monitoring services by the Distribution Licensee. The "Order on the Implementation of the Meter Asset Provider Scheme in the Nigerian Electricity Supply Industry" stipulates the following: (1) cost for lump-sum prepayment of NGN36,991.50 for single-phase/NGN67,055.85 for 3-phase meters (excluding VAT), (2) installment payments limited to 120 installments (months) and (3) if paying installments, an interest rate of 21% per year (since VAT in Nigeria is 7.5%, a single-phase meter over 120 months of equal payments would be NGN748/month (at the exchange rate of NGN1=JPY0.263, the cost is 197 yen/month).

iii) MAPs must install the meter at the premises of the Customer within ten working days of receipt of full payment by the Customer. Authorization by the Distribution Licensee to pay for the meter will only be issued after certifying the readiness of the premises for the safe and secure installation of the meter.

Agreement for Meter Installation and Monitoring Services by the MAP:

***** MAP meter installation and monitoring services are based on the following two agreements with Distribution Licensees:

- In the MSA, the parties agree on: (a) the number of meters to be installed by the MAP in the Distribution Licensee's network over an agreed period, (b) Recovery of the cost of meters plus a reasonable return over a decade, (c) an acceptable form of securitization of the metering service charge and timely payments to the MAP, (d) Indexation provision over the MSA tenure to address variability in applicable macro-economic indices, (e) Meter specifications and (f) Any other provisions agreed by the parties.
- Service Level Agreements (SLA) specifying the following standards and responsibilities: (i) Timeframe for meter installation, (ii) Minimum installation standards, (iii) Maintenance, (iv) Periodic meter reading, (v) Meter replacements, (vi) Protection against unauthorized access/tampering, (vii) Key Performance Indicators, (viii) Data management and exchange

of information, (ix) Compensation for meter bypass and tampering by agents of the MAP and (x) Any other service standard.

Insurance and Disaster Recovery Plans:

* The MAP must insure the meter assets and secure all metering equipment.

Cost Structure:

* The cost structure of the Metering Service Charge covers the cost of providing the meter asset and the ongoing costs of operating and maintaining the same. The cost structure provides a transparent way of billing metering costs so that customers only pay for their own metering services.

Reliable Payment of Metering Service Charges:

* Distribution Licensees must issue a payment security in the following format within 30 days of an MSA commencing:
- An irrevocable direct pay Letter of Credit or other forms of security executable on demand in favor of the MAP and issued by a bank and in a form acceptable to the MAP.
- A support system mutually agreed between the parties, under which all payments for metering services by customers at the time of vending are ring-fenced to a dedicated account established to secure payment to the MAP.
- A securitization framework that may be developed in collaboration with financial institutions (such as Development Finance Institutions, Bank of Industry, Development Bank of Nigeria Plc, the Infrastructure Bank, etc.) or the Central Bank of Nigeria.
- Any other payment security structure as may be agreed between the parties.
* Distribution Licensees may create a variance account to equalize payments to MAPs arising from bulk or irregular purchase of energy credits by customers.

2) MAP and National Mass Metering Regulations 2021

The MAP and National Mass Metering Regulations 2021 were established and came into effect as of August 9, 2021 to amend the MAP Regulations 2008 and promote National Mass Metering Programme (NMMP). MAP and National Mass Metering Regulations 2021 provide standard rules for implementing NMMP, which are formulated and being implemented by the Federal Government in cooperation with the Central Bank, considering the lack of progress in metering customers under MAP Regulations 2008. According to a staff of the World Bank in charge of the Distribution Sector Recovery Program (DISREP), lending by the Federal Government/Central Bank will amount to around USD 400 million. With USD 120 million to be lent through DISREP, loan programs totaling over USD 500 million will be implemented to provide meters to most unmetered customers, the number of which is estimated at over 6 million.

Profile of NMMP:

* Considering that only 583,733 customer meters were installed from August 1, 2019 to June 30, 2021, 571,835 of which from upfront payments, under MAP Regulations 2008, the

Federal Government - in cooperation with the Central Bank - commenced a low-interest loan program to Distribution Licensees, the lack of funding of which is considered as a main reason of the wide metering gap, with single digit interest and 10-year repayment to close metering gap at customer level.

* To prepare MAP and National Mass Metering Regulations 2021, NERC held stakeholder consultation meetings, which concluded i) the urgency of accelerating the meter roll-out, ii) upholding the sanctity of existing contracts with MAPs and iii) promotion of private sector investment in metering services are imperatives to develop the power sector sustainably.

Permission for the Metering Service Providers (MSP):

* Local Meter Manufacturers/Assemblers (LMMAs) can serve as MSPs with the following conditions of eligibility:
    a) Provide confirmation that their local value addition is not less than the assembly of six (6) meter components at factory level
    b) Distribution Licensee's confirmation that the meters supplied by the LMMA have fully met the standards in terms of reliability and quality.
    c) Evidence of sufficient working capital (including stock of materials and/or work in progress} to manufacture a minimum of 100,000 meters annually.
    d) Evidence of partnership with a Metering Service Provider or MAP to implement the meter installation obligations of the LMMA's contractual arrangements with Distribution Licensees
* To obtain certification as MSP, LMMA should comply with provisions in the "Guidelines for Certification for Metering Service Providers and related Matters 2013" or any other regulatory instruments as determined by the Commission.

Meter Procurement Process in the NMMP:

* Procurement processes in NMMP shall be open and competitive in compliance with the principles of prudence in EPSRA.
* The total quantities to be procured by Distribution Licensees shall be bundled in lots based on the specifications of meters provided by Distribution Licensees verified manufacturing capacity and the roll-out targets approved by NERC.
* The criteria for eligibility to participate in the bid process shall be restricted to local meter manufacturers in compliance with the Federal Government's policy directive.
* NERC shall appoint an independent verification agent to review and validate the manufacturing capacity of all eligible LMMAs.
* There shall be a central Project Implementation Unit (PIU) to oversee the procurement process for NMMP.
* The evaluation criteria to determine the regulated cost of meters under NMMP shall be based on a combined scoring of the unit cost of meters, track record of delivered quantities by the LMMA over the last three years to Distribution Licensees, verified manufacturing capacity

and responsiveness to the Distribution Licensee's technical specifications. The cost of meters determined by the outcome of the NMMP procurement process shall be the basis of contracting with all LMMAs.

* NERC shall issue an order reviewing the cost of meters (including installation) under the MAP scheme. The reviewed costs specified in the Order shall form the basis of contracting to supply and install MAPs.
* All bids to supply meters by LMMAs under NMMP shall be supported by bid bonds as determined by the PIU.
* The determination of contract volumes with LMMAs shall be mutually agreed between the LMMAs and Distribution Licensees in accordance with the verified manufacturing capacity of LMMA. All Meter Purchase Agreements executed by Distribution Licensees and LMMAs shall be filed with NERC.
* All contracts to supply meters under NMMP shall be backed by performance bonds.

Technical Requirement for the NMMA:

* Distribution Licensees, LMMAs and MAPs shall comply with the Metering Code, the Guidelines for Certification of Metering Service Provider and other applicable regulatory instruments of the Commission.
* All technology systems deployed in accordance with these Regulations shall be compatible with the Distribution Licensee's metering infrastructure and evidence of applicable certification shall be provided along with applications filed at NERC.

Local Content:

* All meters procured under the NMMP shall comply with the requirement for 100% local manufacture and/or assembly. All MAPs shall comply with a minimum of 30% local content threshold as measured by the quantity of meters installed to consumers. NERC may amend the minimum local content thresholds in accordance with the provisions of the "NERC Regulations on National Content Development for the Power Sector" or any other regulatory instrument.

Rights of the Distribution Licensee:

* All meters supplied by LMMAs and MAPs shall form part of the Distribution Licensee's assets and the Distribution Licensee has all rights and privileges for the use of the meters.

Obligations of the Distribution Licensee:

* Provision of meter deployment plans, along with details of the customers to be metered, in compliance with NERC's metering targets.
* Execution of Metering Service Agreements and Meter Procurement Agreements with successful MAPs and LMMAs respectively to supply and install meters.
* Timely provision of relevant information to MAPs, to enable them to meet their obligations in the MSA.
* Periodic inspection of meters to ensure integrity and reading accuracy.

* Repair and replacement of faulty meters in compliance with the Metering Code and other NERC regulatory instruments.
* Billing of customers strictly based on their consumption pattern in the last billing cycle or the existing energy cap of the load cluster, whichever is lower on account of the Distribution Licensee's failure to repair or replace a meter within two working days of receiving the customer's complaint.
* Confirmation of the readiness of the customer's premises for metering within 10 days of the application for a MAP meter by the Customer.
* Ensuring installation of a meter within 10 days of being notified of the MAP's failure where a MAP fails to meter a customer.
* Execution of Meter Procurement Agreements with successful LMMAs.
* Refund of the cost of meters to customers who make upfront payments for meters through approved MAPs and in compliance with the provisions of these Regulations.
* Refund to customers of the cumulative Meter Service Charge (MSC) payments made to MAPs in compliance with the provisions of these Regulations.
* Payment of the unamortized cost of meters to MAPs supplied to customers under the MSC framework.

Rights of the MAP:

* A timely payment in full for services rendered in accordance with the terms of the MSA with the Distribution Licensee.
* Access to customer premises to carry out its operations with respect to metering.

Obligations of the MAP:

* Installation of meters and metering accessories in compliance with the Distribution Licensee's specifications, industry standards and codes for meter installation.
* Obtaining the requisite test certifications and approvals for meters in compliance with extant codes, regulations and industry requirements.
* Engaging only certified MSP (Installers) to deploy meters while fulfilling its obligations under the MSA.
* Compliance with the provisions of the Metering Code by ensuring that all meters are tested and calibrated by the Nigerian Electricity Management Services Agency (NEMSA) prior to customer installations.
* Compliance with agreed service standards in MSAs with Distribution Licensees.
* Installation of meters at customer premises within ten days of being notified of payment and the Distribution Licensee's confirmation that the premises are ready for metering.

Rights of the Customer:

* Installation of an appropriate meter to determine energy consumption accurately and provide for energy accounting.
* Refund of the cost of the meter through energy credits by the Distribution Licensee, where a

customer elects to pay upfront for meters under these Regulations. A reimbursement schedule to be approved by the Commission, commensurate with the financial standing of the Distribution Licensee. This provision also to be applied to upfront payments already made by customers once the MAP framework starts in 2018.

* Refund of the cumulative amount paid through energy credits, where a customer has made monthly payments under MSC.
* Repair or replacement of faulty meters by Distribution Licensees within two (2) days in accordance with the provisions of the Metering Code at no additional cost to the customer. Replacement of the meter by the Distribution Licensee based on an upfront payment by the customer or other mutually agreed terms of payment, where it is established that the customer willfully damaged a meter.
* Entitlement to a fair resolution of the dispute in compliance with the Metering Code and other regulatory instruments of NERC and replacement of the meter by the Distribution Licensee pending the resolution of the dispute, where dispute arise on responsibility for destruction of a meter.
* The Customer and representative of Distribution Licensee's shall jointly note the energy credits remaining on meters being replaced and the customer shall be credited with the outstanding energy credits on replacement meters within 48 hours of installation.

Obligations of the Customer:

* Granting access to their premises to inspect and install meters in accordance with the installation requirements of the Distribution Licensee. Any customer that denies access to premises for the purposes of inspecting and installing meters shall be disconnected from supply and denied service by the Distribution Licensee until access is granted to the premises.
* Ensuring the safety of the meter by not tampering with it and also ensuring that unauthorized persons are not granted access to the meter.

Rights and Obligations of LMMA:

* The rights and obligations of LMMA shall be as provided in the terms of their contracts with Distribution Licensees.
* LMMAs shall be required to submit monthly returns with NERC on performance under their contracts with Distribution Licensees and transactions with MAPs, including pricing, volumes and pending deliveries.

Reporting Obligations:

* Distribution Licensees, MAPs and LMMAs shall be required to file detailed meter deployment plan, monthly meter production, sales, deployment and/or installation, or any other returns with NERC.

Metering Service Agreement:

* MSAs executed between Distribution Licensees and MAPs shall provide for a) number of meters to be installed by the MAP in the Distribution, Licensee's network over an agreed

period, b) details of the cost structure, c) payment terms, d) meter specifications, e) warranties, f) other terms agreed by the parties.

Meter Purchase Agreement:

* MPAs executed between Distribution Licensees and LMMAs shall provide for a) quantity of meters to be supplied by the LMMA, b) delivery period, c) cost structure, d) payment terms, e) meter specifications, f) warranties, g) other terms agreed by the parties. **Service Level Agreements:**
  * SLAs executed between Distribution Licensees and LMMAs or MAPs shall specify the minimum standards and responsibilities on a) timeframe for meter installation, b) minimum installation standards, c) protection against unauthorized access/tampering, d) key performance indicators, e) compensation for meter bypass and tampering by agents of LMMA and MAP.

Vendor Finance:

* Where a Distribution Licensee and LMMA or MAP mutually agree on a deferred payment arrangement, the base cost of meters shall not exceed the regulated price approved by NERC. Where the cost of financing exceeds the rate granted by the CBN under NMMP, the approval of NERC shall be obtained prior to executing the MPA.

Meter Financing by Distribution Licensees:

* Where Distribution Licensees directly procure meters from other sources outside the MAP and NMMP framework:
  a) The basis for the additional meter financing option and associated terms and conditions shall be subject to NERC's approval.
  b) The allowable costs of meters, accessories, installation and warranties shall not exceed the regulated pricing approved by NERC.
  c) The terms of supply shall not be in conflict and/or competition with the terms of existing MAP and NMMP contracts.

Modification of MAP Regulations:

* Distribution Licensees are continuously obligated to comply with NERC's metering targets utilizing financial sources, as well as the conventional sources of a) MAP financing and b) own funds, c) loans to be provided by the NMMP framework, d) Vendor Finance and e) other efficient external financing for meters.
* The contractual scope, along with the associated meter costs under the MAP framework, shall be extended once the NMMP procurement process is completed to include a network clean up in readiness for metering. This scope extension, however, shall not include the supply of connection cables and associated accessories.
* Distribution Licensees may reassign an MAP's allocated metering volumes to the NMMP option or any other preferred metering framework.

* Distribution Licensees will be able to appoint LMMA as MAP where eligible on completion of NMMP, while the appointment is prohibited during implementation of NMMP.

3) Numbers of Companies Registered as MSP and MAP

The updated list of MSP Licensees as of June 18, 2021 is shown on the NERC homepage. The number of companies certified as NSP by NERC is 98, of which 15 are meter manufacturers, 23 are meter vendors and 58 are corporate meter installers. NERC's homepage also shows a list (although undated, it is presumably the most recent) of companies having obtained a Non-Objection Certificate (NOC, when a company that has NOC concludes a contract with a Distribution Licensee as MAP, NERC does not raise any objection against the contract). There are 35 companies listed, eleven (11) of which have certificates as NSPs.

2-2 Organization and function of the Power Sector

(1) Organization of the Power Sector

The Federal Ministry of Power (FMP) and its subordinate agencies comprise most of the power sector organizations. FMP and its affiliated agencies are listed in Table 2-2.1 below.

Table 2-2.1 FMP and its Subordinate Agencies

Organizations	Main Roles and Responsibilities
Federal Ministry of Power (FMP)	FMP oversees the formulation, implementation supervision and coordination of the power sector policies and programs.
National Electricity Regulatory Commission (NERC)	NERC is the regulatory agency for the power sector. The entire power sector, including power generation, transmission, distribution and bulk traders, are under the jurisdiction of NERC. NERC is also is responsible for licensing power sector operators.
Transmission Company of Nigeria (TCN)	TCN is the state-run transmission company. It comprises the following three operating divisions and administrative divisions.
Transmission Service Provider (TSP)	TSP is responsible for managing the assets regarding transmission networks, formulating construction and operation plans for transmission networks and carrying out construction projects.
System Operator (SO)	SO oversees i) dispatching generating units; ii) handling power system emergencies and restoring the system, coordinating generation and transmission outages, reporting scheduled and planned actions and unexpected occurrences to users and the regulator; iii) performing demand forecasting; iv) supervising compliance with and enforcing the Grid Code, testing and monitoring users' equipment; and v) conducting system tests pertaining to the network, etc.
Market Operator (MO)	MO is charged i) electricity metering at receiving points from generators and transmitting points to distribution companies (DisCos), settlement of electricity volumes and ii) collection of service charges related to the power system operation, payments to service providers, etc.
Nigerian Bulk Electricity Trading Plc. (NBET)	NBET is the bulk trader of electricity. It purchases power from generation companies (GenCos), including independent power producers (IPPs) and sells it to DisCos.
Nigeria Electricity Liability Management Ltd. (NELMCO)	NELMCO has the mandate to assume and manage pension liabilities of PHCN employees, which has taken them from its predecessor company and to hold the non-core assets of PHCN and sell or dispose of them or deal with them in any manner for the purpose of financing the repayment of pension liabilities.
Niger Delta Power Holding Company (NDPHC)	NDPHC is the implementing agency of NIPP. NDPHC holds and manages the assets developed by NIPP.
Rural Electrification Agency (REA)	REA the implementing agency for rural electrification promotion.
National Power Training Institute of Nigeria (NAPTIN)	NAPTIN is the organization with a mandate to train staff in the power sector. At present, a scheme to provide apprenticeship craft training on electrical techniques to the unemployed, namely, the National Power Sector Apprenticeship Scheme (NAPSAS), is managed by NAPTIN.
Nigeria Electricity Management Services (NEMSA)	NEMSA is the organization with a mandate to provide technical support and inspect the facilities of electricity service operators.

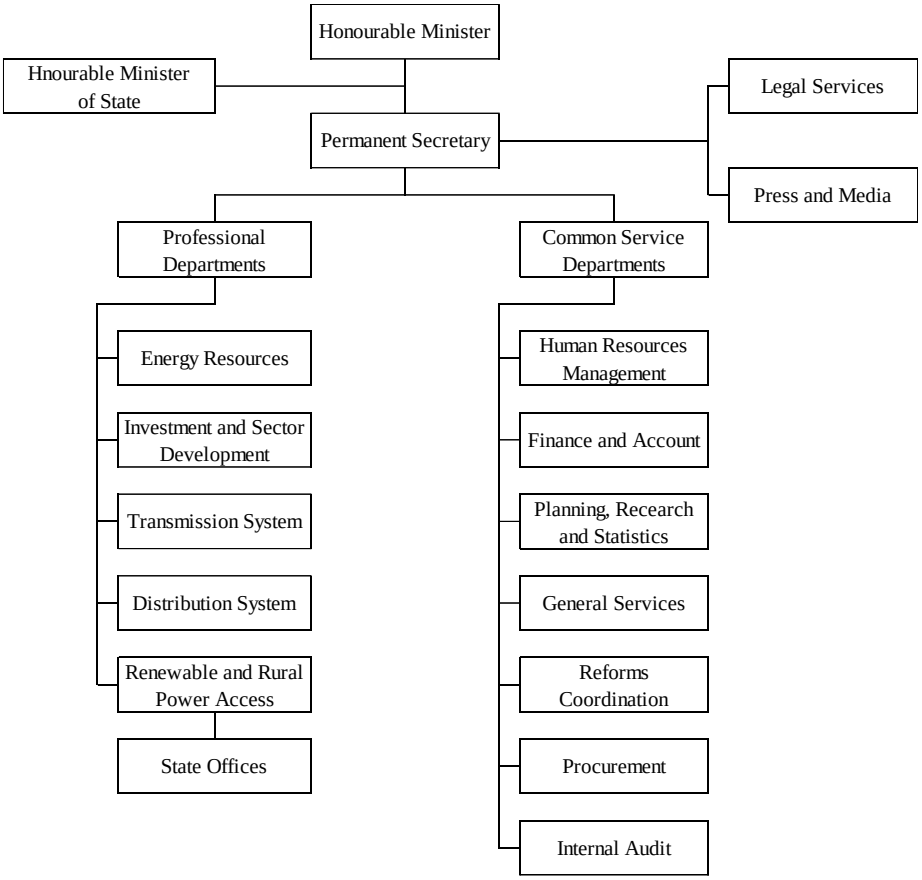
Source: prepared by the JICA Survey Team based on information from the websites of the above agencies

(2) Outline of FMP

According to the description of Section 13 of the Constitution of the Federal Republic of Nigeria (1999, 2011 as amended), FMP oversees and monitors the generation, transmission and distribution of electric power in a supervisory role. FMP also formulates and implements policies of the Federal Government of Nigeria to develop and streamline the Nigerian Electricity Supply Industry (NESI).

As shown in Figure 2-2.1, FMP comprises the Honorable Minister, Honorable Minister of State,

Permanent Secretary, five professional departments (energy resources, investment and sector development, transmission system, distribution system and renewable and rural power access), seven common services departments such as human resources management, finance and account and legal services and press and media which are directly under the Permanent Secretary.



Source: Prepared by the JICA Survey Team based on the information from FMP

Figure 2-2.1 Organizational structure of FMP

(3) Overview of NERC

Established in 2005 under Part III (Sections 31-61) of the Electric Power Sector Reform Act (2004), NERC (the Nigeria Electricity Regulatory Commission) is the body regulating Nigeria's electricity sector. It has the following objectives:

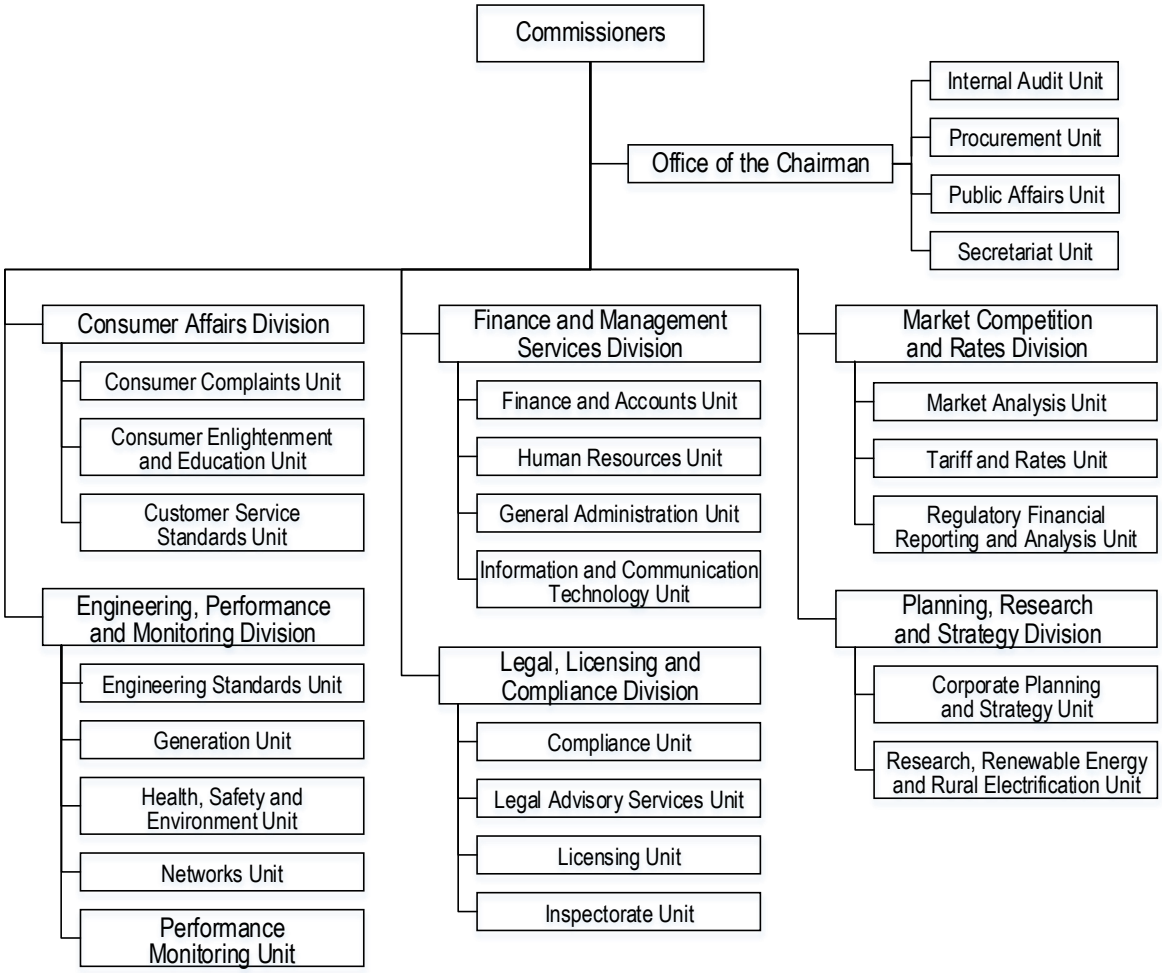
i) Realize an efficient power sector that optimally uses resources
ii) Maximize access to electricity services in both urban and rural areas
iii) Ensure that adequate electricity is provided to consumers
iv) Ensure that the prices charged are fair to consumers and suffice to allow the licensees to finance their activities and allow reasonable earnings
v) Ensure the safety, security, reliability and quality of service in the production and delivery of electricity to consumers
vi) Ensure that regulation for both licensees and consumers is fair and balanced

vii) Present quarterly reports to the President and National Assembly

To achieve the above goals, NERC is expected to perform the following functions:

i) Promote competition and private sector participation
ii) Establish and approve appropriate operating codes and safety, security, reliability and quality standards
iii) Establish appropriate consumer rights and obligations regarding the provision and use of electric services
iv) License and regulate businesses engaged in the generation, transmission, system operation and trading of electricity
v) Approve and revise market rules
vi) Monitor transactions in the electricity market
vii) Carry out other matters necessary to achieve the objectives

NERC is led by seven full-time commissioners who are appointed by the President and confirmed by the Senate. Commissioners appoint qualified individuals with expertise relevant to NERC's jurisdiction in both public and private sectors, namely, generation, transmission, system operations and trading of electricity, as well as legal, accounting, economic, financial and administrative matters. NERC is also expected to have one person from each of the five geo-political regions appointed, but the Chairperson can be from any region. NERC comprises six Divisions, each of which is led by a Commissioner.



Source: NERC

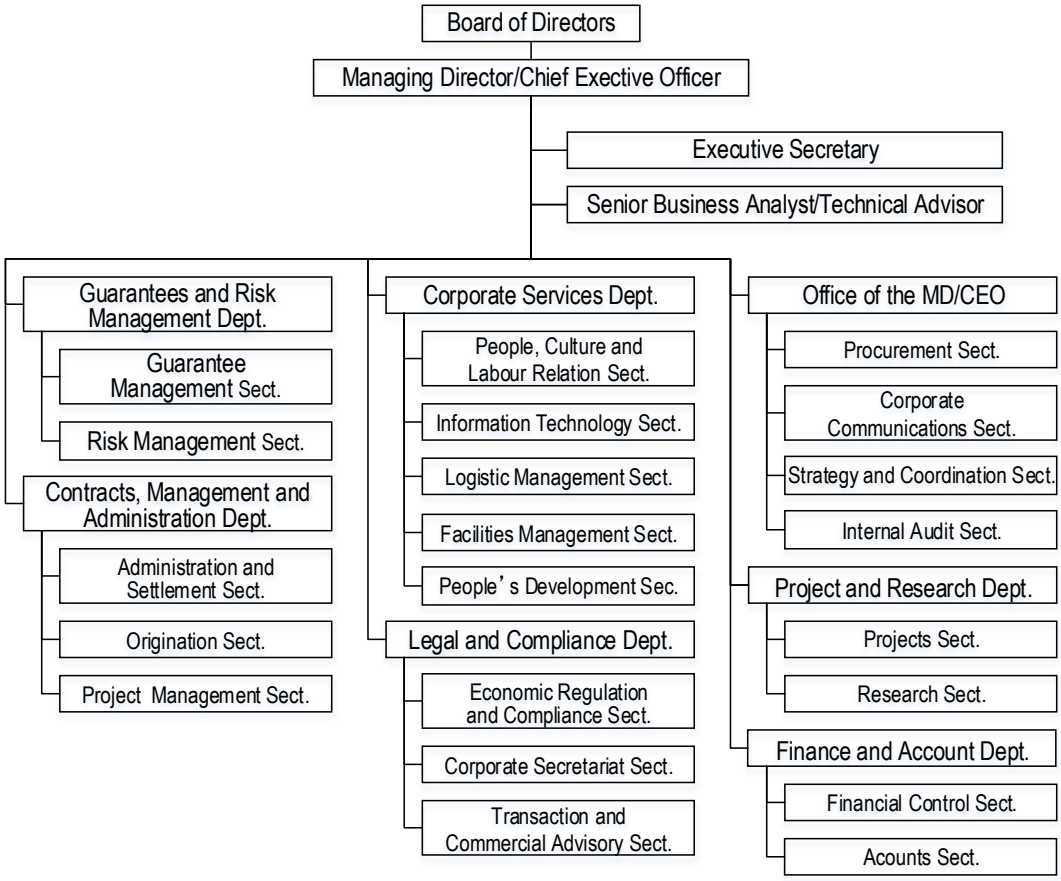
Figure 2-2.2 NERC Organization Chart

(4) Overview of Nigeria Bulk (NBET)

Nigeria Bulk Electricity Trading Plc (NBET) is a 100% federally owned company that was established in July 2010 to manage the electricity pool. The purpose of establishing NBET was to realize power market pricing through transparent, effective and efficient mediation, guarantee payment to investors in the power sector and develop a financially-sustainable power market.

Its Board of Directors is chaired by the Minister of Finance, Budget and National Planning. Its members include the President of the Bureau of Public Enterprises (BPE), Directors of the Budget Office and General Debt Management Office and a representative from the Ministry of Power.

NBET comprises seven bureaus and 21 divisions.



Source: NBET

Figure 2-2.3 NBET Organization Chart

(5) Outline of GenCos

Privatized generation companies in Nigeria (GenCos) are categorized as (1) former NEPA thermal power plants, whose shares are sold privately after the unbundling of PHCN (Afam Power Plc, Geregu Power Plc, Sapele Power Plc, Ughelli Power Plc, etc.), (2) former NEPA hydropower plants, whose assets are still government-owned but their concession for operation and maintenance is transferred to private companies after the unbundling of PHCN (Kainji Hydro Power Plc, Shiroro Hydro Power Plc, etc.), (3) thermal power plants constructed by NIPP (National Integrated Power Project) and owned and operated by NDPHC (Niger Delta Power Holding Company), (4) IPP (Independent Power Producer） power plants constructed and operated by private companies. Table 2-2.2 shows the list of existing thermal and hydro power plants.

Table 2-2.2 Existing thermal and hydro power plants

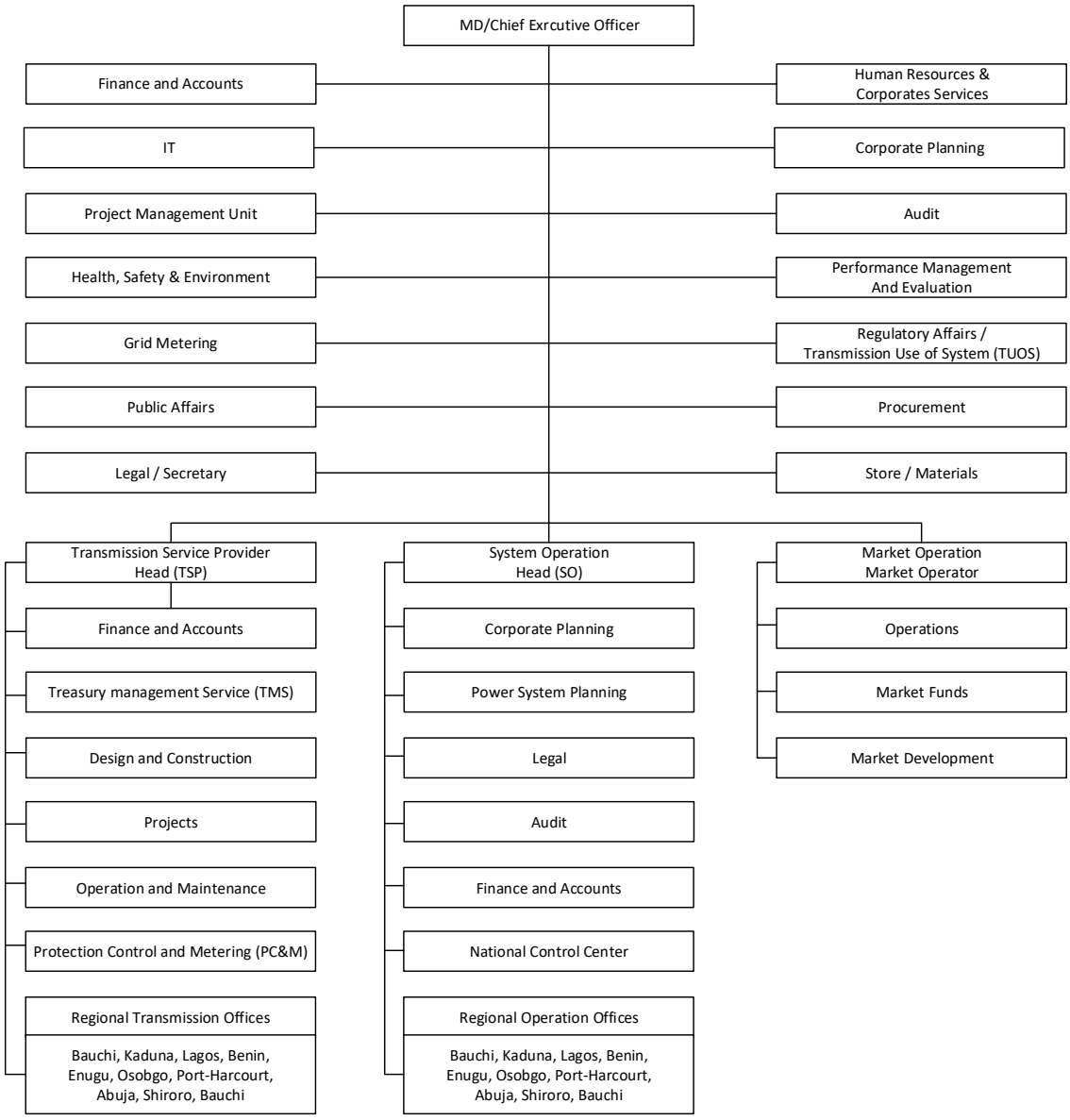
Category	Power Plant	Installed Capacity (MW)	Available Capacity (MW)	Availability Factor (%)
FGN Successor Companies (Privatized Hydro Station)	Kainji	760	320	42
	Jebba	578	441	76
	Shiroro	600	448	75
	Subtotal	1,938	1,209	62
Total (Hydro)		**1,938**	**1,209**	**62**
FGN Successor Companies (Privatized 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
	Subtotal	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
	Subtotal	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
	Ibom (GT)	155	111	72
	Afam VI (GT)	650	533	82
	Paras (GT)	58	36	61
	AES (GT)	294	0	0
	Subtotal	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

(6) Overview of TCN

The Power Holding Company of Nigeria (PHCN) was established in May 2005 to take over the assets, rights and obligations, employees, etc., of the National Electric Power Authority (NEPA) under the Electric Power Sector Reform Act (EPSRA) of 2005. Subsequently, to attract private capital, the businesses under PHCN were unbundled into 11 power generation companies (GenCos), 11 distribution companies (DisCos) and one transmission company (TCN). Of these, the GenCos and DisCos were privatized by selling from 51 to 100% of their shares to the private sector. Meanwhile, TCN is a public corporation, of which 100% of shares are government-owned.

TCN has over 3,500 employees and is organized into three divisions: a Transmission Service Provider (TSP), System Operator (SO) and Market Operator (MO). Figure 2-2.4 shows the organizational chart for TCN.

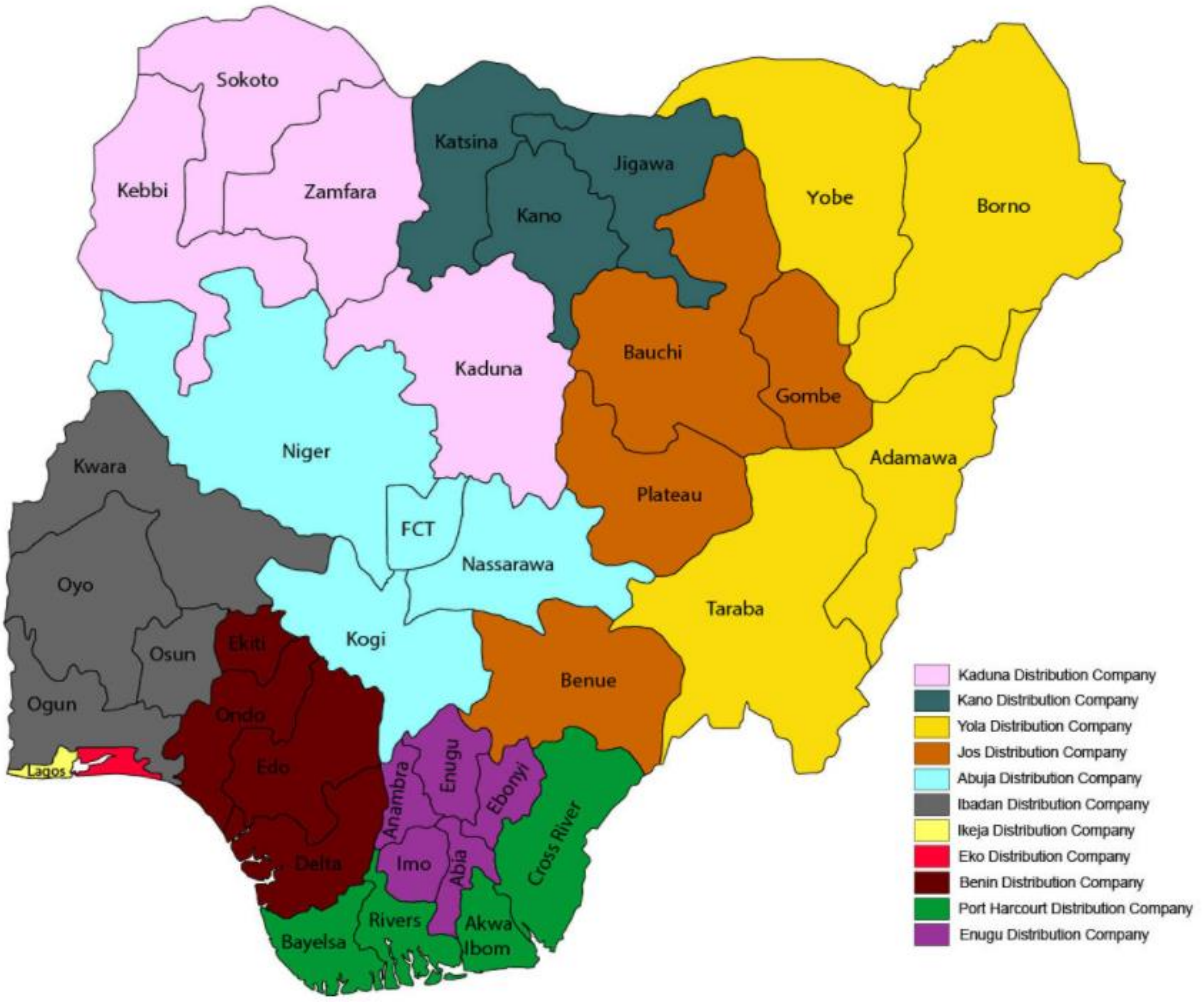


Source: TCN (as of August 2017)

Figure 2-2.4 TCN Organization Chart

(7) Overview of DisCo

Currently, Nigeria is in the Transitional Electricity Market (TEM) stage until a free competitive market is established. NBET purchases electricity from GenCos, DisCos purchase electricity from GenCos and they distribute power to consumers. As shown in Figure 2-2.5, 11 DisCos are currently distributing electricity throughout Nigeria.



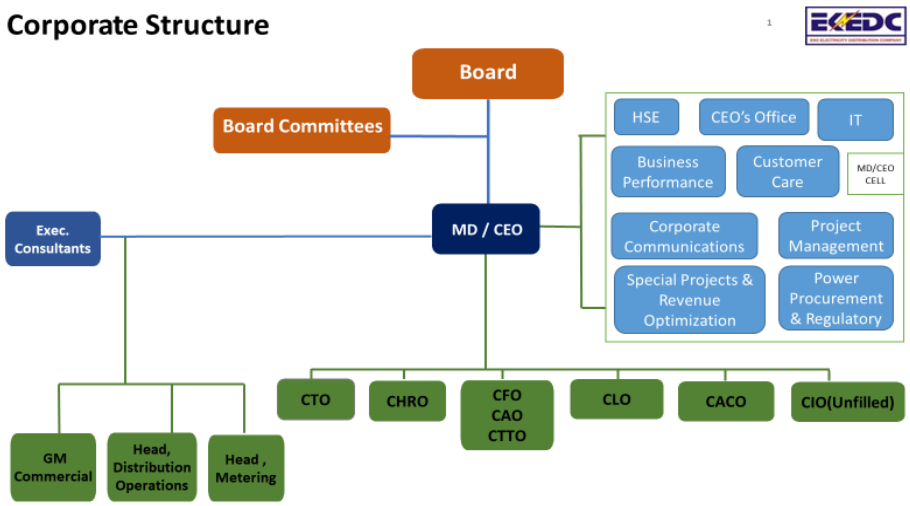
Source: (created by the Survey Team from DisCo web page information)

Figure 2-2.5 DisCos in Nigeria

The following is information on Eko Distribution Company, a DisCo serving Lagos State.

1) Overview of Eko Distribution Company

As shown in Figure 2-2.6, the company is structured with the CEO as chief executive officer and person in charge of technology, human resources, finance and other areas. Table 2-2.3 shows the number of employees and their breakdown. The total staff strength is 1,848, 47%, or 866 of whom are technicians. The majority (665) of technicians are engaged in power distribution operations. Where EKEDC distributes electricity, 272,911 electricity meters have been installed while 262,225 are still pending installation. Even in Lagos State, the second-most populous in Nigeria after Kano State, DisCos have only installed around half the electricity meters (see 2-2-2 Management of Electricity Distribution Companies for details).



Source: Obtained from EKEDC

Figure 2-2.6 EKEDC Organization Chart

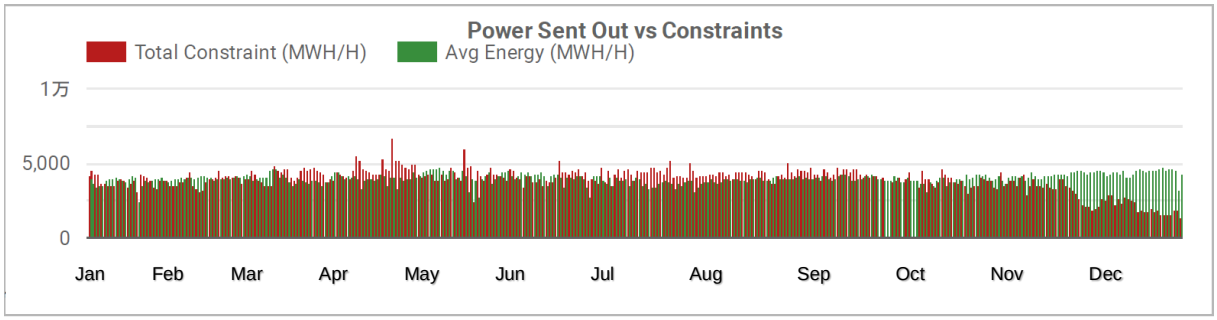
Table 2-2.3 Number and Breakdown of Employees in EKEDC2-2

Function	Department	Number of STAFF
TECHNICAL	Distribution Operations	665
	Metering	84
	Technical	117
NON-TECHNICAL	Audit and Compliance	14
	Business Performance (MD/CEO CELL)	4
	CEO Office (MD/CEO CELL)	10
	Commercial	491
	Corporate Communications (MD/CEO CELL)	41
	Customer Service (MD/CEO CELL)	44
	Finance	154
	HR & Admin	118
	HSE (MD/CEO CELL)	22
	IT (MD/CEO CELL)	39
	Legal	6
	Power Procurement and Regulatory (MD/CEO CELL)	14
	Project Management (MD/CEO CELL)	7
	Special Projects and Revenue Optimization (MD/CEO CELL)	16
	Total	1846

Source: Obtained from EKEDC (as of August 2020)

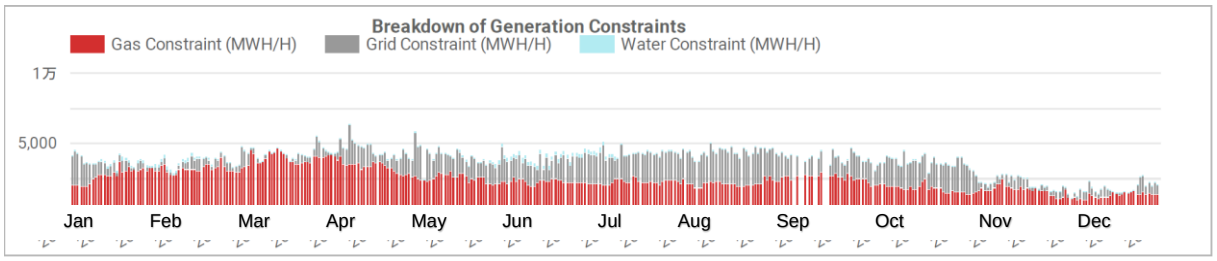
2-3 Power demand

Since electricity supply does not suffice to meet potential demand, load shedding is implemented continually in Nigeria. Figure 2-3.1 and Figure 2-3.2 show the average hourly energy supply and the breakdown of constraint for supply in 2020, respectively. As shown in Figure 2-3.1, the average hourly supply had been hovering at around 4,000MW while the supply constraints remained the same or higher than the energy supplied. Figure 2-3.3 explains how the major constraint in the earlier half of 2020 was a limited supply of natural gas to fuel thermal power plants but the gas constraint became a grid constraint in around mid-2020.



Source: Advisory Power Team, Vice-President Office

Figure 2-3.1 Power sent out versus constraints in 2020



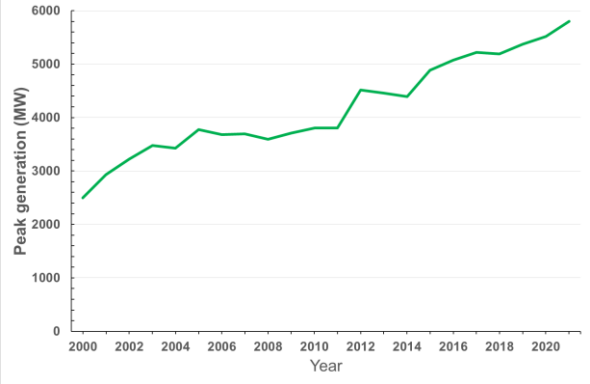
Source: Advisory Power Team, Vice-President Office

Figure 2-3.2 Breakdown of generation constraints

Figure 2-3.3 and Figure 2-3.4 show the national peak generation and energy generated in Nigeria, respectively. Peak generation and energy generated have grown at an average rate of 4%/year. The highest peak generation of 5,802 MW was recorded on 1 March 2021. As shown in Figure 2-3.4, the level of energy generated dropped sharply in 2009 and 2016. Figure 2-3.5 represents the energy generated from thermal and hydro power plants. While the energy generated from hydro is relatively stable, the energy generated from thermal sources greatly decreased from January to June, which explains the low overall level of energy generated in 2016. The amount of natural gas supplied by the NGC (Nigerian Gas Company) in 2016 dropped by 20% compared to 2015[4]. Due to insufficient gas supply, the major fuel for thermal power plants, their availability was lowered.

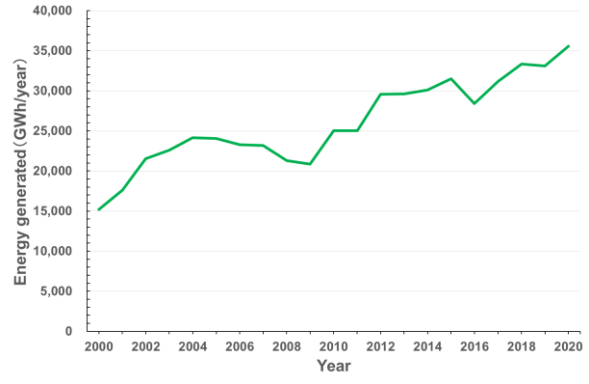
[4] According to newspaper reports at the time of 2016, inadequate capacity of gas production and processing facilities for domestic use and vandalism to gas supply infrastructure were blamed for the decline in gas supplies for thermal power generation.

As explained above, power demand in Nigeria is suppressed and its electricity consumption per capita[5] of 0.16 MWh is much lower than neighboring Sub-Saharan African countries such as 4.0 MWh of South Africa and 0.30 MWh of Ghana.



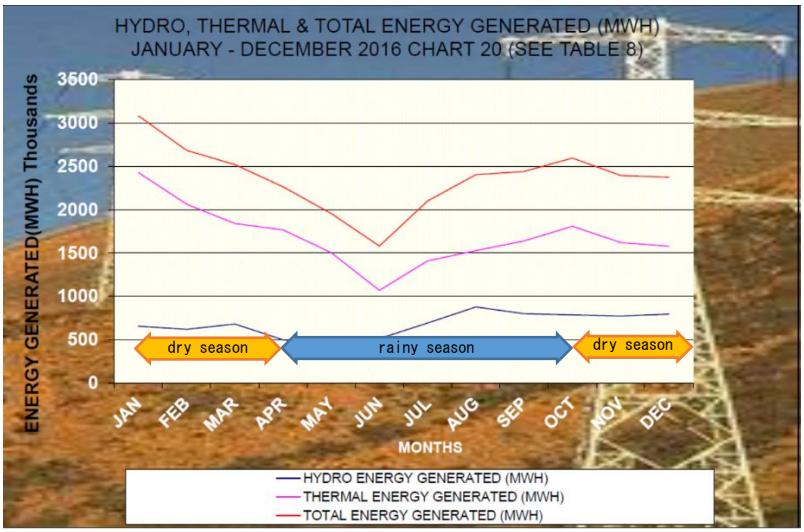
Source: Transmission Company of Nigeria "Annual Technical Report", Advisory Power Team Vice-President Office

Figure 2-3.3 History of peak generation



Source: Transmission Company of Nigeria "Annual Technical Report", Advisory Power Team Vice-President Office

Figure 2-3.4 History of energy generated



Source: Transmission Company of Nigeria "Annual Technical Report"

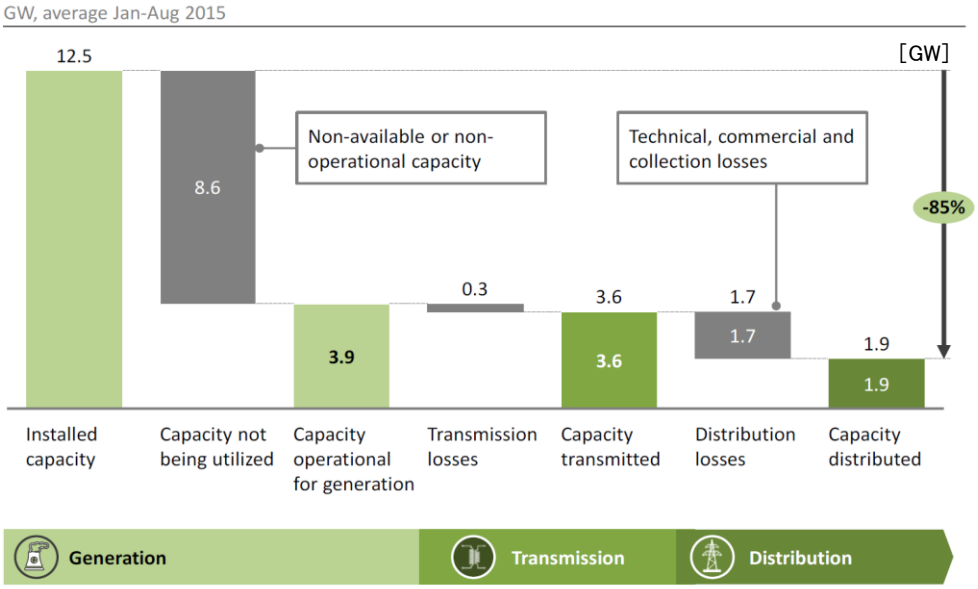
Figure 2-3.5 Monthly energy generated by thermal and hydro power (2016)

[5] International Energy Agency, Data and Statistics

2-4 Challenges of the power sector

The power sector in Nigeria faces three major challenges such as: (1) insufficient and unstable power supply, (2) financial difficulties and (3) high transmission and distribution losses.

The energy flow in the Nigerian power sector in 2015 is shown in Figure 2-4.1. Nigeria had an installed generation capacity of 12.5GW, while the operational capacity of generation was only 3.9GW due to aged and broken power generation equipment or insufficient natural gas, which is the main fuel for power generation in Nigeria. With a transmission loss of 0.3GW and a distribution loss of 1.7GW, only 1.9GW, comprising 15% of the installed generation capacity, was distributed to end users.

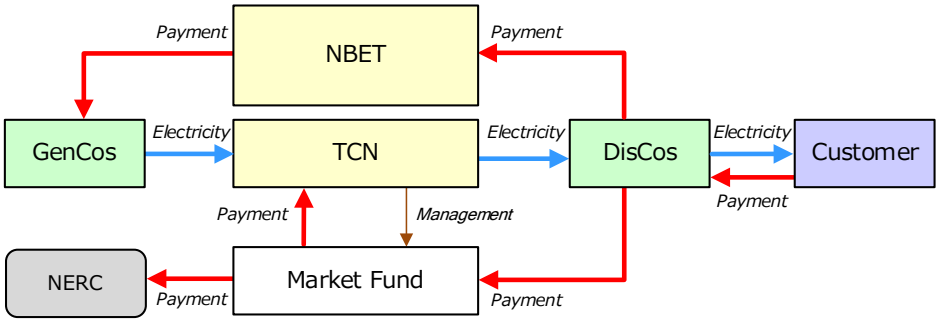


Source: Prepared by the JICA Survey Team based a figure included in ERGP

Figure 2-4.1 Energy flow in the Nigerian power sector in 2015

Vertically integrated NEPA was unbundled into generation, transmission and distribution as shown in Figure 2-4.2 after the Power Sector Reform Act was enacted. Generation (GenCo) and distribution were privatized while transmission remains state-owned.

Figure 2-4.2 shows the flow of electricity and payment in the Nigerian electricity market. Currently, the market is in a transitional stage, in which NBET intervenes in transactions and adjusts any imbalance in electricity tariffs until the market moves on to full competitive stage. During the TEM stage, NBET buys electricity from GenCo and sells it to DisCo. The payment for the services undertaken by TCN, which delivers power from GenCo to DisCo and for NERC, which provides regulation related services, is made through the market fund, following the same mechanism before the power sector reform was in place. Improving DisCo's financial performance remains one of the most critical challenges to ensure a successful transition from TEM stage to the Full Competition Stage.



Source: Prepared by the JICA Survey Team

Figure 2-4.2 Flow of electricity and payment (TEM Stage)

(1) Insufficient and unstable power supply

Potential power demand in Nigeria is estimated to at 12.8GW (Power System Master Plan, JICA) but the available generation and transmission capacity is limited to 3.9 and 3.6 GW (Figure 2-4.1) to an insufficient and unstable gas supply. Under these circumstances, load shedding is widespread, in both urban and rural areas. Accordingly, the insufficient and unstable power supply in Nigeria impedes economic growth.

(2) Financial difficulties

The payment made by DisCo to NBET and by NBET to GenCo was almost quarter to one third of the invoiced amount for the year from October 2017 to September 2018. The most critical reason for non-payment by DisCo was the low collection rate for electricity tariffs from their final consumers. The average collection rate by DisCo from their consumers was 69.2% (June, 2019)[6], which was due to large-scale (e.g. government agencies) as well as private consumers defaulting on their payment obligations.

Furthermore, the weak Naira in the currency market causes the financial performance of DisCo to deteriorate, because the current electricity tariff scheme prevents DisCo from transferring any foreign exchange losses from the tariff to the final consumer. Most of the investment made by DisCo is on a foreign currency (dollar) basis and GenCo's fuel (gas) price, which comprises the majority of the generation cost, is also linked to the US dollar, although the revenue of DisCo through the electricity tariff is on a local currency (Naira) basis. Under these circumstances, DisCo has no choice other than to prioritize repayment of liabilities previously borrowed to buy shares of distribution companies during the privatization process. Accordingly, DisCo is unable to make the necessary investment to reduce distribution losses and improve their supply efficiency.

(3) High transmission and distribution losses

As shown in Figure 2-4.1, only 1.9 GW is available for distribution due to very high losses of 85% through generation, transmission and distribution, while the rated generation capacity is as high as

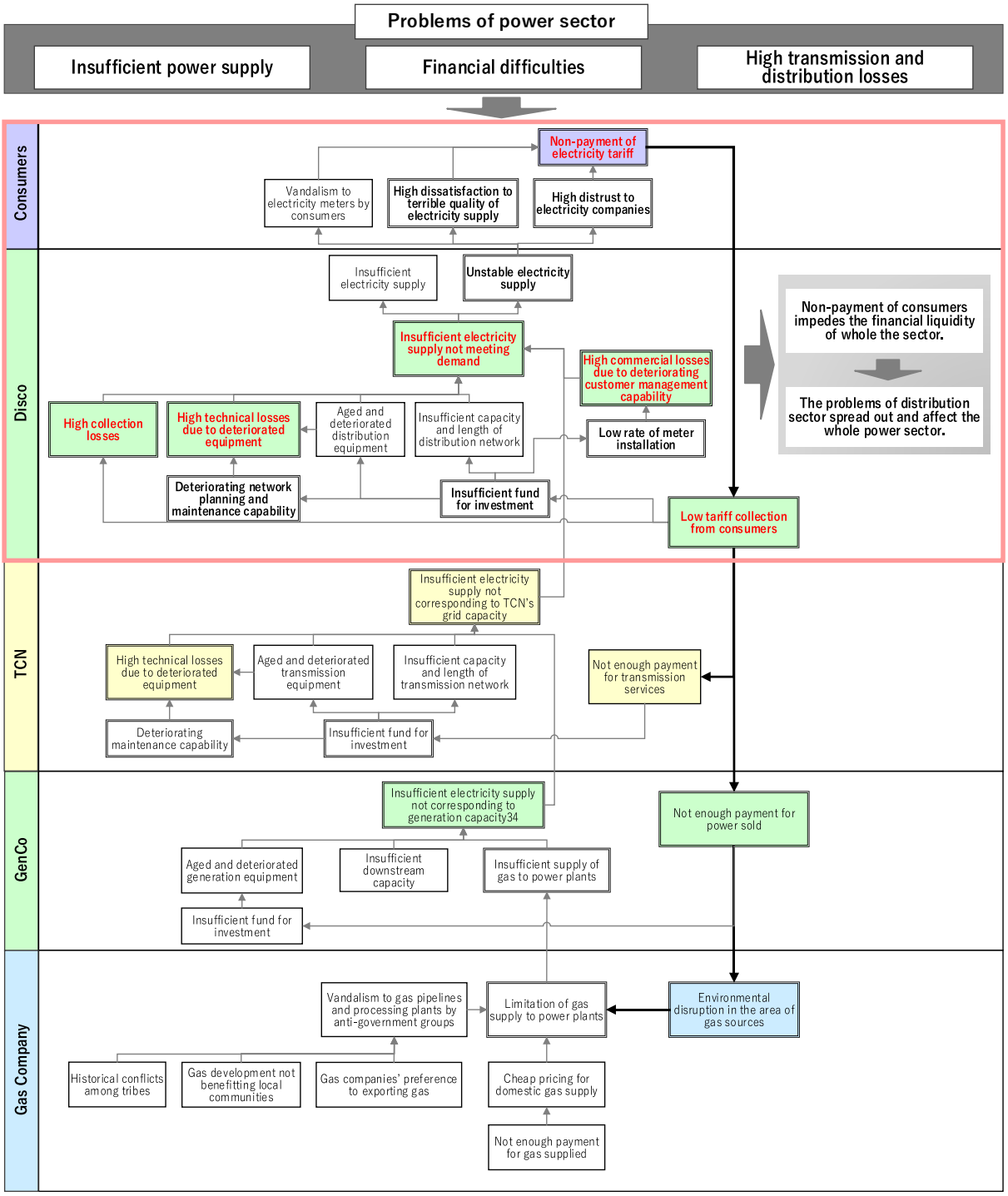
[6] NERC quarterly report, June 2019

12.5GW.

The abovementioned challenges in the power sector are caused by all the segments of generation, transmission and distribution, which are closely interconnected. Figure 2-4.3 shows the link tree chart of problems throughout all power sector segments. Non-payment of consumers impedes the financial liquidity of the entire sector, causing problems of the distribution sector to spread out and affect the whole power sector. Table 2-4.1 shows the problems affecting each power sector segment.

Table 2-4.1 Problems of each power sector segment

Subsector	Problem
Consumers	Since consumers have strong complaints and dissatisfaction about the “terrible quality of electricity supply” and “high distrust on the business way and attitude of DisCos”, they are unwilling to pay their electricity tariff.
DisCo	DisCo suffers from a lack of funding due to high distribution losses, which are mainly attributed to non-payment from consumers. Commercial losses are high because of the low installation rate of electricity meters caused by insufficient investment, which, in turn, entails deteriorating customer management capability. Insufficient investment funding prevented DisCo from conducting proper maintenance, whereupon its distribution assets deteriorated and generated high technical losses. High technical, commercial and collection losses hinder efforts to supply sufficient electricity to meet demand.
TCN	Insufficient investment funding prevented TCN from conducting proper maintenance, whereupon its transmission assets deteriorated and generated high technical losses. High technical losses hinder efforts to supply sufficient electricity to meet demand.
GenCo Gas company	The Nigerian Gas Company (NGC) is unable to fully collect its gas tariff, thus NGC limits the gas supply to GenCos. Accordingly, GenCos cannot receive sufficient gas for their power generation and it is difficult for them to generate electricity fully utilizing their installed capacity.



Source: Prepared by the JICA Survey Team

Figure 2-4.3 Link tree chart of problems in all power sector segments

Chapter 3 Current status and issues in the power distribution field

3-1 Current status and issues of power distribution facilities

As shown in Figure 2-4.2, generation and distribution were privatized while transmission remains state-owned in Nigeria. As things stand, the market is in a transitional stage, in which NBET intervenes in transactions and adjusts any imbalance in electricity tariffs until the market reaches a fully competitive stage. Improving DisCos' financial performance is one of the most critical challenges to ensure a successful transition from TEM stage to the Full Competition Stage. This section refers to the current status and distribution facility issues.

3-1-1 Configuration of power distribution facilities

(1) System configuration

Figure 3-1.1 shows the main configuration of the Nigerian power grid. Power is transmitted from the power plant to the boundary substation of the Transmission Company of Nigeria (TCN) and the Electricity Distribution Companies (DisCo) via 330kV and 132kV transmission lines. At the boundary substation, the voltage is stepped down from 132 kV to 33 kV, then transmitted by a 33 kV transmission line to the injection point (distribution substation), where it is further stepped down to 11 kV distribution voltage. In some cases, a 33-kV power distribution line may be outgoing from the 33-kV bus at the boundary substation. The 33kV power system includes a mix of radial and loop configurations.

Figure 3-1.2 shows the distribution system configuration. Most of the power distribution systems are three-phase (neutral point direct grounding) systems with a primary voltage of 11kV. The power distributed at 11kV is stepped down to low voltage (400/230V) by a distribution transformer. The low-voltage system is a three-phase, four-wire system.

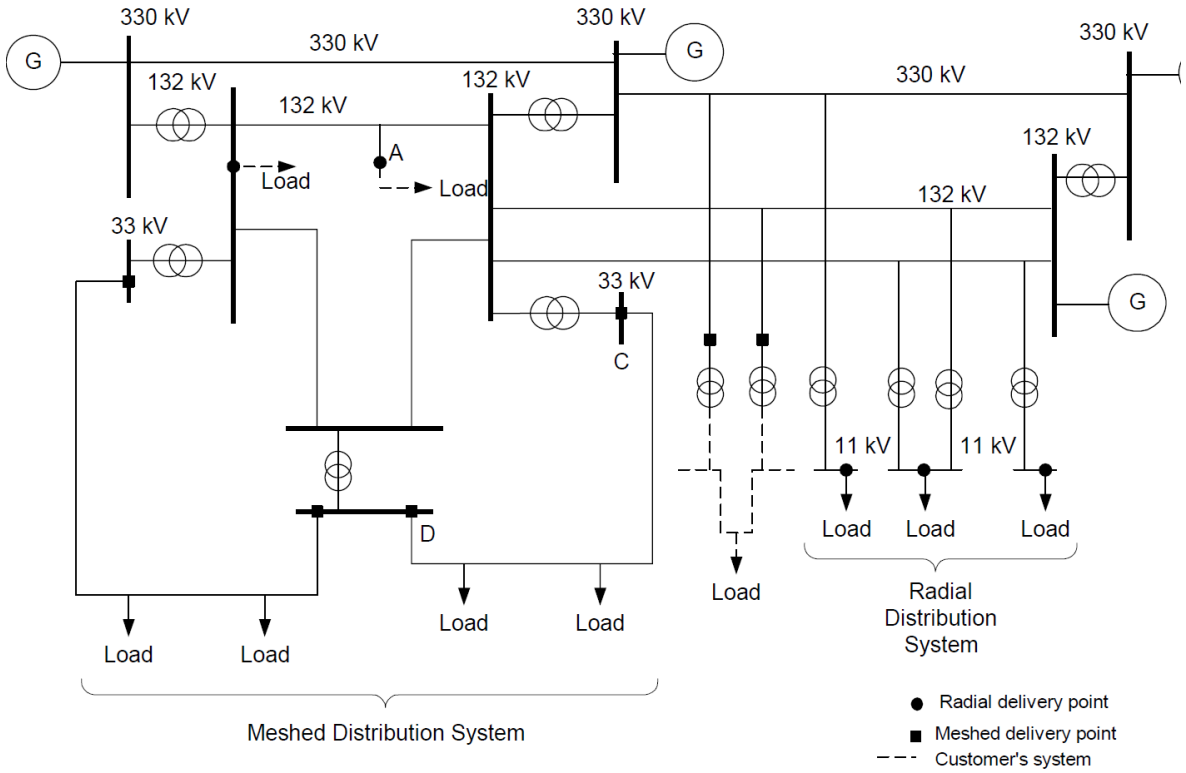


Figure 3-1.1 Power system configuration in Nigeria (Grid code appendices Page 26 Fig.2)

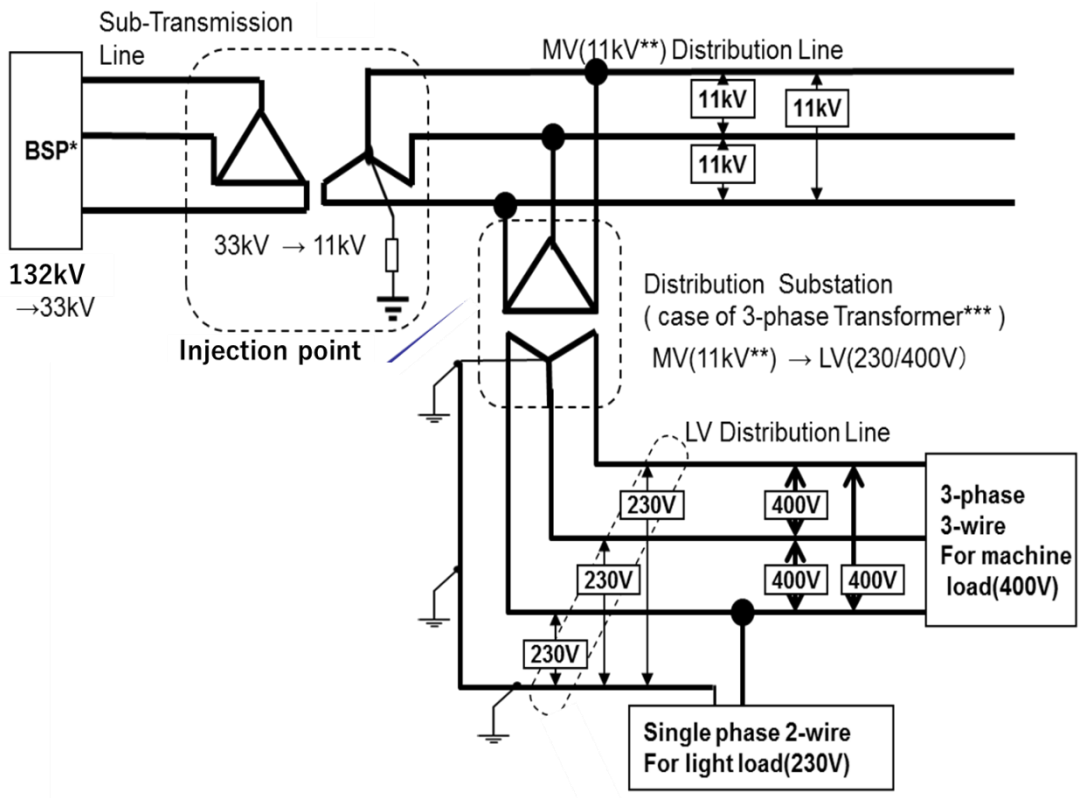
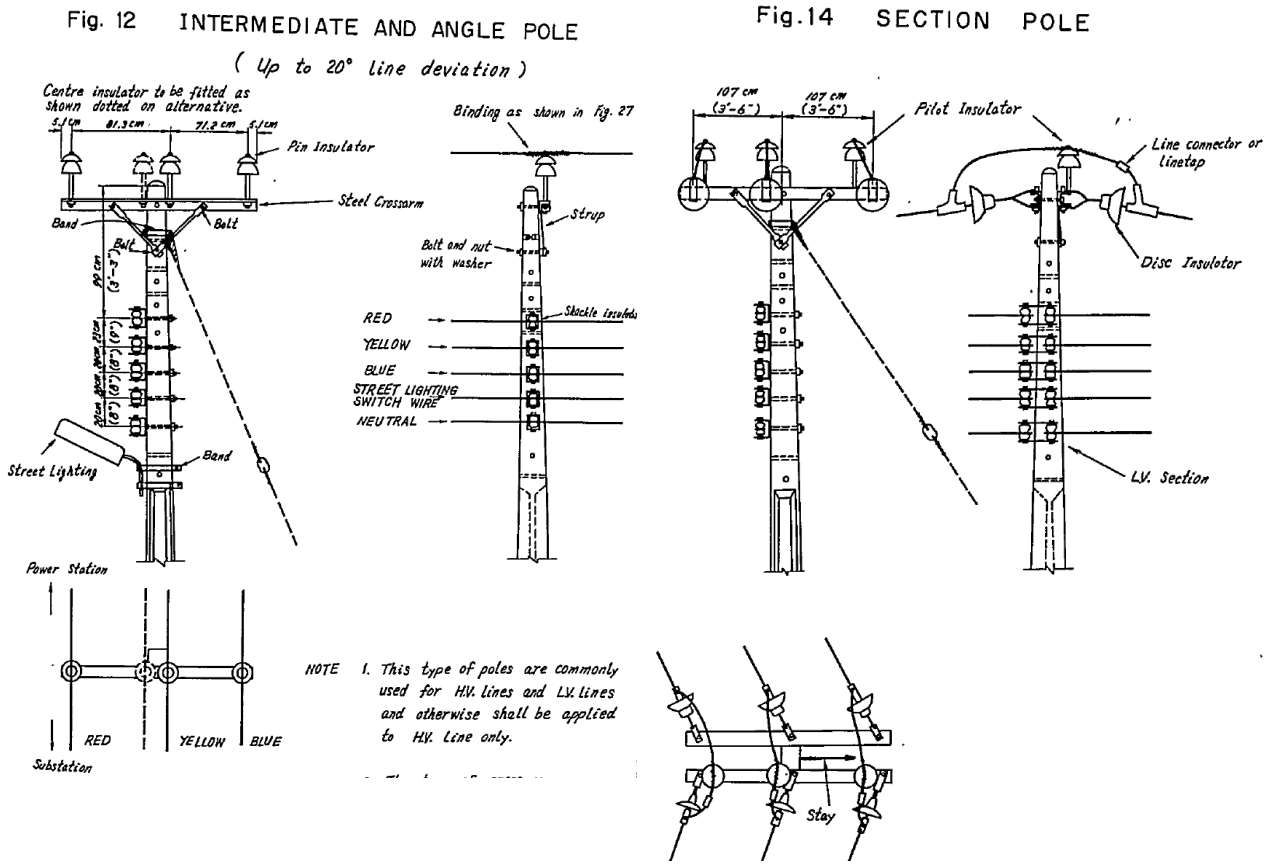


Figure 3-1.2 Power distribution system configuration

(2) Configuration of power distribution facilities

The supports (poles) for high- and low-voltage lines are often separate and square concrete or wooden poles are often used as utility poles. Figure 3-1.3 shows standard arrangements for high-voltage line poles. However, note that the figure shows both high- and low-voltage lines mounted together.

Poles must be spaced a maximum of 45 to 50m apart[1]. The safety factor of the pole body and foundation (considering the equipment load installed on the pole) is 2.5[2]. The ground clearance for overhead conductors of 66kV or less must be maintained at a minimum of 6.1m and 5.8m for low voltage conductors of 400V[3].



(a) Straight section of the pole (b) Angle and jumper points on the pole

Figure 3-1.3 Standard arrangements for high-voltage poles

Figure 3-1.4 shows the standard arrangements for transformer installation poles. This figure shows the structure when installed on the ground in an installation method applied to large-capacity transformer banks. Conversely, in the case of pole-mounted transformers, a ground clearance of at least 3 m[4] must be secured. As a general rule, lightning arresters must also be installed on the primary side of the

[1] 5.1.1. Route Surveys: Nigerian Electricity Supply and Installation Standards Regulations 2015
[2] 5.1.5.7.4. Load Bearing Capacity for Support Structures of Distribution Lines and Safety Factor: Nigerian Electricity Supply and Installation Standards Regulations 2015
[3] 5.1.5.4. Conductor Sag: Nigerian Electricity Supply and Installation Standards Regulations 2015
[4] 6.5 Pole Mounted Distribution Substation: Nigerian Electricity Supply and Installation Standards Regulations 2015

transformer to protect it from lightning surges.[5].

A drop-off fuse is installed on the primary side of the distribution transformer to protect the transformer from overcurrent.

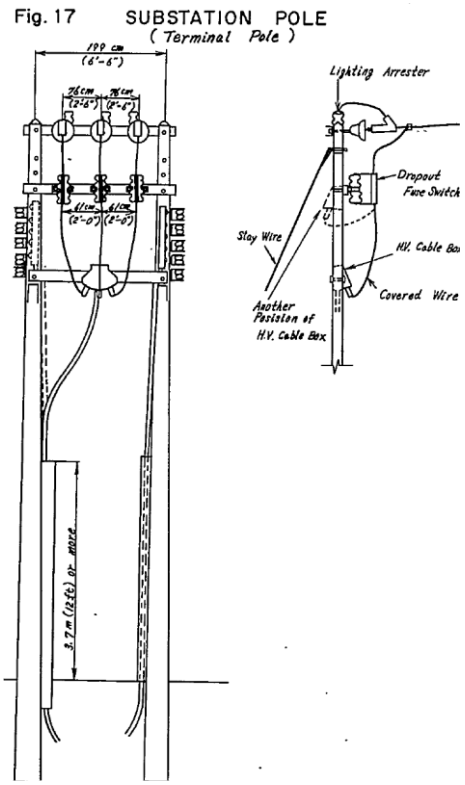


Figure 3-1.4 Standard arrangements for transformer installation poles

As a general rule, the conductors used in overhead distribution lines are AAC or ACSR and of the class and quality specified in IEC61089, with a minimum cross-sectional area of conductors of 100 mm^2 [6].

As things stand, the high-voltage distribution lines are extremely long. For example, with regard to 33kV distribution feeders, some reports describe the length as up to 350km in rural areas and 70km in urban areas (both of which average values)[7].

Low-voltage distribution systems are branched into four, six, or eight circuits by the distribution board at the distribution transformer bank, depending on the load (customer) distribution (Figure 3-1.5). An ammeter, voltmeter and watt-hour meter are also installed in distribution panels to monitor transformer load conditions[8]. In the distribution panel, meanwhile, fuses are installed for each circuit of the low-voltage line to protect the conductor from overcurrent.

[5] 4.2.4.3.5. Lightning Arresters: Nigerian Electricity Supply and Installation Standards Regulations 2015
[6] 5.2.6. Line Conductors: Nigerian Electricity Supply and Installation Standards Regulations 2015
[7] How to increase network reliability and supply quality in manageable areas with economic considerations: Page 29
[8] 6.3 LV Distribution (Feeder Pillar) Panels: Nigerian Electricity Supply and Installation Standards Regulations 2015

The capacity series for distribution transformers supplying the low-voltage system comprises 50, 100, 200, 400 and 500 kVA[9].

Because large-capacity distribution transformers are used, low-voltage lines tend to be long, with many lines extending more than 1.5 km. The such form of low-voltage line leads to much larger technical losses[10].

Low-voltage lines are also the weakest point in the Nigerian power distribution system in terms of supply reliability. In most low-voltage lines, conductors connected by wire jointing are found in multiple locations in a feeder, which leads to conductor strength declining and increases voltage drop and loss. The conductor breakage phenomenon exacerbated by such joints is because lightning and weather conditions render the equipment more prone to short-circuit faults and weather conditions because spacers are not used for low-voltage lines.

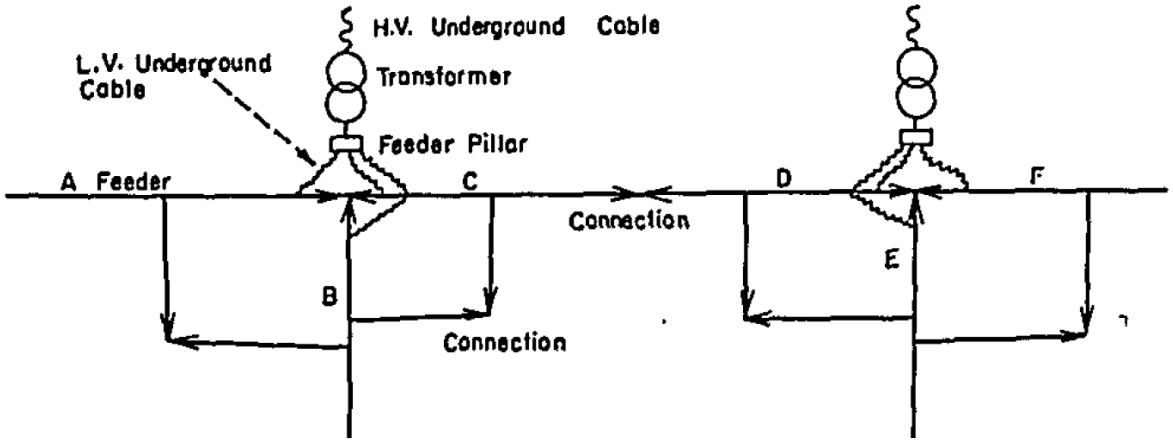


Figure 3-1.5 Configuration of low-voltage system
(Feasibility study report on rural electrification in north-central state of Nigeria, JICA report, June 1975, Fig V-2)

(3) Configuration of (injection) distribution substations

There are two types of (injection) distribution substations; those below 2.5MVA (unmanned) and those above 2.5MVA (manned).

The (injection) distribution substations receive power from one 33kV transmission circuit, while 11kV power distribution feeders are outgoing depending on transformer capacity, through one or two transformers and switchgear panels. In a 15MVA transformer, two or three feeders are outgoing in most cases, including four feeders in rare cases.

[9] 5.1.4 Distribution Substation and 0.415KV Feeders: How to increase network reliability and supply quality in manageable areas with economic considerations
[10] 5.1.4 Distribution Substation and 0.415KV Feeders: How to increase network reliability and supply quality in manageable areas with economic considerations

3-1-2 Installed (supply) capacity of major power distribution companies

The installed (supply) capacity of the major distribution companies obtained from the PIP of each distribution company is shown in Table 3-1.1 to Table 3-1.3.

Assuming that the normal capacities of the 33kV and 11kV feeders are 20 and 5MW respectively, the total capacity of feeders in each major power distribution company can be calculated as shown in Table 3-1.4 (regardless of the diversity factor between feeders). This table indicate that the capacity of the (injection) distribution substation is coordinated with that of the distribution feeders.

Table 3-1.1 Facilities outline of Abuja DisCo

Facilities	Quantity
TNC Transmission Station	18 locations 1,785 MVA
- 33kV feeder	91 7907.5 km
- 11kV feeder	***** 5627.7 km
- 132/33kV transformer	*****
- 33/11kV transformers	157 2,481 MVA
-33/0.415kV distribution transformers	*****MVA
- 11/0.415kV distribution transformers	16,646 4,985.8 MVA

Source: Draft PIP (Abuja)

Table 3-1.2 Facilities outline of Eko DisCo

Facilities	Quantity
TNC Transmission Station	12locations 2,500 MVA
- 33kV feeder	87 Underground 50 Overhead 37 948.7 km
- 11kV feeder	300 3067.8 km
- 132/33kV transformer	42
- 33/11kV transformers	104 (at 40S/S) 1537.5MVA-Energized 2500MVA－Installed
-33/0.415kV distribution transformers	1601 662.3MVA
- 11/0.415kV distribution transformers	9079 3363.3MVA

Source: Draft PIP (Eko)

Table 3-1.3 Overview of Ikeja DisCo equipment

Facilities	Quantity
TNC Transmission Station	17locations 2,620MVA
- 33kV feeder	89 (UG:21, Oh:68) 1642.3km
- 11kV feeder	281 2496.6km and 5,927.4km(0.415kV)
- 132/33kV transformer	44
Injection Substation No 73	113
- 33/11kV transformers	155 2,053MVA
-33/0.415kV distribution transformers	1,302 991.9MVA
- 11/0.415kV distribution transformers	16,412 3,499.9MVA

Source: Draft PIP (Ikeja)

Table 3-1.4 Coordination of installed capacity of major DisCos

DisCo	Abuja	Eko	Ikeja
33kV Total capacity of Feeders (MW)	1820	1740	1780
33/11kV transformers	2481	2500	2053
11kV Total capacity of Feeders (MW)	1500	1500	1405

Source: Prepared by the survey team from Draft PIP (Abuja, Ikeja and Eko)

3-1-3 Distribution facilities capacity and supply-demand relationship

The power distribution companies in Nigeria comprise 11 privately owned companies, which hinders efforts to determine the overall supply and demand relationship based on unified data. Accordingly, the relationship between supply (installed) capacity and demand of major DisCos is evaluated based on relevant data extracted from existing reports and analysis of the same.

(1) Information obtained from the PSRP (Power Sector Recovery Programme)

It has been shown that the supply capacity in the electricity supply chain is not limited to distribution facilities, but restrictions on supply capacity apply in various sectors. This is supported by the fact that the total power received by DisCos, as indicated by the grid operator, is only about 4 GW compared to the assumed potential demand of 12 GW (expressed as if the installed capacity is insufficient).

(2) Information obtained from the PIP (Performance Improvement Plan)

The relationship between installed capacity obtained from the PIP (Performance Improvement Plan) of each DisCo and demand is shown in Table 3-1.5. Potential demand (peak demand assuming that scheduled outages are not implemented) is smaller than the installed capacity of each substation. Accordingly, it cannot be concluded from this data that frequent scheduled outages occur (insufficient capacity) due to restrictions on the capacity of distribution facilities. However, the PIP of each DisCo includes plans to upgrade 33/11kV substations and 33/11kV feeder and distribution transformers (for

400V) even though the total installed capacity exceeds peak demand. This is due to the existence of transformers with less output than rated capacity as a result of transformer failure as shown in the Eko DisCo column in Table 3-1.5, feeders with conductors of below standard size and overloaded distribution transformers. Presumably, these factors explain supply bottlenecks in the distribution system.

The reason for this situation can be attributed to the lack of accurate load management and appropriate maintenance for each of the distribution facilities as well as facility planning and facility formation in coordination with facilities in other departments.

(3) Information obtained from the daily load data of the system operator in Nigeria.

There are many months in which each DisCo received 20 to 30% less than the power allocated by MYTO due to load rejection.

[Conclusion]

The high incidence of planned outages in the distribution system is considered attributable not to a lack of capacity in the distribution facilities, but rather the fact that the system operator's supply allocation (④ in Table 3-1.5) involves operating the system at a far lower power level (MW) than the companies' demand assumptions. However, from a local perspective, supply constraints due to overloading distribution lines and transformers have also occurred. In addition, load rejection by DisCo also appears superficially like a power supply shortage.

The shortage of power supply from the power distribution system is not only due to the lack of installed capacity, but also the business operation of DisCos. Daily grid operations are conducted with a much lower power (MW) than the demand forecast of each DisCo, as shown in the supply allocation system operator in Table 3-1.5.

Table 3-1.5 Supply facilities and electricity demand of each DisCo in the PIP (as of 2020)

Item	Abuja	Ikeja	Eko
① 33/11kV substation capacity (injection point) (MVA)	-	2053	1,537.5 (available amount) 2,500 (plate capacity)
② 33/0.415kV transformer (MVA)	-	991.9	662.3
③ 11/0.415kV transformer (MVA)	4,985.8	3,499.7	3,363.3
④ Supply allocation by system operator (MW)	462.32 (2020.7. 7)	703.03 (2020.7. 7)	542.22 (2020.7. 7)
⑤ Apparent demand (MW)	1,129.4	1,344	838
⑥ Potential demand (MW)	1,714.8	1,641	1,174

Source: Draft PIP (Abuja, Ikeja, Eko)

3-1-4 Current power quality status

(1) Supply voltage

The nominal voltage of the power distribution system in Nigeria and the permissible voltage for each

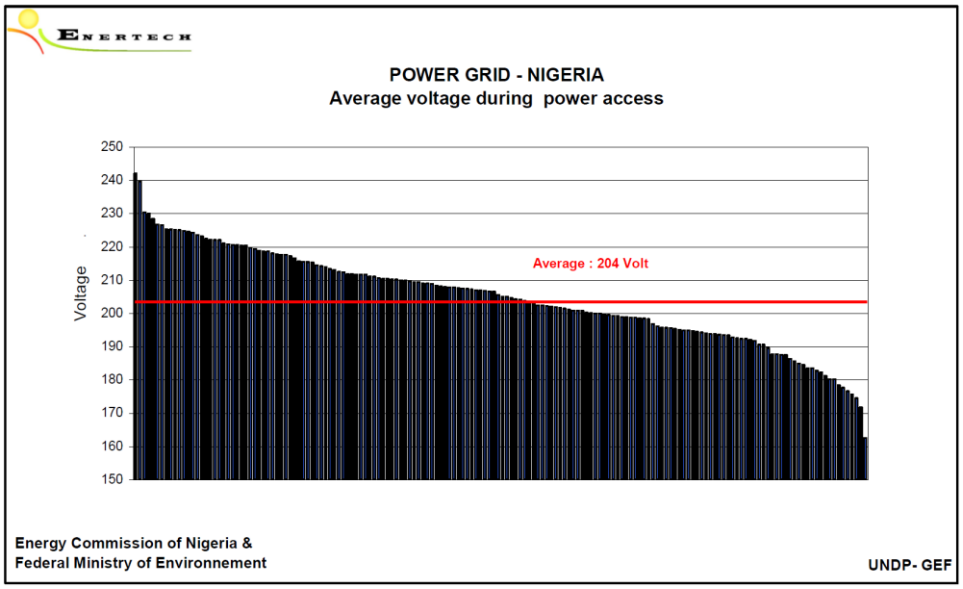
voltage class are shown in Table 3-1.6[11].

The supply voltage to 230V customers, as specified in the Distribution Code, must be between 216.2 and 243.8V. However, the actual supply voltage is an average of 204V, as shown in Figure 3-1.6, which does not satisfy the specified value. According to the estimation in Figure 3-1.6, it can be seen that a low voltage of just below the specified value is supplied to 70% or more of the customers/period. This is considered attributable to the fact that the system voltage can no longer be properly controlled due to the considerable length of both the high-and low-voltage feeders and the lack of voltage control equipment installed as described in Section 3-1-1.

Table 3-1.6 Nominal voltage of the distribution system and allowable voltage of each voltage class

Nominal Voltage	Original Voltage	
	Minimum kV (pu)	Maximum kV (pu)
33kV	31 (0.94)	34.98 (1.06)
16kV	15.2 (0.95)	16.8 (1.05)
11kV	10.45 (0.95)	11.55 (1.05)
400V	376V (0.94)	424V (1.06)
230V	216.2V (0.94)	243.8V (1.06)

Source: Distribution Code 4.3.1.



Source: End-use Metering Campaign for Residential Houses in Nigeria (September 2013) (Metering Campaign Report) :(Energy Commission of the Nigeria Federal Ministry of Environment United Nations Development Programme Global Environment Facility)

Figure 3-1.6 Actual fluctuations of receiving point voltage of the customers

(2) Supply reliability

1) Reality of power outages as experienced by customers

Nigeria experiences frequent power outages due to failing power equipment and an inadequate power supply. Table 3-1.7 displays the actual data for power outages experienced at customer's power

[11] Distribution Code 4.3.1

receiving points, suggesting that outages experienced by customers are largely scheduled in nature.

Table 3-1.7 reveals the following:

- The average daily power outage per customer is 13 hours.
- As for how power outages are applied, it seems that scheduled (rotating) outages are implemented by dividing the area into several sections.
- As for the power outage cycle, it seems that power outages of four to five hours are implemented at intervals (cycles) of three to six hours.

Table 3-1.7 Actual status of power outages (frequency, duration and interval of outages)

		NIGERIA	Abuja	Sokoto	Benin	Bauchi	Lagos	Enugu
Part of power access		55%	63%	39%	59%	39%	66%	64%
Average Voltage during power access	Average	204V	206V	203V	172V	203V	212V	202V
	Minimum	172V	178V	172V	162V	186V	183V	174V
	Maximum	242V	225V	230V	242V	240V	228V	226V
Number of hours housholds get electricity per day	Average	13h/day	15h/day	9,5h/day	14h/day	9,5h/day	16h/day	15h/day
	Minimum	2,5h/day	5,5h/day	2,5h/day	9,5h/day	3,5h/day	9h/day	9h/day
	Maximum	24h/day	21h/day	16h/day	23h/day	14h/day	24h/day	21h/day
Average duration of power outage	Average	4h	3h	5h	4h	5h	4h	3h
	Minimum	0h	1h	2h	1h	2h	0h	1h
	Maximum	15h	7h	10h	9h	12h	15h	8h
Average duration of power access, between two power outage	Average	4,5h	5h	3h	6h	3h	6h	5h
	Minimum	2h	2h	2h	2h	2h	3h	3h
	Maximum	13h	13h	5h	11h	5h	12h	8h

Source: End-use Metering Campaign for Residential Houses in Nigeria (September 2013) (Metering Campaign Report): (Energy Commission of Nigeria Federal Ministry of Environment United Nations Development Programme Global Environment Facility)

2) Current status and reduction targets of power outages in the PIPs

Table 3-1.8 shows the reliability indicators (number of reported customer outages) stated in the PIPs of the major DisCos. It can be seen that each DisCo is currently experiencing an extremely high number. Eko and Ikeja DisCos aim to reduce the number of outages by 25 and 75% respectively from the current level as of the fifth year of the plan.

Table 3-1.8 Current status and targets for reliability indicators in PIP (annual number of customer outage reports)

DisCo	2019	Year 1	Year 2	Year 3	Year 4	Year 5
Abuja	-	-	-	-	-	-
Eko (Number of reported customer outages)	11,622	11,040	10,459	9878	9289	8,717
Ikeja (Number of reported customer outages)	10,845	8,676	6,941	5,553	4,442	3,554

Source: Draft PIP (Abuja, Ikeja, Eko)

(3) System loss (ATC&C Loss: Aggregated Technical and Commercial Loss)

1) Regulations regarding system losses

DisCos must set up energy audit centers in cities with a population of 20,000 or more and conduct energy audits in the licensed areas, together with metering at substations. The energy audit calculates

the amount of electricity sold and distribution losses[12].

Users connecting directly to the high-voltage grid shall maintain a power factor of 0.85 or more at their connection points[13].

DisCos must also take measures to improve the power factor at strategic points of the distribution system by installing required devices to compensate reactive power[14].

2) Current status of the system loss ratio and targets for improvement

Table 3-1.9 shows the current status and improvement targets of the system loss ratio of each DisCo. The loss reduction target for the next five years centers on the assumption that capital investment in this improvement measure will be available if the cost reflective tariff in the MYTO is approved. In addition, Abuja DisCo's technical losses are already relatively low and from a technical perspective, minimal scope for loss reduction is expected in the fifth year of the plan.

[Conclusion]

Most of the system losses are estimated to be commercial and collection. For example, technical losses comprised only 20% of Abuja DisCo's system losses in 2019, with commercial and collection losses comprising the remaining 80%. Accordingly, the efforts to reduce system losses must focus mainly on both commercial and collection losses. The system losses of Ikeja DisCo are already low (compared to other DisCos) and commercial and collection losses are expected to be almost eliminated in the fifth year of the plan (8.80% constitutes the estimated technical losses).

Table 3-1.9 Current status and targets of loss indicators in PIP
(ATC&C Loss (%) and technical loss (%))

DisCo	2019	Year 1	Year 2	Year 3	Year 4	Year 5
Abuja	46.05 (11.72)	36.15 (7.89)	27.54 (6.76)	25.59 (6.17)	22.80 (6.08)	19.27 (6.08)
Eko	26.63	26.63	24.63	22.63	20.63	18.63
Ikeja	21.30	15.90	10.80	8.80	8.80	8.80

Source: Draft PIP (Abuja, Ikeja, Eko)
*1: Values in parentheses represent the technical loss (%).

3-1-5 Issues of power distribution facilities

The problems and issues of the status of distribution facilities and related indicators mentioned above and the problems and issues of distribution facilities in Nigeria described in the reports of other projects[15] are as follows:

- Distribution facilities in all DisCo supply areas are inadequate, unsafe and unreliable. Power outages

[12] Distribution code, Energy Audit, 2.5.4. 2.5.5.
[13] Distribution code, 4.12. POWER FACTOR
[14] Distribution code, 3.9.3
[15] How to increase network reliability and quality of supply in manageable areas with economic considerations, AF-Mercados EMI, Mar. 2020, Page 11~ (This is a report on a field survey conducted as part of the AFD-supported project "Review of Nigeria's Electricity Distribution Infrastructure and Preparation of a Roadmap to Boost the Quality of Electricity Supply". The implementation period is 2019-2020)

proliferate, especially during rainfall and lightning.

- There is no mechanism in place to check and guarantee power quality.
- The low supply voltage can be attributable to long feeders, a lack of installed boosters, the transformer lacking a voltage adjustment function and the fact that capacitor banks cannot be used.
- The main factors behind unsafe and unreliable networks are improper planning and design of feeders and (injection) distribution substations, improper construction work, aged equipment, low-skilled maintenance workers and insufficient spares, lack of response to maintenance approach and monitoring system and inadequate automation system etc.
- DisCos need to redesign their networks and add switchgears (circuit breakers, ring main units, auto reclosers and section switchgear) to improve supply reliability by system control.
- Most 33kV feeders supply two or more distribution substations and numerous distribution transformers and this design and construction standard is a weakness of the 33kV system, given its inability to cope with N-1 failures.
- The following defective facilities are installed in many feeders: tilted poles, inclined arms, loose conductors, improperly connected conductors, broken guy wires, substandard size conductors (installed during emergency restoration) and entangled plants.
- Most distribution substations are aging and poorly designed.
- The transformer capacity of many distribution substations in insufficient to accommodate the actual loads of the feeders connected to them.
- The grounding system in distribution substations is very weak and improperly designed.
- In most substations, voltage regulation by on-load tap changing is no longer possible.

The above project[16] report describes the following business implementation issues as well as the facility-related issues:

- DisCos must adopt a centralized maintenance planning and decentralize the task of conducting maintenance works. The central Maintenance Planning Unit (MPU) must develop maintenance standards and procedures and train technicians on the same.
- The central Maintenance Planning Unit (MPU) must set baselines of reliability indicators (SAIDI, SAIFI and CAIDI) and plan reliability projects. Future targets for those indicators must also be set and closely monitored.
- DisCos must perform large-scale audits of (injection) distribution substations and distribution transformers to ensure all facilities comply with NERC engineering standards and industry best practices.

[16] How to increase network reliability and supply quality in manageable areas with economic considerations, AF-Mercados EMI, Mar. 2020

3-2 Current status and issues related to distribution system faults and restoration

3-2-1 Actual situation of distribution system fault

(1) Number of forced (fault) outages

The number of reported forced outages affecting customers reported for the major DisCos (Abuja, Ikeja and Eko) is shown in Table 3-1.8. Almost 100 reports were made per month and from the customer's perspective, forced outages occur frequently.

Annual trends in terms of the number of faults of high-voltage distribution feeders (33, 11kV) are shown in Table 3-2.1. The frequency of faults of high-voltage distribution feeders (33, 11kV) varies from several hundred to 3,000 per company per year, depending on the DisCo and year.

For the major DisCos (Abuja, Ikeja and Eko), the frequency of faults per high-voltage distribution feeder is calculated from the data in Table 3-2.1 and the number of facilities, as shown in Table 3-2.2, with faults occurring 2.7 to 4.2 times per year. The calculation results show that equipment reliability is low, even at the high-voltage distribution feeder level.

Table 3-2.1 The transition in the number of faults of high-voltage distribution feeders (times/year)

HV (33,11 kV) faults (Frequency/Year)					
DisCo	2015	2016	2017	2018	2019
Abuja	988	1,674	1,981	1,265	207
Benin	1,270	1,665	1,489	1,464	1,411
Eko	922	1,019	957	1,088	1,143
Enugu	3,270	3,192	3,870	3,296	278
Ibadan	2,820	2,355	1,366	1,443	1,537
Ikeja	754	699	753	904	949
Jos	319	493	590	642	983
Kaduna	734	957	906	1,120	1,137
Kano	287	405	954	1,497	1,282
Port Harcourt	356	470	299	213	183
Yola	274	262	292	314	308

Source: NERC

Table 3-2.2 Number of faults per high-voltage distribution line in major DisCos (times/year/feeder)

HV (33kV,11kV) Rate of faults (Frequency/Year/Feeder)							
DisCo	2015	2016	2017	2018	2019	Nos. of cct (As of 2019)	Fault Rate of Feeder (Average for 5 years)
Abuja	988	1,674	1,981	1,265	207	391	4.2
Eko	922	1,019	957	1,088	1,143	387	3.6
Ikeja	754	699	753	904	949	370	2.7

Source: Prepared by the survey team based on data from NERC

*1: The number of lines at Abuja DisCo is estimated by the survey team

*2: The number of faults is calculated assuming an equivalent number of facilities from 2015 to 2019.

(2) Protection system for the distribution system

According to the Distribution Code (Distribution Code, page 34: 4.6. PROTECTION OF THE DISTRIBUTION SYSTEM), the following protection devices are specified to be installed at various

point of the power distribution system:

- ✓ High-voltage transformers of 5 MVA or more:
  - Differential relay and delayed timed overcurrent relay for backup,
  - Ground fault direction relay for parallel operations,
  - Gas operation relay, winding/oil temperature alarm and protection in addition to the above equipment
- ✓ High-voltage transformers from 1.6 to less than 5 MVA:
  - Drop-out fuse on the primary side,
  - Ring main unit (RMU) operated by CT on the secondary side
- ✓ 33kV transmission line:
  - Two overcurrent relays (including instantaneous overcurrent element),
  - Ground fault relay
- ✓ Radial high-voltage feeder: Timed overcurrent relay, ground fault relay
- ✓ Parallel/ring line: Directional delay timed overcurrent and ground fault relay
- ✓ Long distance feeders/transformers:
  - Need to include high sensitivity instantaneous elements.

3-2-2 Current status and issues regarding fault restoration

(1) Improper system configuration

Although the high-voltage distribution system is equipped with the abovementioned protection devices, the configuration of the high-voltage distribution system does not take into consideration the ability to reduce the time required to pinpoint the fault and quickly restore the power supply.

From this perspective, the high-voltage power distribution system has the following problems:

- The switchgear installed in the high-voltage distribution system for system operation and sectionalizing during fault restoration is only the circuit breaker for a feeder installed in (injection) substations[17].
- Despite the extremely long high-voltage distribution system line, no sectionalizing switch is installed on the feeder. It is difficult to interrupt and isolate the fault section in the event of a fault occurring given the lack of a protective fuse on lateral lines[18].
- Locating the fault may be time-consuming and power cannot be restored to the sound sections at an early stage, because the configuration of the high-voltage distribution system is as described above. Consequently the power outage will inevitably have a wide impact. Circumstances like these adversely affect the supply reliability.
- The feeder circuit breakers installed in the (injection) substation do not automatically re-close the

[17] How to increase network reliability and quality of supply in manageable areas with economic considerations, AF-Mercados EMI, Mar. 2020, pp. 36, 37, 44, 52, 62

[18] How to increase network reliability and quality of supply in manageable areas with economic considerations, AF-Mercados EMI, Mar. 2020, pp. 44, 52, 63, 69

circuit when a fault occurs and re-closing is performed manually. Accordingly, it is not only difficult to eliminate transient faults, it also takes time to distinguish them from permanent faults.

(2) Improper operation of protection devices

In addition, it has been reported that even protection devices installed in compliance with the Distribution Code have not been operated properly, leading to a decline in reliability.

- In some cases, the protective fuses used in distribution transformers are not properly rated, or the primary and secondary fuses of the transformer are not coordinated[19].
- It has been reported that in the event of 33kV circuit breakers, disconnectors and other peripheral equipment failing at various substations, power supply is continued by bypassing them. Such incorrect use of protection devices impacts significantly on the entire protection system. In other words, if a fault occurs anywhere in the network, it will cause a ripple effect that will interrupt all 33kV feeders from the transmission substation, resulting in widespread and prolonged power outages[20].

(3) Long fault restoration time

In Nigeria, eight hours is permissible as the power outage time required to pinpoint faults and restore power supply during distribution system faults. This means that once a power outage occurs due to a fault, the outage may continue for up to eight hours. With such a system for fault restoration, it seems difficult to ensure a level of supply reliability capable of eliciting customer satisfaction.

Table 3-2.3 shows the yearly transition in the number of faults recovered within eight hours. Table 3-2.4 shows the percentage of faults (Table 3-2.1) that were recovered within eight hours (Table 3-2.3). Table 3-2.4 shows that the rate of faults restored within eight hours varies from 25 to 96% among DisCos, which suggests that there are actually more than eight hours of power outages.

Abuja DisCo conducts the following analysis in the PIP regarding the rate of faults restored within eight hours[21].

In the capital area and urban centers, on average, 80% of faults are resolved in under eight hours. 10% of the faults are cleared in eight to 24 hours and only about 5% require a 48-hour recovery time. The reason why the recovery time of 48 hours is required is due to the strategic inventory shortage of repair equipment/materials and the constraint of equipment supply.

As this data shows, the fault recovery time assumes a standard that allows for long power outages. To keep customers satisfied with supply reliability going forward, it will be necessary to reduce the fault recovery time such that it does not affect the lives of customers and industrial activities.

[19] How to increase network reliability and quality of supply in manageable areas with economic considerations, AF-Mercados EMI, Mar. 2020, Page 36, 44, 53
[20] Draft PIP of Port Harcourt DisCo, Table 38, Page 36
[21] Draft PIP of Abuja DisCo Page 16

As the abovementioned fault data shows, power outages caused by faults occur frequently in power distribution equipment and once a power outage occurs, restoring the supply takes a long time. Accordingly, the need to boost the supply reliability of the distribution system by reducing the incidence of equipment failures and the fault recovery time is acknowledged. Measures such as improving the system configuration to help pinpoint faults and improving the restoration work method are considered key to accelerating fault resolution.

Table 3-2.3 Number of faults cleared within eight hours (cases/year)

Faults cleared within eight hours (frequency/year/DisCo)					
DisCo	2015	2016	2017	2018	2019
Abuja	757	1,440	1,668	1,027	182
Benin	968	1,158	951	898	755
Eko	564	354	517	527	603
Enugu	2,858	2,545	3,018	2,516	224
Ibadan	2,407	2,080	1,254	1,330	1,480
Ikeja	387	308	342	437	507
Jos	314	431	487	552	793
Kaduna	621	715	696	927	929
Kano	171	266	690	922	1,062
Port Harcourt	283	209	96	61	45
Yola	238	244	262	288	294

Source: NERC

Table 3-2.4 Rate of faults cleared within eight hours

Rate of faults cleared within eight hours (2019)			
DisCo	Total of fault	Cleared within eight hrs.	Rate (%)
Abuja	207	182	88
Benin	1,411	755	53
Eko	1,143	603	53
Enugu	278	224	80
Ibadan	1,537	1,480	96
Ikeja	949	507	53
Jos	983	793	81
Kaduna	1,137	929	82
Kano	1,282	1,062	83
Port Harcourt	183	45	25
Yola	308	294	95

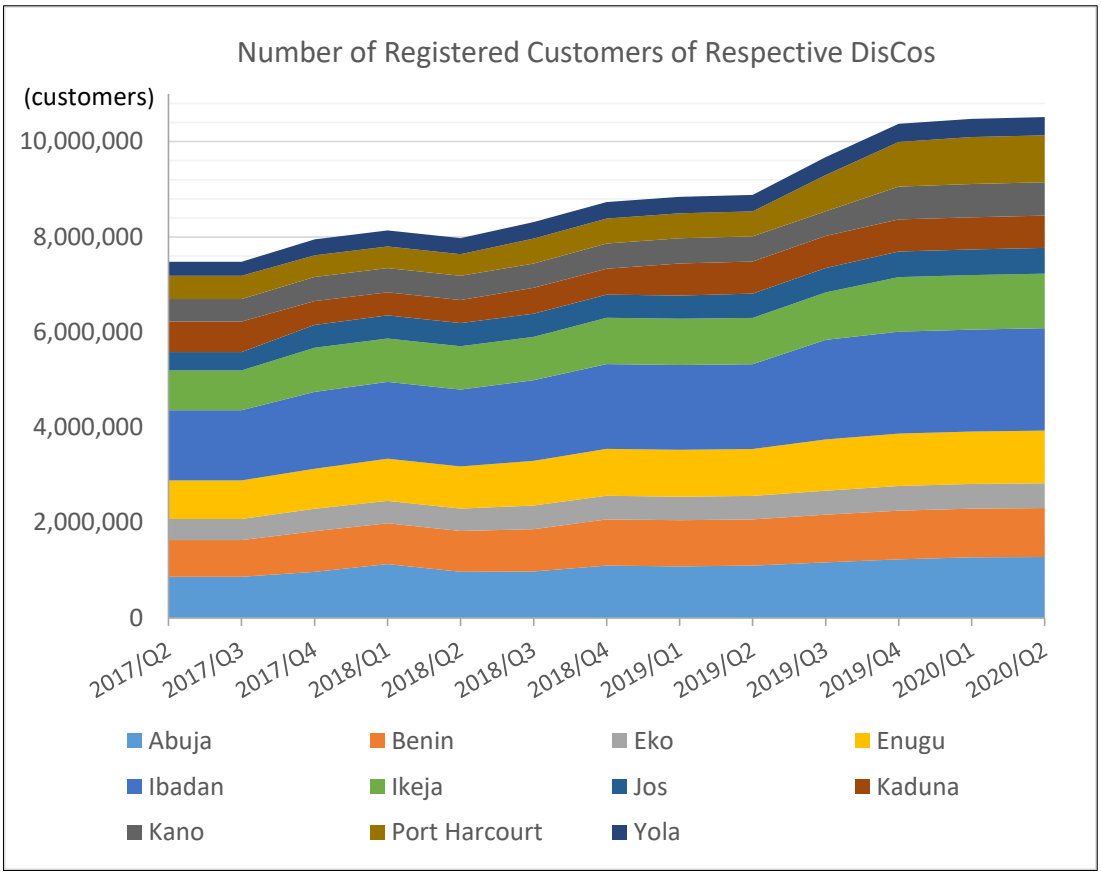
Source: NERC

3-3 Business conditions and issues of DisCos

3-3-1 Business conditions of DisCos

(1) Number of customers and volume of power distributed

The customer totals for all eleven power distribution companies (DisCos) from 2017 for the second quarter (Q2) to 2020 Q2 are shown in Figure 3-3.1 and Table 3-3.1, while the customer share of each DisCo as a proportion of the total number of customers for all DisCos is shown in Table 3-3.2. The customer total for the eleven DisCos has continued growing since 2017 Q2, except 2018 Q2 and exceeded 10 million in the fourth quarter (Q4) of 2019.



Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

Figure 3-3.1 Number of customers of DisCos

According to recent data, Ibadan DisCo has the most customers, comprising about 20% of the overall total for all DisCos, followed by Abuja DisCo, Ikeja DisCo, Enugu DisCo and Benin DisCo, whereby these four DisCos collectively comprise 54% of all customers. The DisCo with the fewest customers is Yola DisCo, comprising only 3.6% of the total number.

Although customer numbers and lists are the key pieces of information for managing DisCos, this information does not appear to be accurately understood by respective DisCos. In Table 3-3.1, the quarters marked in pink are those in which customer totals have declined compared to the previous quarter, while quarters marked in yellow are those in which the number of customers has remained

unchanged. In response, NERC is implementing the Customer Enumeration Program, which encourages and promotes the efforts of DisCos to accurately identify customers connected to each distribution line and distribution transformer. However, as shown in Table 3-3.2, it appears as though the program has not yet been implemented to completion.

Table 3-3.1 Number of customers of DisCos

c	2017/Q2	2017/Q3	2017/Q4	2018/Q1	2018/Q2	2018/Q3	2018/Q4	2019/Q1	2019/Q2	2019/Q3	2019/Q4	2020/Q1	2020/Q2
Abuja	862,696	862,696	966,192	1,129,521	967,667	973,926	1,097,279	1,080,637	1,097,279	1,164,748	1,228,288	1,271,563	1,277,921
Benin	771,226	771,226	853,587	856,292	856,292	888,143	970,000	970,000	970,000	1,001,821	1,022,458	1,022,458	1,027,570
Eko	442,201	442,201	471,013	470,766	470,766	496,442	496,442	493,639	493,639	504,225	518,192	518,192	520,783
Enugu	809,829	809,829	840,208	884,992	884,992	938,311	985,112	985,112	985,112	1,075,626	1,100,292	1,100,292	1,105,793
Ibadan	1,474,364	1,474,364	1,613,635	1,613,635	1,613,635	1,693,346	1,779,751	1,779,751	1,779,751	2,090,781	2,139,741	2,139,741	2,150,440
Ikeja	835,734	835,734	927,672	910,338	910,338	910,465	972,589	972,589	972,589	996,769	1,145,622	1,145,622	1,145,622
Jos	384,691	384,691	478,698	486,198	486,198	486,580	486,580	486,198	510,198	512,108	537,726	537,726	540,415
Kaduna	641,582	641,582	500,476	484,310	484,310	543,654	543,654	673,848	673,848	673,848	673,848	675,059	678,434
Kano	472,453	472,453	506,638	508,640	508,640	508,943	529,114	529,114	529,114	516,947	689,304	699,618	699,618
Port Harcourt	488,600	488,600	453,818	453,818	453,818	524,255	524,255	523,693	523,693	761,105	937,305	985,782	985,782
Yola	293,478	293,478	335,184	337,220	337,220	346,342	346,342	346,220	346,220	376,751	381,803	381,803	383,712
All DisCos	**7,476,856**	**7,476,856**	**7,947,121**	**8,135,730**	**7,006,209**	**8,310,408**	**8,731,118**	**8,840,801**	**8,881,443**	**9,674,729**	**10,374,579**	**10,477,856**	**10,516,090**

Legend: number customers remained unchanged from the previous quarter, number of customers

Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

Table 3-3.2 Share of customers of each DisCo as a proportion of the total of all DisCos

DisCos	2017/Q3	2017/Q3	2017/Q4	2018/Q1	2018/Q2	2018/Q3	2018/Q4	2019/Q1	2019/Q2	2019/Q3	2019/Q4	2020/Q1	2020/Q2
Abuja	11.5%	11.5%	12.2%	13.9%	13.8%	11.7%	12.6%	12.2%	12.4%	12.0%	11.8%	12.1%	12.2%
Benin	10.3%	10.3%	10.7%	10.5%	12.2%	10.7%	11.1%	11.0%	10.9%	10.4%	9.9%	9.8%	9.8%
Eko	5.9%	5.9%	5.9%	5.8%	6.7%	6.0%	5.7%	5.6%	5.6%	5.2%	5.0%	4.9%	5.0%
Enugu	10.8%	10.8%	10.6%	10.9%	12.6%	11.3%	11.3%	11.1%	11.1%	11.1%	10.6%	10.5%	10.5%
Ibadan	19.7%	19.7%	20.3%	19.8%	23.0%	20.4%	20.4%	20.1%	20.0%	21.6%	20.6%	20.4%	20.4%
Ikeja	11.2%	11.2%	11.7%	11.2%	13.0%	11.0%	11.1%	11.0%	11.0%	10.3%	11.0%	10.9%	10.9%
Jos	5.1%	5.1%	6.0%	6.0%	6.9%	5.9%	5.6%	5.5%	5.7%	5.3%	5.2%	5.1%	5.1%
Kaduna	8.6%	8.6%	6.3%	6.0%	6.9%	6.5%	6.2%	7.6%	7.6%	7.0%	6.5%	6.4%	6.5%
Kano	6.3%	6.3%	6.4%	6.3%	7.3%	6.1%	6.1%	6.0%	6.0%	5.3%	6.6%	6.7%	6.7%
Port Harcourt	6.5%	6.5%	5.7%	5.6%	6.5%	6.3%	6.0%	5.9%	5.9%	7.9%	9.0%	9.4%	9.4%
Yola	3.9%	3.9%	4.2%	4.1%	4.8%	4.2%	4.0%	3.9%	3.9%	3.9%	3.7%	3.6%	3.6%
All DisCos	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

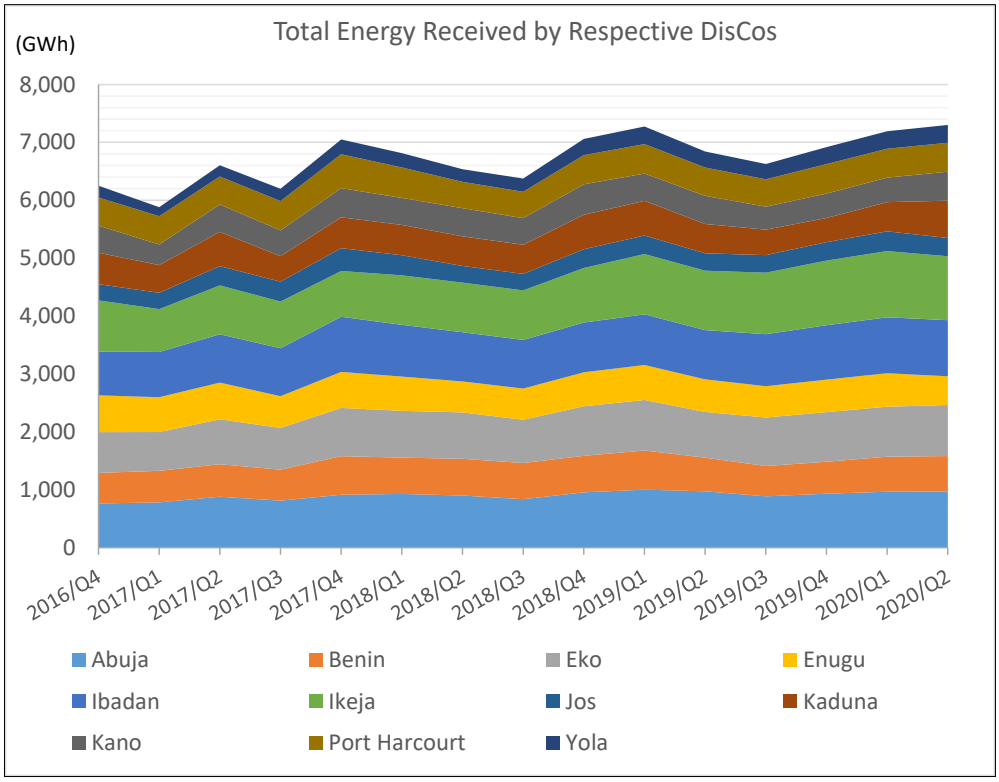
Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

The volume of power received from the Transmission Company of Nigeria (TCN) by DisCos for 2016 Q4 to 2020 Q2 is shown in Figure 3-3.2. The total volume of power transmitted from TCN to DisCos, while showing a moderate upward trend, has repeatedly increased and decreased, peaking at 7,275 GWh in 2019 Q1 (the first quarter).

The volume of power received from TCN by each DisCo from 2016 Q4 to 2020 Q2 is shown in Table 3-3.3 and the share of the electricity volume received by each DisCo as a proportion of the volume of power received by all DisCos are shown in Table 3-3.4. Since 2019 Q1, Ikeja DisCo has received the most electricity from TCN, followed by Abuja and Ibadan DisCos (the second and third positions have changed between quarters), while Yola and Jos DisCos received the smallest electricity volume from TCN and each comprises only 4% or so of the total.

In Table 3-3.4, the quarters in which the share of power received by a DisCo in the total electricity received exceeds the electricity allocated share assumed in the Multi-Year Tariff Order (MYTO) are marked in light green. Abuja DisCo, Eko DisCo and Port Harcourt DisCo have exceeded their MYTO allocations in every quarter since 2016 Q4, while Kano DisCo has received below its MYTO allocation

in every quarter since 2016 Q4.



Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

Figure 3-3.2 Volume of power received by DisCos

Table 3-3.3 Volume of power received by DisCos

DisCos	2016/Q4	2017/Q1	2017/Q2	2017/Q3	2017/Q4	2018/Q1	2018/Q2	2018/Q3	2018/Q4	2019/Q1	2019/Q2	2019/Q3	2019/Q4	2020/Q1	2020/Q2
Abuja	763	782	880	812	914	928	900	837	955	1,002	973	887	932	966	971
Benin	529	545	561	535	666	627	635	625	631	676	581	523	552	605	611
Eko	703	670	776	721	833	809	801	747	856	873	790	838	857	864	882
Enugu	636	602	634	548	623	591	535	539	587	604	563	541	561	579	496
Ibadan	758	781	835	828	952	894	850	840	860	874	851	898	940	965	969
Ikeja	882	741	844	807	791	855	857	856	942	1,043	1,026	1,063	1,117	1,144	1,105
Jos	280	281	333	344	394	347	288	285	324	320	300	303	318	341	315
Kaduna	543	480	591	440	533	524	511	503	595	599	507	440	417	504	645
Kano	468	355	474	445	504	466	487	460	526	471	486	397	422	424	500
Port Harcourt	487	488	483	507	586	526	455	455	504	509	489	473	510	499	500
Yola	203	156	194	212	255	248	218	229	280	304	277	264	293	302	308
All DisCos	**6,252**	**5,881**	**6,605**	**6,200**	**7,051**	**6,815**	**6,537**	**6,376**	**7,062**	**7,275**	**6,843**	**6,627**	**6,918**	**7,195**	**7,303**

Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

Table 3-3.4 Share of the volume of power received by each DisCos in the total electricity volume received by DisCos

DisCos	MYTO Allocation	2016/Q4	2017/Q1	2017/Q2	2017/Q3	2017/Q4	2018/Q1	2018/Q2	2018/Q3	2018/Q4	2019/Q1	2019/Q2	2019/Q3	2019/Q4	2020/Q1	2020/Q1
Abuja	11.5%	12.2%	13.3%	13.3%	13.1%	13.0%	13.6%	13.8%	13.1%	13.5%	13.8%	14.2%	13.4%	13.5%	13.4%	13.3%
Benin	9.0%	8.5%	9.3%	8.5%	8.6%	9.4%	9.2%	9.7%	9.8%	8.9%	9.3%	8.5%	7.9%	8.0%	8.4%	8.4%
Eko	11.0%	11.2%	11.4%	11.7%	11.6%	11.8%	11.9%	12.3%	11.7%	12.1%	12.0%	11.5%	12.6%	12.4%	12.0%	12.1%
Enugu	9.0%	10.2%	10.2%	9.6%	8.8%	8.8%	8.7%	8.2%	8.5%	8.3%	8.3%	8.2%	8.2%	8.1%	8.0%	6.8%
Ibadan	13.0%	12.1%	13.3%	12.6%	13.4%	13.5%	13.1%	13.0%	13.2%	12.2%	12.0%	12.4%	13.6%	13.6%	13.4%	13.3%
Ikeja	15.0%	14.1%	12.6%	12.8%	13.0%	11.2%	12.5%	13.1%	13.4%	13.3%	14.3%	15.0%	16.0%	16.1%	15.9%	15.1%
Jos	5.5%	4.5%	4.8%	5.0%	5.5%	5.6%	5.1%	4.4%	4.5%	4.6%	4.4%	4.4%	4.6%	4.6%	4.7%	4.3%
Kaduna	8.0%	8.7%	8.2%	8.9%	7.1%	7.6%	7.7%	7.8%	7.9%	8.4%	8.2%	7.4%	6.6%	6.0%	7.0%	8.8%
Kano	8.0%	7.5%	6.0%	7.2%	7.2%	7.1%	6.8%	7.4%	7.2%	7.4%	6.5%	7.1%	6.0%	6.1%	5.9%	6.8%
Port Harcourt	6.5%	7.8%	8.3%	7.3%	8.2%	8.3%	7.7%	7.0%	7.1%	7.1%	7.0%	7.1%	7.1%	7.4%	6.9%	6.8%
Yola	3.5%	3.2%	2.7%	2.9%	3.4%	3.6%	3.6%	3.3%	3.6%	4.0%	4.2%	4.0%	4.0%	4.2%	4.2%	4.2%
All DisCos	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Target Tree	**37.5%**	**37.6%**	**37.3%**	**37.9%**	**37.7%**	**36.0%**	**38.0%**	**39.1%**	**38.3%**	**39.0%**	**40.1%**	**40.8%**	**42.1%**	**42.0%**	**0.0%**	**0.0%**

Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

Table 3-3.5 shows the number of customers and the volume of power distributed per unit area (based on electricity received from TCN) for each DisCo. In terms of the densities for both customers and power distribution, Eko and Ikeja DisCos, which share Lagos State, have by far the highest, while Yola, Jos and Kaduna DisCos have the lowest. If these indicators are low, it can be inferred that management efficiency will decline due to the longer distribution lines per unit of power supplied, increased staff travel time and reduced efficiency of service operations. In addition, although the ratio of large (maximum demand) users to small users is thought to affect management efficiency, information on the ratio of large to small users at each DisCo has not been collected at this time. Previously, it was recognized that a larger percentage of industrial and commercial users would result in a higher bill collection rate and streamlined management, but these classifications have been abolished from the 2020 MYTO.

Table 3-3.5 Number of customers and the amount of power distributed per unit area for each DisCo

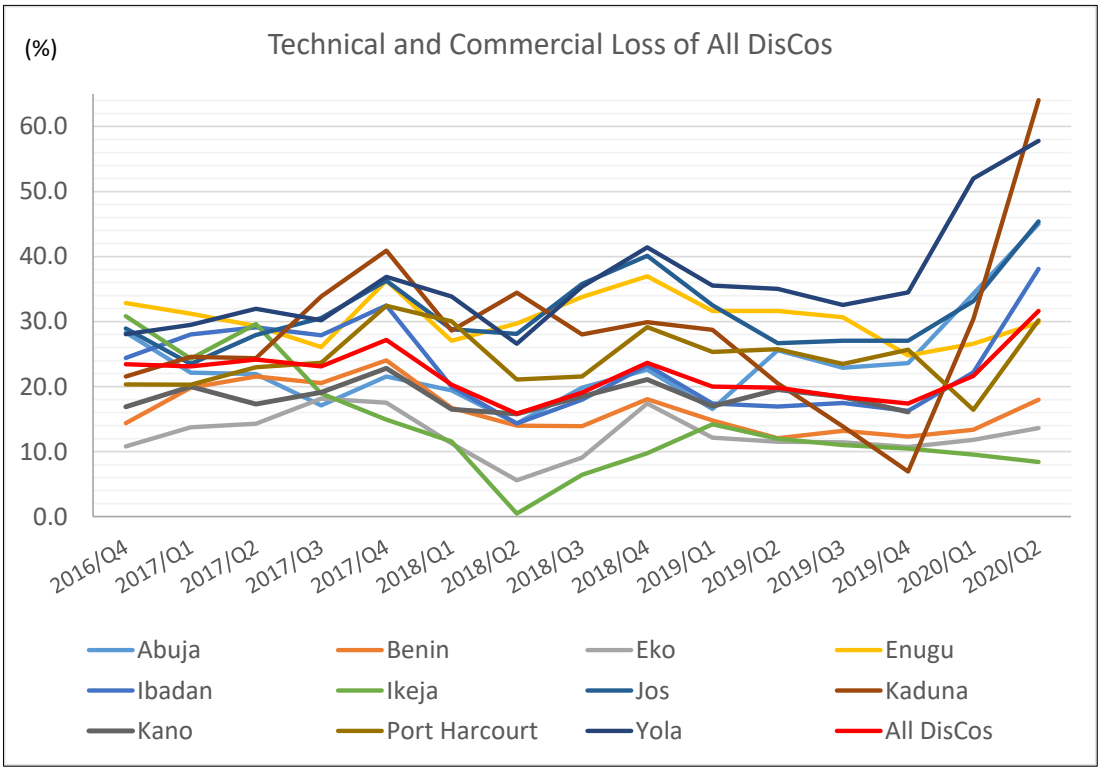
DisCos	Conerage Area (km^2)	Population (2016)	Population Density (person/km)	Average Nos. of Customers (2019/Q3-2020Q2)	Customer Density (customer/km^2)	Energy Received (GWh/year) (2019/Q3-2020/Q2)	Energy Received per year per Customer (KWh/year/customer)	Energy Received per year per Inhabitant (GWh/year/person)	Energy Received per year per km (GWh/year/km^2)
Abuja	140,628	16,117,258	114.6	1,235,630	8.8	3,756	3,040	233	26,709
Benin	57,353	17,841,450	311.1	1,018,577	17.8	2,291	2,249	128	39,946
Eko	1,673	6,275,299	3,752.0	515,348	308.1	3,441	6,677	548	2,057,399
Enugu	29,525	21,955,414	743.6	1,095,501	37.1	2,177	1,987	99	73,734
Ibadan	91,292	20,957,062	229.6	2,130,176	23.3	3,772	1,771	180	41,318
Ikeja	1,673	6,275,299	3,752.0	1,108,409	662.7	4,429	3,996	706	2,648,132
Jos	132,859	19,736,533	148.6	531,994	4.0	1,277	2,400	65	9,612
Kaduna	148,588	22,205,933	149.4	675,297	4.5	2,006	2,971	90	13,500
Kano	67,477	26,736,374	396.2	651,372	9.7	1,743	2,676	65	25,831
Port Harcourt	49,087	18,930,331	385.6	917,494	18.7	1,982	2,160	105	40,377
Yola	207,790	16,469,590	79.3	381,017	1.8	1,167	3,063	71	5,616
All DisCos	**927,944**	**193,500,543**	**208.5**	**10,260,814**	**11.1**	**28,043**	**2,733**	**145**	**30,221**

Note: The area and population of the jurisdictions of Eko and Ikeja DisCos are deemed to be the same, according to 2011 BPE data. Here, both are assumed to have half the area and population of Lagos State.

Source: Information Brochure of Distribution Companies, BPE 2011, NERC Quarterly Report and statistics published by the Nigeria Bureau of Statistics.

(2) Power distribution losses

Figure 3-3.3 shows the technical and commercial losses (defined as 1 - billed power/received power) for each DisCo for 2016 Q4 to 2020 Q2. Technical and commercial losses are low at the three DisCos of Ikeja, Eko and Benin at 8-18% and high at the four DisCos of Kaduna, Yola, Jos and Abuja, at around 45 to 64%. These four DisCos saw a significant increase in technical and commercial losses in 2020 Q1 and Q2. By analyzing any changed circumstances when such losses increase or decrease considerably, it may be possible to find the cause of the increase or decrease in losses and ultimately establish countermeasures.



Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

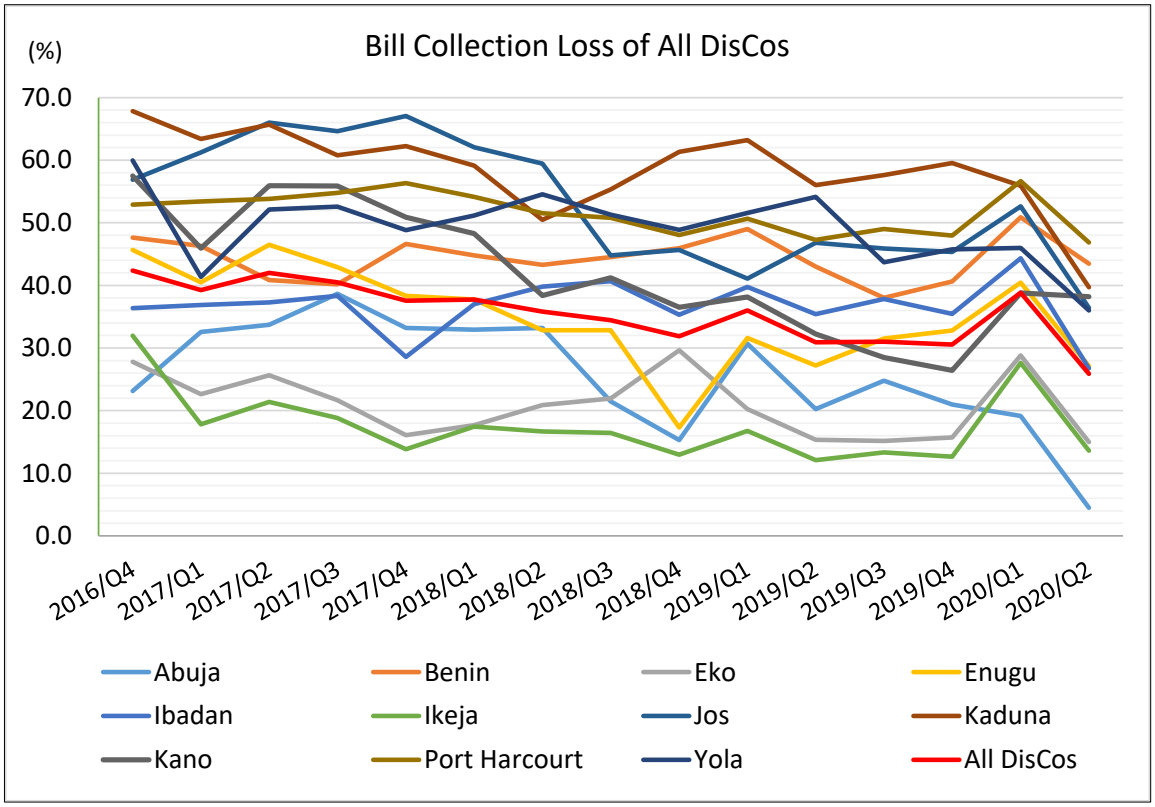
Figure 3-3.3 Technical and commercial losses of DisCos

Figure 3-3.4 shows the change in the bill collection losses (defined as 1 - the amount of bill collected/amount billed) for each power company from 2016 Q4 to 2020 Q2. Bill collection losses were low at the three DisCos of Abuja, Ikeja and Eko, at 4 to 15% and high at the DisCos of Port Harcourt, Benin, Kaduna, Kano, Jos and Yola at 36 to 47%. In 2020 Q1, bill collection losses increased by about 10% except for the three DisCos of Abuja, Yola and Kaduna. In 2020 Q2, however, bill collection loss decreased considerably by 7-17% except for Kano DisCo.

Figure 3-3.5 shows the aggregated (ATC&C) losses, (defined as (1 - (1-technical and commercial losses) multiplied by (1 - bill collection losses))) for each DisCo from 2016 Q4 to 2020 Q2. The DisCos are divided into three groups: those with aggregated losses of 20-30% (DisCos of Eko and Ikeja), those with losses of around 50% (the five DisCos of Abuja, Benin, Enugu, Ibadan and Kano) and the remainder with losses of 60-80%. In 2020 Q1, all DisCos saw an increase in ATC&C losses

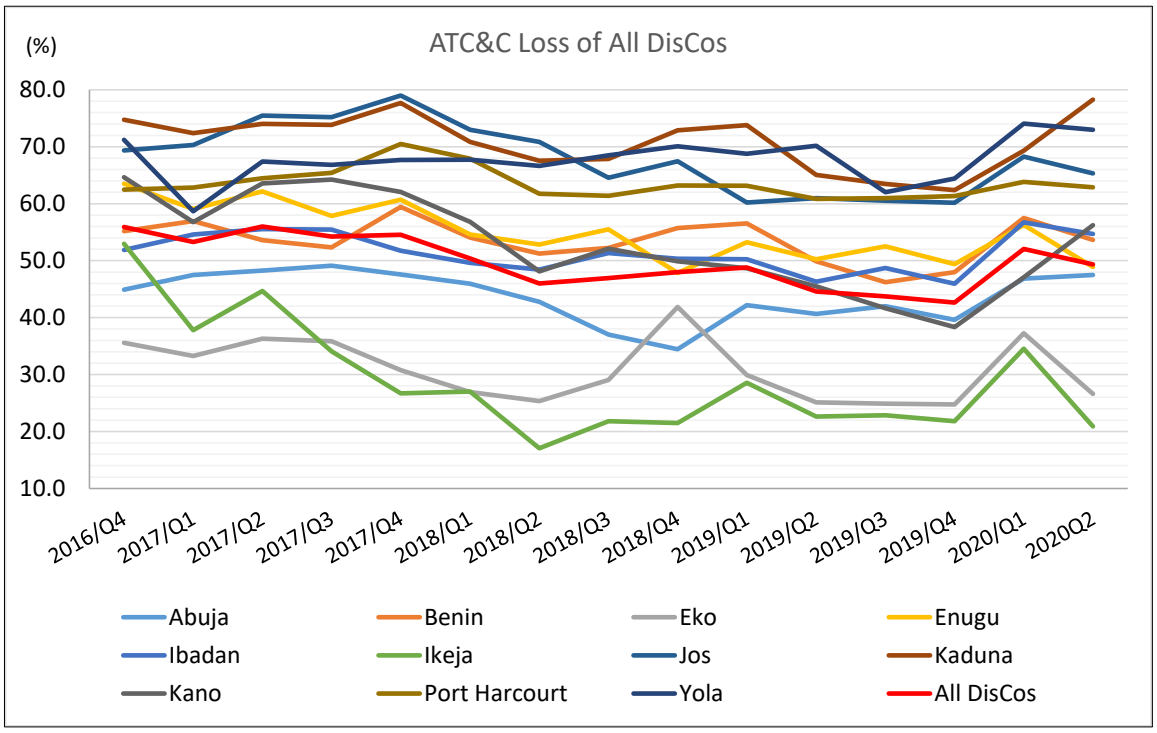
of 2-12% (average of nearly 10%), while the aggregate loss increased in three DisCos of Abuja, Kaduna and Kano, declined by more than 10% in Eko and Ikeja DisCos and slightly decreased in other DisCos in 2020 Q2.

As shown above, the loss ratios do not maintain a constant value or change with a certain trend, but instead increase or decrease noticeably quarter by quarter. This is presumably because the respective loss reduction measures are not being implemented in a stable or steady manner.



Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

Figure 3-3.4 Bill Collection loss of DisCos



Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

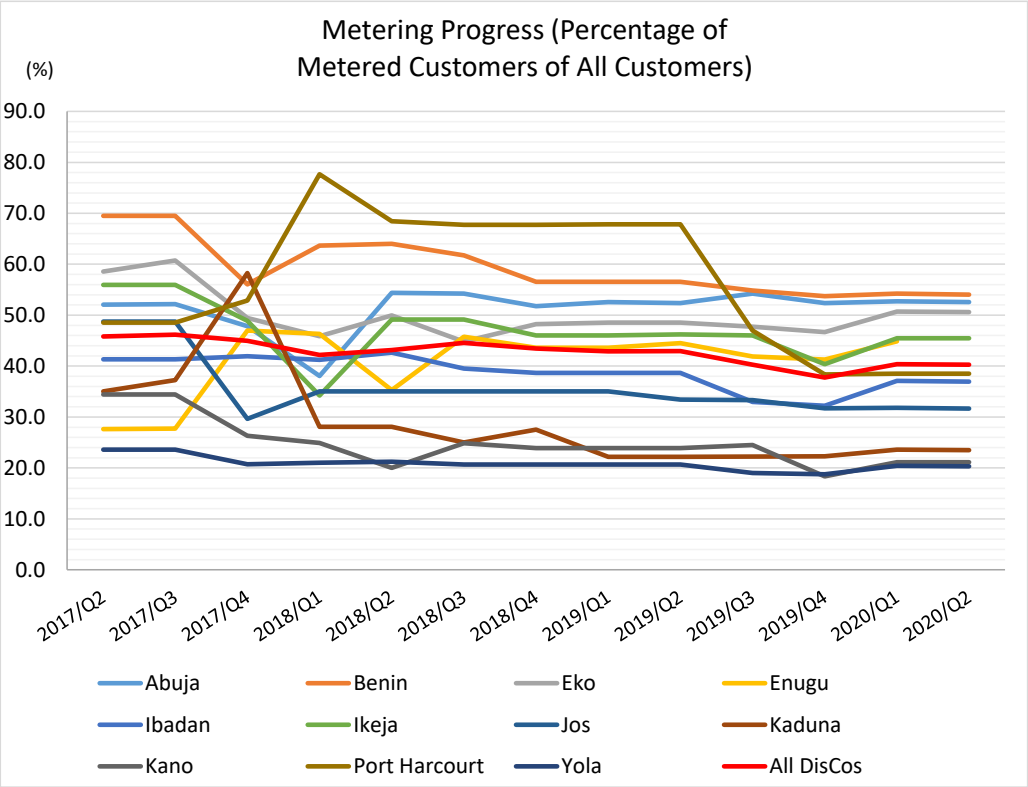
Figure 3-3.5 Aggregated loss of DisCos

(3) Installation of meters

Figure 3-3.6 shows the customer meter installation rate (defined as the number of customers with meters/number of registered customers) for each DisCo since 2016 Q4. The installation rate of customer meters in Nigeria is very low, at 40% of the weighted average for all DisCos. Even though Abuja and Benin DisCos have the highest installation rates, even their meter installation rates are less than 55%. The meter installation rates of Kaduna, Kano and Yola DisCos, which have the lowest installation rate, are only about 20%. Since 2018, when a Meter Asset Provider (MAP) Regulation was established and implemented, customer meter installation rates have not substantially increased. On the contrary, the installation rate largely decreased in Port Harcourt and Benin DisCos. Clearly, measures to promote customer meter installation, such as the enactment and implementation of the MAP Regulation, have not elicited the expected results.

Considering that the overall DisCo (weighted) average of customer meter installation rate is about 40% and the overall DisCos' (weighted) average of technical and commercial losses is about 30%, i.e. DisCos are billing for about 70% of the power received from TCN and given an estimated technical loss in the power distribution sector of around 10%, it can be inferred that a significant portion of bills are issued to customers without meters (so-called estimated bill).

As mentioned above, given that the data on the number of customers is unlikely to be updated promptly, it is unlikely that the customer meter installation rate would be accurately known either.

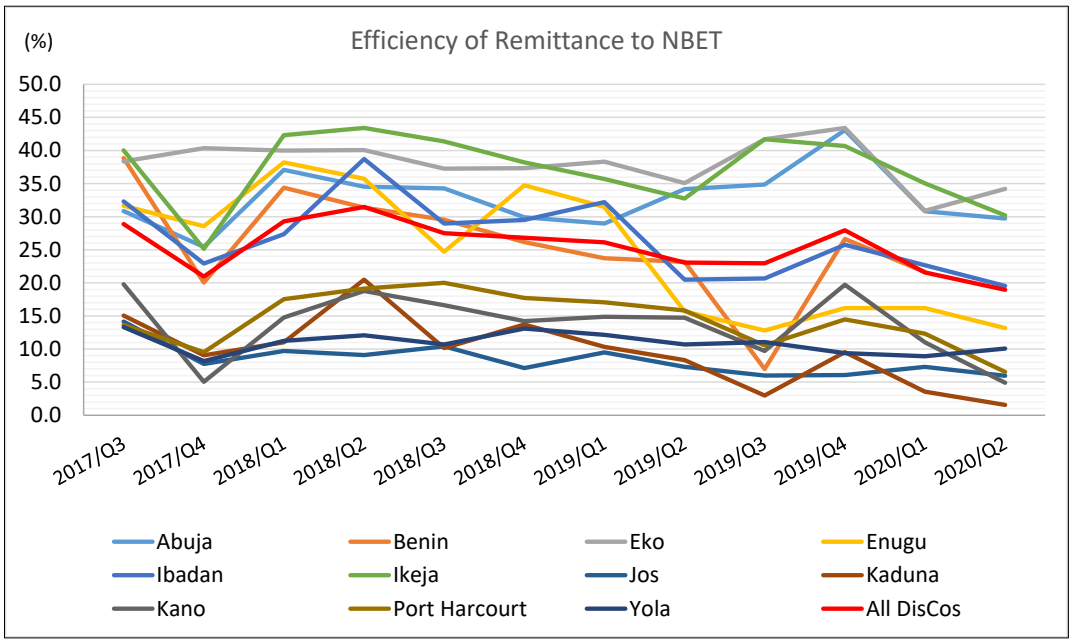


Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

Figure 3-3.6 Costumer meter installation rates for each DisCo

(4) Remittance to NBET and TCN

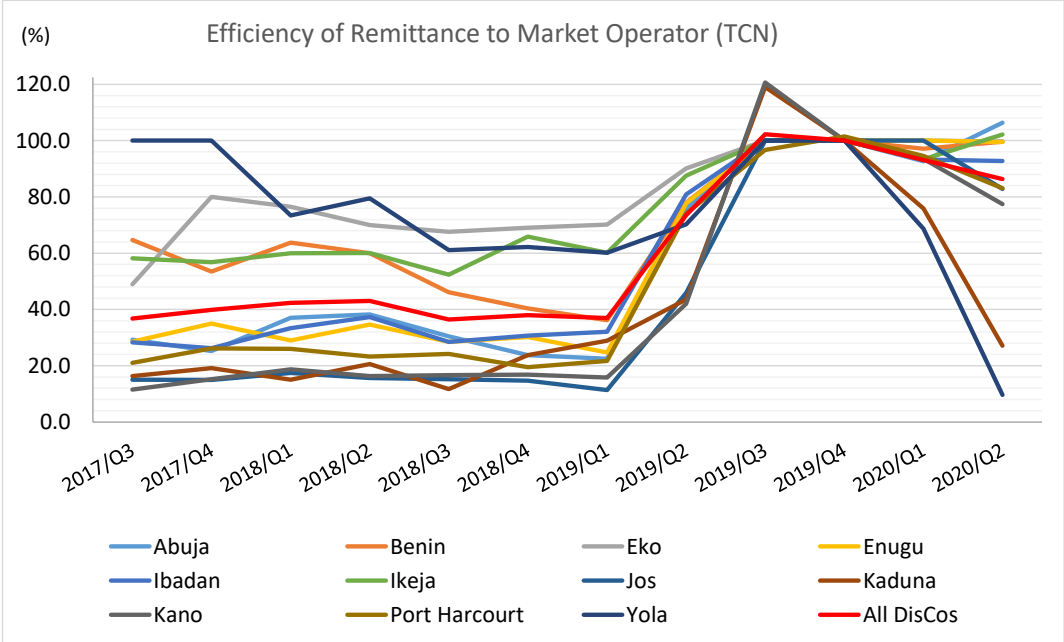
The remittance rate to NBET (Nigeria Bulk Electricity Trading Plc, a Nigerian electricity bulk trader) and Market Operator (MO, for which TCN works) (defined as the amount paid to NBET and MO/amount billed by NBET and MO) is shown in Figure 3-3.7 and Figure 3-3.8, respectively. Regarding the remittance rate to NBET, there are three groups: the 30-35% group (three DisCos of Abuja, Eko and Ikeja), the group of around 20% (two DisCos of Benin and Ibadan) and the group with less than 15% (six DisCos of Enugu, Jos, Kaduna, Kano, Port Harcourt and Yola). The fact that even the group with the highest remittance rate can only pay about 1/3 of the power generation cost suggests that none of the DisCos are in a sustainable financial position.



Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

Figure 3-3.7 Remittance rate to the NBET for each DisCo

In terms of payments to the MO, DisCos have achieved payment rates exceeding 80% since 2019 Q3, except for the two DisCos of Kaduna and Yola. While this may be due to the fact that i) billing from the MO constitutes about 20% of the NBET billing and ii) government subsidies are applied to payments to NBETs and payments to the MO seem prioritized in payments from the DisCos. In 2020, the payment rates to MO from DisCos of Kaduna and Yola declined significantly by 50 and 60%, respectively for some reason.

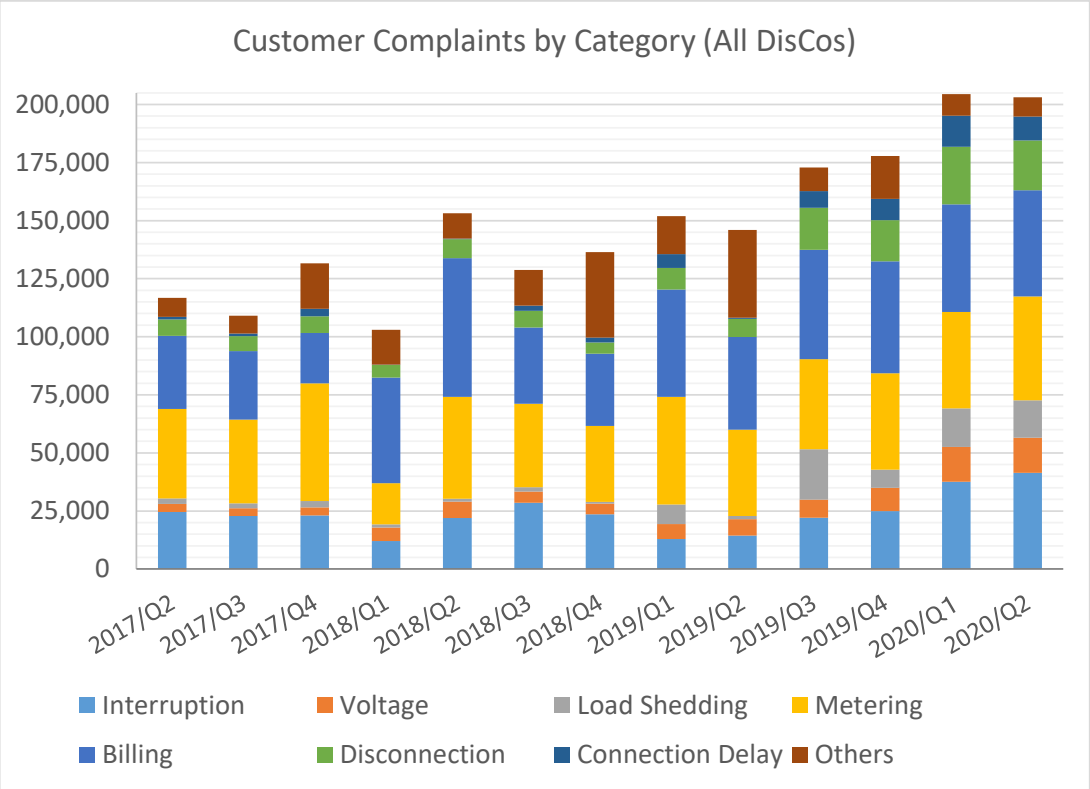


Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

Figure 3-3.8 Remittance rate to the MO for each DisCo

(5) Complaints from customers

The number of complaints by type for each DisCo from 2017 Q2 to 2020 Q2 is shown in Figure 3-3.9 and the total number is rising. In terms of percentage of complaints by complaint type, complaints about billing prevail, comprising 23% of all complaints (2020 Q2), followed by complaints about meter installation and reading, which comprise 22% and those about power interruption, comprising 20%. These three complaint types comprise 65% of the total (2020 Q2).

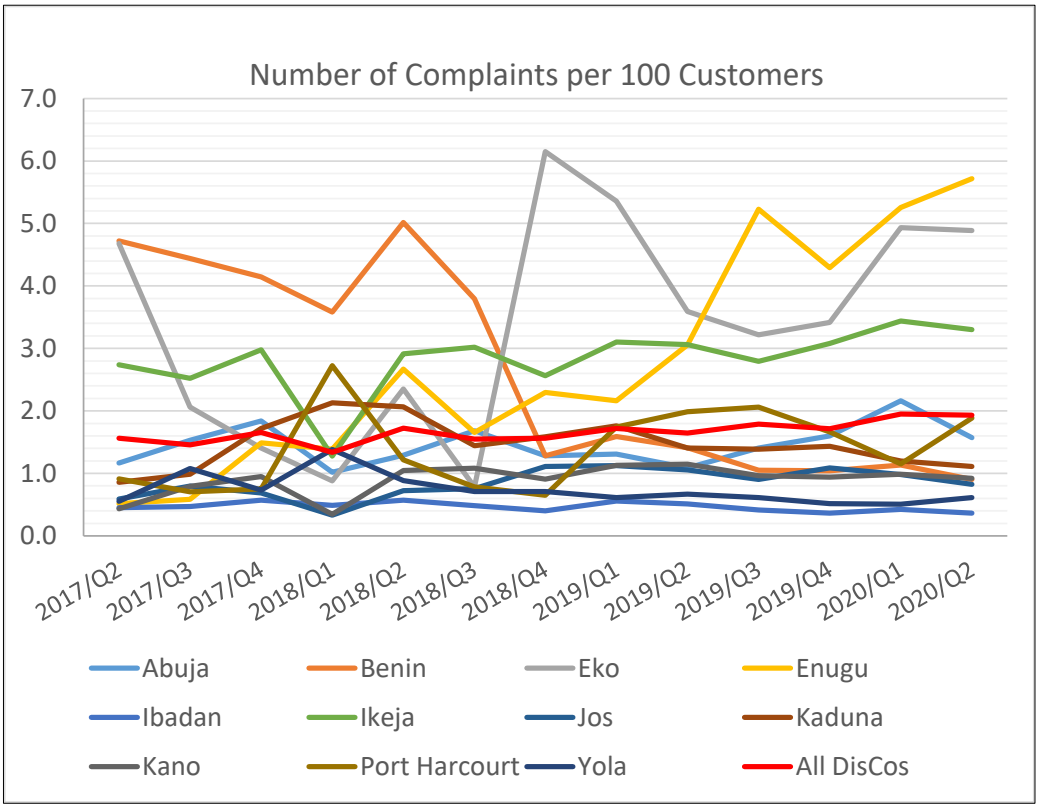


Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

Figure 3-3.9 Number of complaints by complaint type

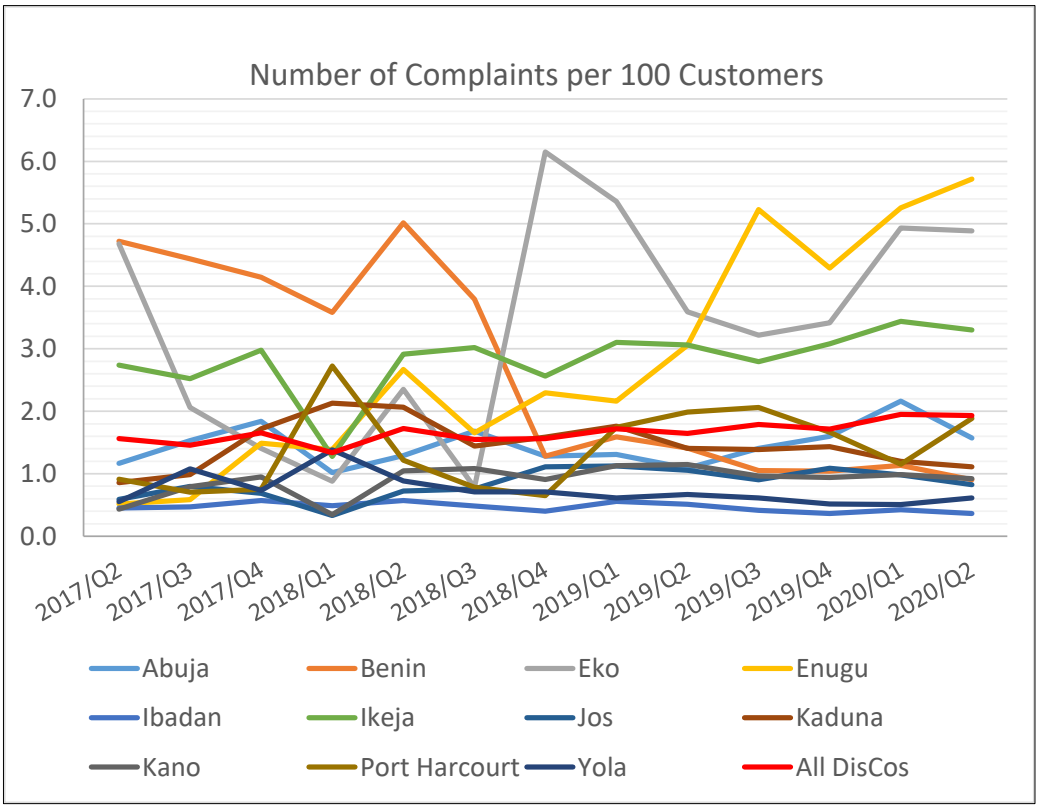
Figure 3-3.10 shows the number of complaints per 100 customers for each DisCo from 2017 Q2 to 2020 Q2. Overall, the number of complaints per 100 customers is slowly increasing. The highest number of complaints per 100 customers came from the three DisCos including Enugu, Eko and Ikeja. This is not to say that the service level at these three DisCos is low. Instead, this is considered attributable to the numerous industrial and commercial users in these DisCos' franchise areas and the high level of service required by these customers.

Figure 3-3.11 shows the rate of unresolved complaints at each DisCo from 2017 Q2 to 2020 Q2. Although the rate of unresolved complaints is declining overall, about 7% of complaints remain unresolved by DisCos. This data is a compilation of self-reports from each DisCo and may not necessarily mean that 90% of complaints have actually been resolved. NERC has established one contact point in the jurisdiction of each DisCo to receive complaints that are not resolved by the DisCo.



Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

Figure 3-3.10 Number of complaints per 100 customers for each DisCo



Source: NERC Quarterly Report, https://nerc.gov.ng/index.php/library/documents/NERC-Reports/NERC-Quarterly-Reports/

Figure 3-3.11 Rate of unresolved complaints at each DisCo

(6) Financial Statements of DisCos

In this subsection, the financial statements of three DisCos are analyzed, namely, Eko DisCo, an DisCo with a comparatively favorable business environment, Port Harcourt DisCo, conversely, experiencing a comparatively harsh business environment and Abuja DisCo as an intermediate example.

Profit/Loss Statements of Abuja DisCo from 2015 to 2019 are shown in Table 3-3.6. Revenue of 2019 increased to 3.1 times the figure for 2018. Changes in received energy (see above (1)), distribution loss (see above (2) and tariff level of 2019 (comparison of tariff levels of 2018 and 2019 in Minor Review of MYTO 2015) do not account for the increase in revenue. *Notes to the Financial Statements* of 2019 explains that NERC awarded NGN 102.2 billion as a tariff shortfall for 2015-2018 and NGN 62.7 billion as a tariff shortfall for 2019 and those were recorded as other revenue, while revenue from customers in 2019 increased only to NGN 88.3 billion from NGN 82.2 billion of 2018. With the other revenue, the Net Profit/Loss Margin (defined as Net Profit or Loss ÷ Sales) for the year reached 49% and administrative expenses declined considerably, for reasons which remain to be clarified.

Table 3-3.6 Profit/Loss Statement of Abuja DisCo

PROFIT/LOSS STATEMENT (NGN billion)	2019	2018	2017	2016	2015
Revenue	255.99	82.22	65.72	61.15	62.53
Cost of sales	▲104.05	▲95.40	▲85.01	▲66.49	▲54.20
Gross profit/loss	***151.94***	***▲13.18***	***▲19.29***	***▲5.34***	***8.34***
Other operating income	2.63	1.41	0.37	0.41	0.52
Impairment loss on trade and other receivables and contract assets	▲21.94	▲19.19	▲8.56	-	-
Administrative expense	▲25.03	▲31.18	▲22.00	▲30.38	▲48.06
Operating loss	***107.61***	***▲62.14***	***▲49.47***	***▲35.31***	***▲39.20***
(Operating Margin)	*42%*	*▲76%*	*▲75%*	*▲58%*	*▲63%*
Finance cost	▲6.04	▲24.41	▲26.90	▲12.24	▲2.82
Finance income	24.23	0.94	0.48	0.26	0.30
Net finance cost	*18.19*	*▲23.47*	*▲26.42*	*▲11.99*	*▲2.52*
Loss before minimum and income tax	*125.79*	*▲85.62*	*▲75.90*	*▲47.30*	*▲41.72*
Minimum tax	▲1.25	▲0.10	▲0.08	▲0.15	▲0.25
Income tax	▲0.25	-	-	-	-
Profit/Loss for the year	***124.29***	***▲85.72***	***▲75.98***	***▲47.45***	***▲41.97***
(Net Profit/Loss Margin)	*49%*	*▲104%*	*▲116%*	*▲78%*	*▲67%*

Source: Annual Report, 2019-2016, Abuja Electricity Distribution Plc

Balance sheets for Abuja DisCo from 2015 to 2019 are given in Table 3-3.7. Though the trade and other receivables (mainly uncollected electricity charges) reached nearly half the revenues for the year in 2015-2018, the ratio of trade and other receivables to the revenues fell sharply in 2019. The ratio of the trade and other receivables to sales (billing amount), however, remained largely unchanged from 2018, while the amount of trade and other receivables slightly increased compared to that year.

Although the accumulated deficit largely decreased in 2019 due to substantial profit made in the year, a considerable cumulative deficit was still recorded and an extraordinary negative Equity Ratio (defined as Equity ÷ Asset) persisted, given that equity remained negative in the year. In 2019, trade and other payables declined substantially because of the considerable profit made in the year.

The Current Ratio (defined as current assets ÷ current liability), which is a management benchmark and for which 100% is generally thought to denote good management, declined from 37 to 18% during

the period 2015 - 2018. Though the Current Ratio, in turn, is improved to 35% in 2019 due to abated current liabilities and increased current assets, the Current Ratio remained far below 100%. The Quick Asset Ratio (defined as (current assets - inventory) ÷ current liability) is almost equivalent given that the inventory is quite few.

Despite the positive profit in 2019, the amount of fixed or non-current assets increased very little. This could mean that financial conditions still precluded sufficient investment in fixed assets such as facilities and equipment.

Table 3-3.7 Balance Sheets of Abuja DisCo

BALANCE SHEET (NGN billion)	2019	2018	2017	2016	2015
ASSETS	***166.19***	***169.94***	***120.15***	***117.21***	***109.49***
Non-current assets	*115.33*	*122.20*	*92.08*	*84.13*	*83.15*
Property, plant and equipment	113.59	111.65	91.95	84.09	83.08
Trade and other receivables	-	9.35	0.03	-	-
Prepayment	-	0.05	0.02	0.01	0.04
Other non-current assets	1.74	1.15	0.08	0.03	0.03
Current assets	*50.86*	*47.74*	*28.07*	*33.07*	*26.34*
Inventories	0.26	0.40	0.32	0.41	0.74
Trade and other receivables	48.90	42.31	22.89	29.99	23.61
Prepayments	0.43	0.63	0.51	0.20	0.22
Cash and cash equivalents	1.27	4.40	4.34	2.47	1.77
EQUITY AND LIABILITIES	***166.19***	***169.94***	***120.15***	***117.21***	***109.49***
EQUITY	***▲4.57***	***▲128.77***	***▲86.09***	***▲11.02***	***36.43***
Share capital	0.02	0.01	0.01	0.01	0.01
Revaluation reserve	43.96	43.96	19.48	18.58	18.58
Accumulated deficit/Retained earnings	▲48.54	▲172.74	▲105.58	▲29.60	17.85
LIABILITIES	***170.76***	***298.71***	***206.24***	***128.23***	***73.06***
Non-current liabilities	*25.38*	*29.40*	*4.98*	*1.55*	*1.72*
Loans and borrowings	17.30	19.64	1.33	0.72	0.89
Deferred revenue/income	7.34	9.32	3.10	0.81	0.83
Other non-current liabilities	0.73	0.45	0.56	0.02	-
Current liabilities	*145.38*	*269.31*	*201.26*	*126.68*	*71.34*
Loans and borrowings	4.98	4.34	1.91	1.29	0.56
Trade and other payable	136.25	263.01	196.17	121.68	67.10
Deferred revenue/income	1.53	1.08	0.53	0.61	0.46
Current tax liabilities	1.30	-	0.48	0.93	1.04
Other current liabilities (Contract liabilities + Employee benefits obligation + Provisions)	1.33	0.88	2.17	2.17	2.17
Equity ratio	*▲3%*	*▲76%*	*▲72%*	*▲9%*	*33%*
Current ratio	*35%*	*18%*	*14%*	*26%*	*37%*
Quick assets ratio	*35%*	*17%*	*14%*	*26%*	*36%*

Source: Annual Report, 2019-2016, Abuja Electricity Distribution Plc

Table 3-3.8 shows the cash flow statements of Abuja DisCo for 2015-2019. In the cash flow statement of 2019. 'Tariff shortfall awarded by NERC' appeared as a huge negative adjustment in cash flow from operating activities. Net cash used in investment activities in each year for the period 2015 - 2019 was a small amount and insufficient for an electricity company which belongs to capital intensive industries.

Table 3-3.8 Cash Flow Statements of Abuja DisCo

CASH FLOW STATEMENT (NGN billion)	2019	2018	2017	2016	2015
Cash flow from operating activities:					
Profit/(Loss) for the year	*124.29*	*▲85.72*	*▲75.98*	*▲47.45*	*▲41.97*
Adjustments for:	*▲158.53*	*52.93*	*39.98*	*28.94*	*42.25*
- Tariff shortfall awarded by NERC	▲164.91	-	-	-	-
- Depreciation of property, plant and equipment	4.47	5.03	4.56	3.98	5.32
- Amortization of government grant	▲1.53	▲1.08	▲0.08	▲0.02	▲0.02
- Impairment loss on trade and other receivables and c	21.94	19.19	8.56	13.22	18.34
- Revaluation deficit on property, plant and equipment	-	6.15	▲0.01	-	15.95
- Finance income	▲24.23	▲0.94	▲0.48	▲0.26	▲0.30
- Finance costs	6.04	24.41	26.93	12.06	2.82
- Minimum tax	1.25	0.10	0.08	0.15	0.25
- Income tax expense	0.25	-	-	-	-
- Other adjustments	▲1.82	0.06	0.41	▲0.19	▲0.12
	▲34.24	***▲32.79***	***▲36.00***	***▲18.51***	***0.28***
Changes in:	*45.32*	*20.78*	*45.55*	*23.63*	*▲0.58*
Trade and other receivables	▲18.19	▲21.10	▲1.45	▲19.60	▲27.43
Trade and other payables	61.71	43.13	47.16	42.79	27.30
Prepayments	1.22	▲0.16	▲0.32	0.05	▲0.04
Inventories	0.15	▲0.08	0.09	0.33	▲0.18
Other changes	0.44	▲1.02	0.07	0.07	▲0.23
Cash generated from operating activities:	***11.08***	***▲12.02***	***9.55***	***5.12***	***▲0.30***
Payment of defined benefit obligation	▲0.08	▲0.01	-	-	-
Payment of long service award	▲0.15	-	-	-	-
Payment of letter of credit collateral	▲0.99	▲8.30	▲0.03	-	-
Income taxes paid	▲0.05	▲0.40	▲0.50	▲0.26	-
Net cash generated from operating activities	***9.81***	***▲20.73***	***9.01***	***4.86***	***▲0.30***
Cash flows from investing activities:					
Acquisition of property, plant and equipment	▲3.71	▲4.74	▲8.08	▲4.96	▲2.16
Additions to right-of-use assets	▲1.20	-	-	-	-
Acquisition of intangible assets	-	▲1.03	▲0.09	▲0.05	▲0.03
Interest received	0.67	0.81	0.12	0.01	0.00
Net cash used in investing activities	***▲4.24***	***▲4.96***	***▲8.05***	***▲5.00***	***▲2.19***
Cash flows from financing activities:					
Proceeds from loans and borrowings	-	31.83	2.30	1.17	1.04
Interest payments	▲2.84	▲2.38	▲0.10	▲0.07	-
Principal repayments	▲5.55	▲3.24	▲0.66	▲0.27	▲0.21
Payment of lease liabilities	▲0.28	-	-	-	
CAPMI refunds	-	▲0.44	▲0.58	▲0.17	-
Net cash outflow from financing activities	***▲8.66***	***25.76***	***0.96***	***0.67***	***0.83***
Net increase/decrease in cash and cash equivalents	***▲3.10***	***0.07***	***1.93***	***0.52***	***▲1.66***
Cash and cash equivalents at 1 January	4.40	4.34	2.47	1.77	3.43
Effect of movement in exchange rate	▲0.03	▲0.01	▲0.06	0.18	0.00
Cash and cash equivalents at 31 December	***1.27***	***4.40***	***4.34***	***2.47***	***1.77***

Source: Annual Report, 2019-2016, Abuja Electricity Distribution Plc

Table 3-3.9 gives profit/loss statements of Eko DisCo for 2015-2018. Profit/loss statements of Eko DisCo for 2019 were not yet published on the homepage. The trends in the profit/loss statements of Eko DisCo for 2015 - 2018 resembled those of Abuja DisCo, where both the operating and annual losses had increased.

Table 3-3.9 Profit/Loss Statements of Eko DisCo

PROFIT/LOSS STATEMENT (NGN billion)	2019	2018	2017	2016	2015
Revenue		76.16	69.07	56.54	51.01
Cost of sales		▲86.01	▲76.07	▲53.04	▲38.30
Gross profit/loss		***▲9.85***	***▲7.00***	***3.50***	***12.71***
Other operating income		0.46	0.45	0.53	0.18
Impairment loss on trade and other receivables and contract assets		-	-	-	-
Administrative expense		▲22.74	▲16.68	▲13.35	▲16.12
Impairment loss on financial assets		▲9.75	▲8.71	-	-
Operating loss		***▲41.89***	***▲31.94***	***▲9.32***	***▲3.23***
(Operating Margin)		*▲55%*	*▲46%*	*▲16%*	*▲6%*
Finance cost		▲17.24	▲9.52	▲19.17	▲3.06
Finance income		0.32	1.76	0.02	0.16
Net finance cost		*▲16.91*	*▲7.77*	*▲19.15*	*▲2.89*
Loss before minimum and income tax		*▲58.80*	*▲39.71*	*▲28.47*	*▲6.13*
Minimum tax		▲0.10	▲0.09	▲0.19	▲0.33
Income tax		-	-	-	▲0.12
Loss for the year		***▲58.90***	***▲39.80***	***▲28.66***	***▲6.58***
(Net Loss Margin)		*▲77%*	*▲58%*	*▲51%*	*▲13%*

Source: Annual Report, 2018-2016, Eko Electricity Distribution Plc

Table 3-3.10 shows the balance sheets of Eko DisCo for 2015 - 2018. As the operating and annual losses year increased, the level of retained earnings declined, resulting in accumulated deficit by 2017 and a negative Equity Ratio (defined as Equity ÷ Asset). During the period 2015 - 2018, the amount of trade and other receivables changed very little. The ratio of trade and other receivables to revenue, however, fell from around half to a third with increasing revenue (sales).

However, the Current Ratio (defined as current assets ÷ current liability) in 2015 surpassed 100%, which is a benchmark of good management. The Current Ratio, however, had fallen to 22% by 2018. Just like Abuja DisCo, the Quick Asset Ratio (defined as (current assets - inventory) ÷ current liability) is almost the same as the Current Ratio.

Also, like Abuja, the amount of fixed or non-current assets remained almost the same during 2015-2018, which could mean financial conditions not allowing the necessary investment in fixed assets such as facilities and equipment.

Table 3-3.10 Balance Sheets of Eko DisCo

ASSETS		***89.77***	***88.90***	***87.62***	***88.55***
Non-current assets		*55.80*	*56.23*	*56.34*	*54.95*
Property, plant and equipment		50.37	51.54	53.34	54.81
Trade and other receivables		2.30	1.50	-	-
Prepayment		2.89	3.06	2.84	-
Other non-current assets		0.24	0.13	0.16	0.14
Current assets		*33.97*	*32.67*	*31.27*	*33.60*
Inventories		1.72	1.62	1.25	1.17
Trade and other receivables		24.61	23.51	24.25	25.76
Prepayments		0.15	0.04	0.03	1.14
Contract assets		2.87	-	-	-
Cash and cash equivalents		4.62	7.51	5.74	5.54
EQUITY AND LIABILITIES		***89.77***	***88.90***	***87.62***	***88.55***
EQUITY		***▲71.17***	***▲14.81***	***24.99***	***53.65***
Share capital		0.01	0.01	0.01	0.01
Revaluation reserve		-	-	-	-
Accumulated deficit/Retained earnings		▲71.17	▲14.82	24.98	53.64
LIABILITIES		***160.93***	***103.71***	***62.63***	***34.91***
Non-current liabilities		*3.92*	*5.95*	*6.71*	*4.40*
Loans and borrowings		3.06	4.93	5.47	2.95
Deferred revenue/income		0.86	1.02	1.24	1.45
Other non-current liabilities		-	-	-	-
Current liabilities		*157.01*	*97.76*	*55.92*	*30.50*
Loans and borrowings		1.66	2.64	7.04	6.87
Trade and other payable		154.01	93.15	46.70	20.99
Contract liabilities		0.34	-	-	-
Deferred revenue/income		0.61	0.67	0.74	1.33
Current tax liabilities		0.39	1.30	1.43	1.30
Other current liabilities (Contract liabilities + Employee benefits obligation + Provisions)		-	-	0.01	0.01
Equity ratio		*▲79%*	*▲17%*	*29%*	*61%*
Current ratio		*22%*	*33%*	*56%*	*110%*
Quick assets ratio		*19%*	*32%*	*54%*	*103%*

Source: Annual Report, 2018-2016, Eko Electricity Distribution Plc

Table 3-3.11 gives the cash flow statements of Eko DisCo for 2015-2018. Like Abuja DisCo, the net cash used for investment activities in each year over the period 2015 - 2018 was also low and seemingly insufficient for an electricity company.

Table 3-3.11 Cash Flow Statements of Eko DisCo

CASH FLOW STATEMENT (NGN billion)	2019	2018	2017	2016	2015
Cash flow from operating activities:					
Profit/(Loss) for the year		▲*58.90*	▲*39.80*	▲*28.66*	▲*6.58*
Adjustments for:		*33.51*	*23.09*	*24.89*	*14.09*
- Depreciation of property, plant and equipment		6.66	6.31	6.04	5.79
- Impairment loss on trade and other receivables and contract assets		9.75	8.71	-	4.75
- Finance income		▲0.32	▲1.76	▲0.02	▲0.16
- Finance costs		17.24	9.52	19.17	3.06
- Minimum tax		0.10	0.09	0.19	0.33
- Other adjustments		0.09	0.22	▲0.50	0.32
		▲25.39	***▲16.71***	***▲3.78***	***7.51***
Changes in:		*33.13*	*28.58*	*9.89*	▲*9.00*
Trade and other receivables		▲11.98	▲9.47	▲11.47	▲19.59
Trade and other payables		44.89	38.91	21.61	10.63
Prepayments		0.06	▲0.22	0.20	0.04
Inventories		▲0.14	▲0.56	0.14	▲0.91
Other changes		0.29	▲0.08	▲0.60	0.84
Cash generated from operating activities:		***7.74***	***11.87***	***6.11***	***▲1.49***
Settlement of provisions		-	▲0.01	-	-
Income taxes paid		▲1.01	▲0.22	▲0.06	-
Net cash generated from operating activities		***6.73***	***11.65***	***6.05***	***▲1.49***
Cash flows from investing activities:					
Acquisition of property, plant and equipment		▲5.34	▲4.52	▲3.67	▲2.15
Additions to right-of-use assets		-	-	-	-
Acquisition of intangible assets		▲0.17	▲0.01	▲0.05	▲0.08
Proceeds from sale of property, plant and equipment		-	0.04	-	
Interest received		0.09	0.02	0.02	0.13
Cash used in investing activities		***▲5.42***	***▲4.48***	***▲3.70***	***▲2.11***
Cash flows from financing activities:					
Loan received		0.21	-	1.31	7.69
Interest payments		▲0.63	▲0.90	▲0.95	▲0.48
Principal repayments		▲3.31	▲4.09	▲2.14	▲0.17
Bank charges paid		▲0.46	▲0.41	▲0.36	
Net cash outflow from financing activities		***▲4.19***	***▲5.41***	***▲2.15***	***7.05***
Net increase/decrease in cash and cash equivalents		***▲2.88***	***1.76***	***0.20***	***3.45***
Cash and cash equivalents at 1 January		7.51	5.74	5.54	2.06
Effect of movement in exchange rate		▲0.01	0.01	0.00	0.00
Cash and cash equivalents at 31 December		***4.62***	***7.51***	***5.74***	***5.54***

Source: Annual Report, 2018-2016, Eko Electricity Distribution Plc

Profit/loss statements of Port Harcourt DisCo for 2015 - 2019 are provided in Table 3-3.12. Revenues (sales) grew until 2017 and a modest profit was obtained in 2017. In 2018 and 2019, however, revenues declined, the costs of sales increased and a net loss involving impairment of financial assets and operating losses were appropriated, as well as recording annual losses. According to the Notes to the financial statements of 2019, most of the net impairment losses on financial assets in 2018 and 2019 were attributable to trade receivables.

While in Abuja DisCo, the tariff shortfall awarded by NERC in 2019 was recorded as revenue in the profit/loss statement, for Port Harcourt DisCo, it was recorded as both other receivables and a portion of trade payables to NBET and the Market Operators (TCN) as described below.

Table 3-3.12 Profit/Loss Statements of Port Harcourt DisCo

PROFIT/LOSS STATEMENT (NGN billion)	2019	2018	2017	2016	2015
Revenue	49.88	48.61	52.13	49.94	33.55
Cost of sales	▲57.98	▲53.10	▲49.96	▲44.54	▲28.47
Gross profit/loss	***▲8.10***	***▲4.49***	***2.16***	***5.40***	***5.09***
Other operating income	45.38	33.04	27.45	0.47	0.74
Net impairment loss on financial assets	▲28.74	▲25.00	-	-	-
Administrative expense	▲9.77	▲11.43	▲20.95	▲24.67	▲18.61
Operating profit/loss	***▲1.22***	***▲7.88***	***8.66***	***▲18.81***	***▲12.78***
(Operating Margin)	*▲2%*	*▲16%*	*17%*	*▲38%*	*▲38%*
Finance cost	▲7.72	▲6.72	▲9.04	▲2.66	▲1.69
Finance income	0.13	0.05	1.01	0.05	0.38
Net finance cost	*▲7.59*	*▲6.68*	*▲8.03*	*▲2.61*	*▲1.31*
Loss before minimum and income tax	*▲8.81*	*▲14.55*	*0.63*	*▲21.42*	*▲14.09*
Income tax	-	-	-	8.77	▲0.09
Profit/Loss for the year	***▲8.81***	***▲14.55***	***0.63***	***▲12.65***	***▲14.17***
(Net Loss Margin)	*▲18%*	*▲30%*	*1%*	*▲25%*	*▲42%*

Source: Annual Report and Financial Statements, 2019-2016, Port Harcourt Electricity Distribution Plc

The balance sheets of Port Harcourt DisCo for 2015 - 2018 are shown in Table 3-3.13. In Port Harcourt DisCo, a significant amount of reserves, sufficient to offset accumulated deficits, were injected in 2015 and 2016 and substantial retained earnings were recorded in 2017. In 2018, conversely, accumulated deficit was again written down and equity declined significantly. As for trade and other receivables, the amount increased by 2017 and decreased sharply in 2018. Consequently, the Equity Ratio (defined as Equity ÷ Asset) increased to 63% in 2017 and declined to 21% in 2018.

As mentioned above, a tariff shortfall of NGN 199.6 billion was awarded with an NERC order and appropriated as other receivables and part of trade payables to NBET and MO in 2019. Notes to the financial statements of 2019 stated that in 2018, a tariff shortfall of NGN 137.7 billion was awarded by NERC and net offset against payables to NBET and MO as of year end. Accordingly, the tariff shortfall did not appear in the financial statements.

In 2017, an appropriated amount of trade and other receivables, which is part of current assets, was increased and the Current Ratio (defined as current assets ÷ current liability) reached 155%. The Current Ratio drastically decreased to 12% as trade and other receivable sharply decreased and trade and other payables, as a portion of current liabilities, increased in 2018. In 2019, as the appropriated trade and other receivables increased significantly, as well as trade and other payables as mentioned above, the Current Ratio again increased to 88%. It should be noted that this increase in the Current Ratio does not indicate financial health on the part of Port Harcourt DisCo.

In 2016, significant investment was implemented and fixed or non-current assets almost doubled. After 2017, however, the fixed assets were almost constant and the financial conditions precluded the necessary investment in facilities and equipment.

Table 3-3.13 Balance Sheets of Port Harcourt DisCo

BALANCE SHEET (NGN billion)	2019	2018	2017	2016	2015
ASSETS	***267.71***	***69.55***	***111.78***	***100.99***	***52.55***
Non-current assets	*65.38*	*64.46*	*63.77*	*63.11*	*34.73*
Property, plant and equipment	63.42	64.42	63.74	63.07	34.69
Right-of-use assets	1.79	-	-	-	-
Intangible assets	0.17	0.04	0.04	0.04	0.04
Current assets	*202.34*	*5.09*	*48.01*	*37.88*	*17.82*
Inventories	0.87	0.55	2.55	1.06	0.91
Trade and other receivables	197.87	1.69	44.16	27.52	12.14
Prepayments	-	-	-	2.14	0.01
Cash and cash equivalents	3.60	2.84	1.30	7.16	4.76
EQUITY AND LIABILITIES	***267.71***	***69.55***	***111.78***	***100.99***	***52.55***
EQUITY	***5.59***	***14.40***	***70.18***	***19.53***	***11.33***
Share capital	0.01	0.01	0.01	0.01	0.01
Revaluation reserve	17.82	18.60	19.32	20.11	-
Other reserves	-	-	-	55.20	55.20
Accumulated deficit/Retained earnings	▲12.23	▲4.20	50.86	▲55.79	▲43.87
LIABILITIES	***262.12***	***55.14***	***41.60***	***81.46***	***41.21***
Non-current liabilities	*13.34*	*13.41*	*10.55*	*15.96*	*12.92*
Loans and borrowings	8.05	8.75	6.34	11.73	9.53
Traded and other payable	-	-	-	0.40	0.36
Lease liabilities	1.00	-	-	-	-
Governmental grants	4.28	4.66	4.22	2.23	2.02
Deferred revenue/income	-	-	-	1.61	1.01
Current liabilities	*248.78*	*41.73*	*31.04*	*65.51*	*28.29*
Loans and borrowings	3.04	1.94	3.97	7.52	2.50
Trade and other payable	241.22	36.68	24.16	56.94	25.00
Lease liabilities	1.24	-	-	-	-
Governmental grants	0.55	0.92	0.70	0.45	0.34
Contract liabilities	1.89	1.47	1.55	-	-
Current tax liabilities	0.83	0.72	0.66	0.60	0.44
Equity ratio	*2%*	*21%*	*63%*	*19%*	*22%*
Current ratio	*81%*	*12%*	*155%*	*58%*	*63%*
Quick assets ratio	*81%*	*11%*	*146%*	*53%*	*60%*

Source: Annual Report and Financial Statements, 2019-2016, Port Harcourt Electricity Distribution Plc

Cash flow statements of Port Harcourt DisCo for 2015 - 2019 are given in Table 3-3.14 and exclude any ‘adjustments’ or ‘changes’ to calculate cash flow from operating activities. Instead, the statement just starts with ‘Net cash generated from operating activities’ and ‘VAT paid’.

From the perspective of Abuja DisCo and Eko DisCo, net cash used for investment activities seems insufficient for an electricity distribution company.

Table 3-3.14 Cash Flow Statements of Port Harcourt DisCo

CASH FLOW STATEMENT (NGN billion)	2019	2018	2017	2016	2015
Cash flow from operating activities:					
Cash generated from operating activities:	***5.56***	***6.56***	***4.42***	***▲2.57***	***▲6.79***
Income tax paid	***▲0.03***				
VAT paid	▲1.03	▲1.03	▲0.26	-	-
Net cash generated from operating activities	***4.50***	***5.54***	***4.16***	***▲2.57***	***▲6.79***
Cash flows from investing activities:					
Acquisition of property, plant and equipment	▲1.15	▲2.96	▲2.69	▲0.40	▲1.53
Acquisition of intangible assets	▲0.00	▲0.01	1.01	▲0.00	▲0.05
Interest received	0.13	0.05	-	0.05	0.38
Net cash used in investing activities	***▲1.03***	***▲2.93***	***▲1.68***	***▲0.35***	***▲1.19***
Cash flows from financing activities:					
Proceeds from loans/borrowings	0.98	2.90	0.13	4.11	12.37
Principal elements of lease payments	▲0.75	-	-	-	-
Interest payments	▲1.48	▲1.53	▲1.48	▲2.66	▲1.37
Principal repayments	▲1.98	▲1.71	▲1.30	▲0.96	-
Government grants	-	-	-	0.45	-
Net cash outflow from financing activities	***▲3.22***	***▲0.35***	***▲2.65***	***0.94***	***11.00***
Net increase/decrease in cash and cash equivalents	***0.25***	***2.26***	***▲0.17***	***▲1.98***	***3.02***
Cash and cash equivalents at 1 January	2.84	0.58	0.75	2.73	▲0.28
Cash and cash equivalents at 31 December	***3.09***	***2.84***	***0.58***	***0.75***	***2.73***

Source: Annual Report and Financial Statements, 2019-2016, Port Harcourt Electricity Distribution Plc

3-3-2 Management issues for DisCos

As the financial statements for the three DisCos in Chapter 3 show, Section 3.3.1 (6), DisCos are not being managed sustainably for business operations as private companies. Although Abuja DisCo is expected to post a net profit of NGN 124 billion in 2019, the company is not in a sound financial position, considering that it has payables of NGN 60 billion to NBET and the Market Operator during this period and has posted NGN 165 billion of the fee revenue shortfall approved by NERC to date as revenue.

One possible reason for this financial situation is the lack of revenue. In concrete terms, the company is not collecting fees from customers commensurate with the amount of power received from TCN. The reason for the revenue shortfall is the fact that power fees are insufficient to cover actual costs and the losses in the distribution sector (distribution losses) are high, as shown in Chapter 3, Section 3.3.1 (2). The technical and commercial losses (defined as 1 - as billed power/received power) for DisCos overall are close to 32% and the collection loss is about 26% (defined as 1 - the amount of fee collected/billed), resulting in an aggregate distribution sector loss of nearly 50% (aggregated technical, commercial and collection (ATC&C) loss, (defined as (1- technical and commercial loss) multiplied by (1- collection loss)), reaching 49%. In other words, DisCos have only been able to collect around half the power charges corresponding to the amount of power received from TCN.

In this context, as described above, the following items can be considered factors explaining each type of loss:

Factors that exacerbate technology loss generally include the following:

1) Improperly connected power distribution lines

2) Improper distribution line sizing

3) Functional decline due to aging facilities

4) Inadequate district power distribution networks

5) Absence of a loss location identification system

High commercial losses have been attributable to the following factors:

6) Illegal connections and theft of power by unregistered users

7) Fraudulent acts of bypassing voltmeters

8) Faulty measurement by defective or faulty voltmeters

9) Incorrect billing timing

10) Misreading of meters

11) Insufficient billing due to misclassification of customer types

High bill collection losses have been attributed to the following factors:

1) Questionable bills (including estimated)

2) Low willingness to pay due to low-quality power supply services

3) Complicated and inconvenient methods of fee payment

4) Incorrect delivery of bills

5) Low customer morale

To address these problems, measures to accomplish the tasks described in Section 3-4 are described in the Performance Improvement Plan (PIP) of the DisCos.

3-4 Performance Improvement Plan (PIP) for DisCos

To improve the business profitability of DisCos, each DisCo has formulated its own PIP and is striving to improve operations in various areas. The following are listed as areas for improvement for which key performance indices (KPIs) should be set to measure the results of activities in business areas:

- Loss reduction
- Reliability/availability
- Metering
- Customer satisfaction
- Enhancement of new network connections
- Safety
- Social responsibility

Various measures are developed to achieve the system loss reduction which is expected to impact directly on improving business profitability. The following measures are planned as efforts in terms of distribution facilities and business operations (highly reliable and high-quality power and services), some of which have already been implemented:

(1) System improvements and facilities expansion

This measure is adopted from the perspective that it directly helps ease technical losses and the resulting increase in supply capacity and decline in power outages elicit customer satisfaction, which, in turn, helps streamline the tariff collection process.

Specific implementation measures include the following:

- Network expansion projects: Installation of new injection points and high-voltage distribution lines, etc.
- Network reconfiguration/rehabilitation: Repair of injection points and high-voltage distribution feeders, etc.
- Network upgrade: Injection points, Increasing the capacity of high-voltage distribution lines and distribution transformers
- Protection, control and communication: Establishment of distribution automation systems and remote meter reading systems

The above plan does not specify initiatives related to facilities and business implementation methods that directly contribute to reducing fault recovery time (except power distribution automation). However, as part of the power distribution automation functions, there are plans to introduce each of the fault location, isolation and service restoration functions (FLISR). Eko DisCo also has plans to upgrade existing switchgear on distribution feeders to switchgears that are applicable to power distribution automation systems.

(2) Initiatives to reduce system (ATC&C) losses

Implementation of the following specific measures is planned as measures to reduce system losses by cause:

1) Measures to reduce technical loss

- Replacing low-voltage distribution conductors with overhead cables (aerial bundled cables)
- Newly installing a capacitor bank
- Replacing smaller cables with larger
- Replacing aged/deteriorated cables

2) Measures to reduce commercial losses

- Promotion of installation of customer meters (through MAP)
- Improvement of billing system by charting the link between customers and distribution facilities and metering between feeders and distribution transformers
- Replacement of low-voltage distribution lines with overhead cables in areas where electricity is frequently stolen
- Development and deployment of automated metering infrastructure (AMI) and automated meter reading (AMR) for large customers
- Investigation and replacement of defective and obsolete meters
- Deployment of statistical meters in all distribution transformers
- Proactive power management

3) Measures to reduce collection losses

- Organization and strengthening of the Revenue Protection Unit and Transmission Suspension Implementation Group
- Promotion of a prepaid system and development of various payment routes
- Outsourcing of collection of uncollected bills (those delinquent for more than three months)
- Proactive implementation of credit management
- Customer energy audits and rate classification review

3-5 Trends in Support for the Power Distribution Subsector by Other Donors

Though numerous support projects have been implemented with assistance by other donors for power development in Nigeria, the number of support projects for the distribution subsector remains limited, as the subsector has been privatized. Major support projects are shown in Table 3-5.1. The support from the French Development Agency (AFD) is described in "4-4 Support for NAPTIN by Other Donors".

Table 3-5.1 Major Support Project for the Distribution Subsector by Other Donors

Name of donor	Overview of support
Agence Française de Développement (AFD)	Project on Enhancing Vocational Training Delivery for the Power Sector in Nigeria · Development of training course · Improvement of training facilities and renovation of the regional training centers · Governance and organizational reform
World Bank (WB)	Nigeria Distribution Sector Recovery Program (DISREP) (USD 500 million) · Programme for Result (PforR): USD 345 million · Investment Project Financing (IPF)1: Bulk procurement of customer/retail meters and (USD 120 million) · IPF2: NERC Data Aggregation Platform (DAP) (USD20 million) · Technical Assistance (TA)1: DISREP Implementation Support (USD 10 million) · TA 2-1: Capacity-Building (USD2 million) · TA 2-2: Support for the Power Sector Working Group (USD2 million) · TA 2-3: Design of a Power Consumer Assistance Fund (USD1 million)
African Development Bank (AfDB)	· Co-finance to WB DISREP

AFD: Project on Enhancing Vocational Training Delivery for the Power Sector in Nigeria, August, 2017, AFD
WB/AfDB: Project Appraisal Document, Nigeria - Distribution Sector Recovery Program, January, 2021, World Bank
URL: https://documents1.worldbank.org/curated/en/886051612753240219/pdf/Nigeria-Distribution-Sector-Recovery-Program.pdf
Source: Compiled by JICA survey team based on related documents.

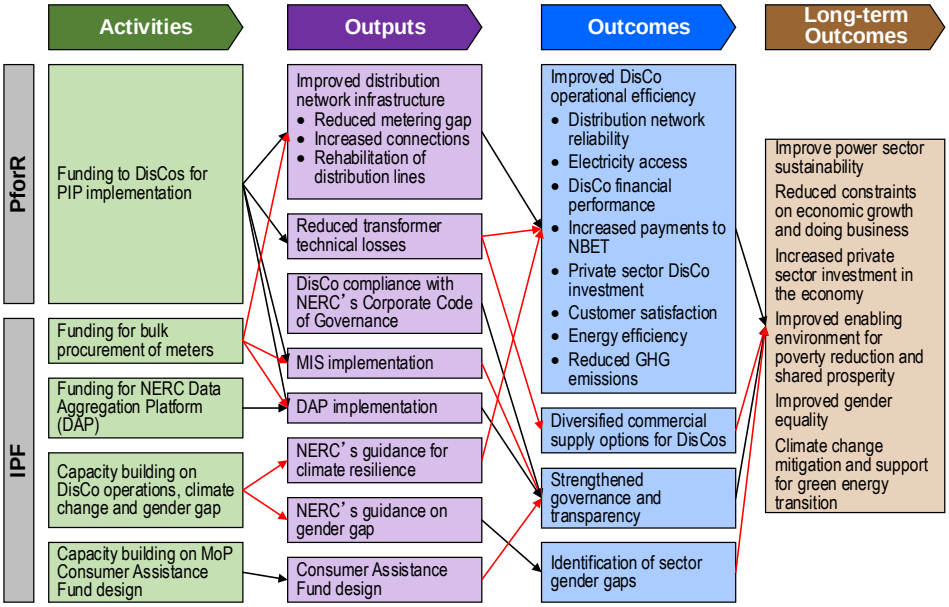
The World Bank (WB) plays a key role in the Nigerian power sector. At present, WB is assisting in efforts to improve the power sector and the distribution subsector with two holistically combined programs, namely Power Sector Rehabilitation Operation (PSRO) and Distribution Sector Recovery Programme (DISREP) to support the Federal Government implementation of the Power Sector Recovery Programme (PSRP). DISREP, approved by the WB's Board of Directors in February 2021, focuses on the distribution subsector, while PSRO, approved by the WB's Board of Directors in June 2020 with a credit amount of USD 750 million, covers the entire power sector.

The PSRO addresses the policy and financial aspects of the PSRP as detailed in pillars I - policy and regulatory environment and IV: financial sustainability, while DISREP addresses the infrastructure and operational aspects of the PSRP as seen in pillars II: network infrastructure and III: operational efficiency. The outline is as follows:

(1) Activities, Outputs, Outcomes and Long-term Outcomes of DISREP

The Programme Appraisal Document of DISREP illustrates its activities, outputs, outcomes and long-term outcomes as shown in Figure 3-5.1 as 'Theory of Change'. As depicted in the figure, DISPRED contains various activities to complete PSRP. Of the total DISPRED cost (USD 1,743 million, 100%), the share of WB (International Bank for Reconstruction and Development (IBRD)) lending is only

(USD 500 million, 29%), USD 700 million (40%) is co-financed by AfDB and USD 486 million (28%) is self-funded (counterpart fund). As for the component of the Programme for Result (PforR) (USD 345 million, 20%), the fund is allocated to DisCos to implement their Performance Improvement Plans (PIPs).



Source: Programme Appraisal Document of DISPRED, January 2021, the World Bank

Figure 3-5.1 Activities, Outputs, Outcomes and Long-term Outcomes of DISREP

(2) Contents of Components of DISREP

DISREP comprises the components of one Programme for Result (PforR), two sets of Investment Project Financing (IPFs) and two forms of Technical Assistance (TA) (The TA2 Component has three sub-components), contents of which are as follows:

Programme for Result (PforR) (USD345 million): PforR is an instrument with which disbursement is made based on verified performance improvement to promote progress of the program and thus incentivize improved governance and provide capacity-building. Activities PforR focus on funding to DisCos for PIP implementation through BPE in the form of shareholder loans. Of USD 345 million, USD 12 million will be allocated to each of eleven DisCos (totaling USD 132 million) and the remaining USD 213 million will be initially allocated in proportion to their investment needs detailed in their PIPs and approved by NERC. Fund allocation between DisCos may vary over the course of the Programme to reallocate funds from low-performing DisCos to those exceeding their operation targets (stretch targets). To participate in the PforR, DisCos should meet the following eligibility criteria, which have been agreed with DisCos:

i) Have their PIP developed and approved by NERC
ii) Have undergone an in-depth internal control review

iii) Have a Board-approved procurement regulatory framework
iv) Have a governance and anti-corruption framework
v) Have a protocol/standard or benchmarking Environmental and Social System and performance of DisCos
vi) Engage suitable Environmental and Social Risk Management Specialists (Consultants)
vii) Commit to implementing their Individual Action Plans, including all necessary fiduciary actions and safeguard actions

IPF Component 1 (IPF1): Bulk procurement of customer/retail meters and meter data management systems (MDS) for DisCos (USD120 million). The meters procured under IPF1 will be distributed to DisCos proportionately based on the metering gaps detailed in their PIPs. The MDMS will be procured and installed in each DisCo to maintain all information necessary to calculate the energy bills for customers based on the meter data. IPF1 is expected to help identify and quantify technical losses across the distribution network.

IPF Component 2 (IPF2): NERC Data Aggregation Platform (DAP) (USD20 million). IPF2 will support NERC in scoping and implementing a comprehensive DAP. The DAP will be installed at NERC and is connected to the management information systems (MIS) of each DisCo to receive real-time information about their operational and commercial performance. The DAP will provide NERC with critical sector information, particularly concerning the supply and demand gap, technical losses, energy efficiency, energy savings and GHG emissions, which will give NERC a detailed understanding of sector performance and help it manage the power sector more efficiently.

TA Component 1 (TA1): DISREP Implementation Support (USD10 million). To support the Program implementation, TA1 will help BPE establish a Project Management Unit (PMU) with the functions of the PforR implementing agency, including operational oversight, financial reporting and reporting on DISREP implementation progress including progress on meeting Disbursement-linked Indicators (DLIs) and DISREP technical, commercial, environmental and social indicators and implementation of action plans.

TA Component 2 (TA2) (USD5 million): TA2 comprises the following three sub-components:

Sub-component 2.1 (TA2-1): Capacity-Building (USD2 million). TA2-1 will support DisCos in capacity-building efforts to strengthen operations and processes to suit their current operating environment and the development of future markets. The training program will be developed and run by the National Power Training Institute of Nigeria (NAPTIN) and will include areas such as new DisCo business models, the transition to a fully competitive market, climate change mitigation in the distribution subsector, a climate-resilient distribution infrastructure, environmental and social processes and monitoring.

Sub-component 2.2 (TA2-2): Support for the Power Sector Working Group (USD2 million). The Power Sector Working Group (PSWG), which operates under the Office of the Vice

President of Nigeria, is responsible for coordinating PSRP implementation activities, including in the distribution sector. DISREP will provide the PSWG with TA support to strengthen their capacity to monitor and oversee PSRP implementation.

Sub-component 2.3 (TA2-1): Design of a Power Consumer Assistance Fund (USD1 million). TA2-3 will provide the MoP with technical support to scope and design a Consumer Assistance Fund. FGN has foreseen a Social Safety Net called the "Consumer Assistance Fund" as defined in the Electric Power Sector Reform Act of 2005 to limit the adverse impacts of increased tariffs on the most vulnerable consumers as far as possible.

(3) Necessity for Continuous Information Exchange and Discussion with WB Staff in charge of

As mentioned above, WB has planned various assistants, including in the distribution subsector. At the moment, however, there is no duplication found in plans of DISREP and JICA's Technical Cooperation Project requested by NAPTIN.

The main mode of WB assistance to the distribution subsector is funding for investment and facilities and the equipment to be funded with WB's assistance will be determined later. This may also have a bearing on JICA's technical cooperation. There may be potential for WB's funding assistance and JICA's technical cooperation to supplement or complement one another.

The Nigeria distribution subsector requires huge funding and assistance from the WB and AfDB cannot fill all the gaps. Information must be collected and analyzed in detail regarding the required investment and necessary funding when JICA examines financial cooperation with the distribution subsector.

With all this in mind, it is necessary to continuously exchange information and discuss in detail with the WB staff overseeing the power sector and JICA to confirm details of the DISREP component, avoid duplication of assistance by the World Bank and JICA and enhance the synergistic effects.

Chapter 4 Current Status and Issues of NAPTIN

4-1 Overview of NAPTIN

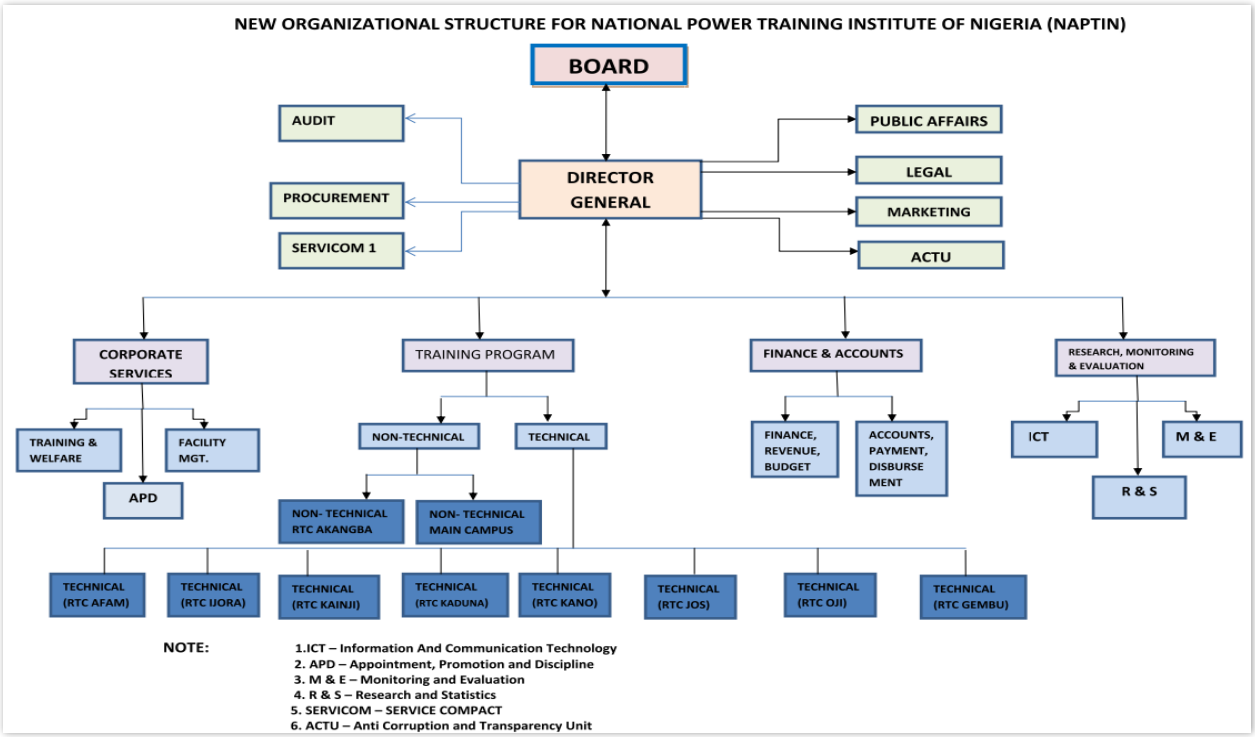
NAPTIN (the National Power Training Institute of Nigeria) was established on March 23, 2009 as an organization for training the institutions involved in the electric power sector, including power generation, transmission and distribution in Nigeria. Because the Electric Power Sector Reform Act (EPSR) of 2005 focused on making electric power and human resource development more stable and reliable, NAPTIN has played a key role. Moreover, all companies involved in the electric power sector, both public and private, have received training, including the 11 privatized power distribution companies, power generation companies, the Transmission Company of Nigeria (TCN) and the Nigerian Electricity Regulatory Commission (NERC). This section provides an overview of the organization, personnel and facilities of NAPTIN.

4-1-1 Organization

NAPTIN is headquartered in Abuja and has eight training centers scattered throughout Nigeria, as shown in Figure 4-1.1. Each center belongs to the training program department shown in Figure 4-1.2, which offers technical and non-technical training courses. NAPTIN has been expanding its headquarters and training centers, with a new head office constructed in 2015 and a new facility - the Genbu Training Center - currently under construction in Taraba Province.

Source: Prepared by the survey team based on materials obtained from NAPTIN.

Figure 4-1.1 NAPTIN's headquarters and training centers



Source: Prepared by the survey team based on materials obtained from NAPTIN.

Figure 4-1.2 Organizational structure of NAPTIN

Source: Prepared by the survey team based on materials obtained from NAPTIN.

Figure 4-1.3 NAPTIN's headquarters building constructed in 2015

4-1-2 Training center facilities

The eight training centers shown in Figure 4-1.1 are equipped with classrooms for training and various other facilities for conducting technical training. The size of the training rooms in each training center is shown in Figure 4-1.1 and the main training facilities related to the power distribution sector are shown in Figure 4-1.2. Each training center has a training room and library as shown in Figure 4-1.4 and some training centers have accommodation facilities, as certain training courses are conducted over multiple days. The Kainji Training Center, the largest of its kind, has seven training rooms, each accommodating up to 30 people, which means more than 200 trainees can be handled at a time. The Kainji Training Center is also

equipped to handle various practical training courses, including the simulated substation shown in Figure 4-1.5.

Source: Prepared by the survey team based on materials obtained from NAPTIN.

Figure 4-1.4 Training room of NAPTIN's training centers (Akangba and Lagos)

Table 4-1.1 Size of training rooms at headquarters and individual training centers

Name of training center	Number of rooms	Capacity of each room (people)	Total capacity (people)
Ijora	5	30	150
Kainji	7	30	210
Akangba	3	30	90
Kaduna	2	30	60
Jos	2	30	60
Afam	2	30	60
Oji	2	30	60
Kano	2	30	60
Abuja (Headquarters)	3	50	150
Total	28	-	900

Source: Prepared by the survey team

Table 4-1.2 Main equipment related to the power distribution sector in each training center

Name of training center	Main equipment	Accommodation facilities
Ijora	・Power system simulator	
Kainji	・Power engineering training room ・Protection, control and measurement equipment ・Simulated substation ・Renewable energy (solar and wind)-related equipment	Yes
Kano	・Power system simulator	
Abuja (Headquarters)	・Solar power system	

Source: Prepared by the survey team

(a) 1MVA, 33kV/11kV/415V substation

(b) Control panel

Figure 4-1.5 Simulated substation (Kainji)

4-2 NAPTIN training implementation status

4-2-1 Status of training course implementation

From its inception in 2009 until Q1 of 2020, NAPTIN has trained more than 16,000 people, around half of whom are from DisCos. In 2020, NAPTIN conducted 106 training courses, with topics including power generation, transmission, substations and renewable energy as well as non-technical courses. The training program and schedule for the power distribution field is shown in Table 4-2.1.

Table 4-2.1 2020 NAPTIN training courses (power distribution field)

S/N	COURSE TITLE	CATEGORY CODE	DURATION	VENUE	MONTH										PRICE
					FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	
1	DISTRIBUTION NETWORK PROTECTION COURSE	D01	5 days	UORA, KAINJI, KANO,		16-20		18-22				14-18		23-27		N70,000
2	ADVANCED TECHNICIANS MULTI-SKILL TRAINING FOR PRACTITIONERS (LINESWORK, CABLE JOINTING & ELECTRICAL FITTERS)	D02	10 days	UORA, KAINJI, AFAM, KADUNA, JOS, KANO,		2-13				20-31				9-20		N100,000
3	BASIC TECHNICIANS MULTI-SKILL TRAINING FOR NEW ENTRY LEVEL (LINESWORK, CABLE JOINTING & ELECTRICAL FITTERS)	D03	15 days	UORA, KAINJI, AFAM, KADUNA, JOS, KANO,			6-24				3-21		5-23			N150,000
4	DISTRIBUTION SUBSTATION OPERATIONS	D04	5 days	OJI, JOS, UORA, KAINJI, KADUNA, KANO, ABUJA		23-27		11-15				7-11		2-6		N70,000
5	DISTRIBUTION NETWORK OPERATIONS & MAINTENANCE	D05	5 days	JOS, UORA, KAINJI, KADUNA KANO, AFAM, ABUJA	17-21			18-22				14-18				N70,000
6	REFRESHER COURSE ON 33KV & 11KV CABLE JOINTING & TERMINATION	D06	5 days	JOS , UORA	3-7				1-5			21-25				N70,000
7	BASIC METER INSTALLATION COURSE (C2)	D07	10 days	ABUJA, OJI, JOS, UORA, KAINJI, KADUNA, KANO, AFAM			6-17			6-17			26-6			N100,000
8	METER INSTALLER SUPERVISOR COURSE (B2)	D08	10 days	ABUJA, OJI, JOS, UORA, KAINJI, KADUNA, KANO, AFAM			6-17			6-17			26-6			N100,000
9	ELECTRICAL HOUSE WIRING	D09		PLEASE VISIT WWW.NAPTIN.GOV.NG FOR THE SCHNEIDER ADVERTISEMENT												
10	ELECTRICITY BUSINESS MANAGEMENT	D10	5 days	AKANGBA	24-28				15-19				5-9			N70,000
11	PLANNING AND CONSTRUCTION OF DISTRIBUTION NETWORK	D11	10 days	ABUJA, KAINJI, UORA		24-6				22-3				23-4		N100,000
12	DISTRIBUTION NETWORK POWER LOSS REDUCTION TECHNIQUES	D12	10 days	ABUJA, KAINJI, UORA				4-15				14-25				N100,000
13	DISTRIBUTION NETWORK DISPATCH AND EMERGENCY RESPONSE	D13	10 days	KAINJI, UORA, AFAM					15-26			21-2				N100,000

Source: Prepared by the survey team based on materials obtained from NAPTIN.
Remarks: For details of the training course of the No. 9 Electrical House Wiring, refer to the following website:
https://www.se.com/ng/en/partners/electricians/schneider-electric-nigeria-electricians-training-program.jsp

The distribution courses include various training programs ranging from basic content to planning and construction of power distribution systems, operation and maintenance of power distribution substations and loss reduction in power distribution systems. These training courses are planned for 5 to 15 days and are offered at several training centers for fees ranging between NGN 70,000 to 150,000 (approximately JPY 26,000 to 56,000: JPY 1/NGN 0.27).

The training courses and number of participants related to the power distribution field from 2009 to 2019 are shown in Table 4-2.2.

Table 4-2.2 Number of participants in training courses in the power distribution field from 2009 to 2019

TYPE OF TRAINING	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	TOTAL
CABLE JOINTING COURSE	48	265	118	51	60	46	184	20	1	50	11	854
ELECTRICAL FITTING COURSE	NIL	88	120	10	80	48	301	30	NIL	50	25	752
DISTRIBUTION LINE CONSTRUCTION & MAINTENANCE COURSE	105	320	110	35	30	50	178	201	19	25	45	1118
POWER SYSTEM COMMERCIALIZATION (METERING, SALES, COLLECTION, CLIENT MANAGEMENT)	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	4	36	NIL	40
POWER SYSTEM PLANNING AND ENVIRONMENTAL SAFEGUARD GUIDANCE	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	4	10	147	161
TRANSFORMER & SWITCHGEARS OPERATION AND MAINTENANCE	20	35	23	14	10	10	5	25	3	24	138	307
POWER SYSTEM PROTECTION, CONTROL AND METERING COURSE	25	33	25	43	33	2	3	15	40	46	147	412
ENERGY EFFICIENCY & MANAGEMENT	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	15	NIL	15
ENERGY AUDIT AND ACCOUNTING	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	1	5	14	20
DISTRIBUTION SUBSTATION OPERATIONS & MNTCE COURSE	75	184	259	18	30	92	286	102	153	164	80	1443
METER INSTALLATION, TAMPERING & MANAGEMENT COURSE	NIL	20	50	50	50	60	1,000	95	26	40	3	1394
SOLAR PV INSTALLATION & MANAGEMENT COURSE	NIL	NIL	NIL	NIL	60	NIL	500	23	36	275	102	996
NAPTIN'S SPECIALIZED & STRUCTURED TRAINING PROGRAMME FOR ENGINEERS AND TECHNOLOGISTS INCLUDING NGSDP	NIL	NIL	NIL	186	120	84	90	145	25	20	140	810
ELECTRICTY MARKETING AND REVENUE GENERATION & PROTECTION COURSE	NIL	133	389	50	30	20	50	40	1	20	NIL	733
TECHNICAL FOR NON -TECHNICAL COURSE	NIL	NIL	NIL	NIL	NIL	30	NIL	20	237	20	60	367
ELECTRICITY BUSINESS MANAGEMENT CHALLENGES AND POWER INFRASTRUCTURE FOR LEC (WAPP)	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	10	10
TOTAL	273	1078	1094	457	503	442	2597	716	550	800	922	9,432

Remarks: NIL means zero (no participants).
Source: Prepared by the survey team based on materials obtained from NAPTIN.

About 9,500 participants attended training from 2009 to 2019 and Table 4-2.3 shows the training courses with about 1,000 participants.

Table 4-2.3 Training courses with numerous participants

Training course	Number of participants (2009 to 2019)
Construction and maintenance of power distribution lines	1118
Operation and maintenance of power distribution substations	1443
Installation, modification (tampering) and management of voltmeters	1394
Installation and management of solar power generation	996

Numerous participants suggests that DisCos are prioritizing the construction of distribution substations and distribution lines. Also noteworthy is the inclusion of modification (tampering) in the training course on voltmeters. The biggest challenge for the electricity distribution sector in Nigeria is reducing technical and commercial losses and boosting the fee collection rate. It is believed that the government is striving to increase the number of voltmeters installed and improve scope to check for the modification of voltmeters by providing relevant training to numerous people as part of an effort to improve fee collection rates.

In 2014, NAPTIN, together with GIZ, conducted market research and assessment on training in Nigeria and is also considering training courses. Between 2018 to 2019, training courses were evaluated via ANED to improve the courses. Such efforts also included NAPTIN meeting regularly with NERC and DisCos and obtaining feedback on training-related requests in a timely manner. Thanks to this regular exchange of information between NAPTIN and DisCos, DisCos recorded a satisfaction level toward training of 3-4 on a 5-point scale, suggesting high satisfaction.

The decline in the number of training participants from DisCos in recent years is due to budget shortages

caused by deteriorating finances. Accordingly, improving the financial situation of DisCos is expected to lead to increased training attendance and upskilling.

4-3 NAPTIN training programs (power distribution field)

4-3-1 Aim of NAPTIN training programs

NAPTIN has set up operation practices and training programs to meet the following requirements (NAPTIN's Home Page):

- To serve as a focal point for human resource development and workforce capacity-building relating to power in Nigeria
- To offer comprehensive hands-on engineering and technical training programs for power sector professionals and graduates
- To develop training on management, leadership, regulatory, ICT and other soft skills for the power sector
- To ensure industry common standards are maintained and disseminate new ideas and technology to the power industry
- To assist in identifying employees' competency gaps and training needs
- To provide advice and support on manpower development to members of the power sector
- To ensure a high maintenance and performance culture is instilled and utilized by engineers/technologists, technicians, artisans and craftsmen through industry-wide training to enhance efficiency

4-3-2 How the content of training programs is set

After the electricity sector was privatized (2009), NAPTIN took over the management of the seven existing regional training centers of PHCN (the Power Holding Company of Nigeria) so that the current training system could be maintained.

The core training courses comprise the following two programs:

① NAPTIN Graduate Skills Development Programme (NGSDP)
② NAPTIN Technical Skills Acquisition Programme (NTSAP)

The above NTSAP covers the following four job categories and the specific content of the individual training programs is set to reflect the needs of the distribution companies (DisCos).

① Linesmen
② Electrical Fitters
③ Cable Jointers
④ Distribution Substation Operators (DSO)

To reflect the needs of power distribution companies (DisCos) in the training program, two extensive needs surveys were conducted with the help of foreign donors since the program started in 2009.

The first survey involved a training market evaluation conducted in 2014 in collaboration with GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit), the results of which were used to determine applicable courses in the Nigerian Electricity Supply Industry (NESI). Many of the training courses currently being set up at NAPTIN are based on this market evaluation. The second was a training needs survey conducted by electricity distribution companies through the Association of Nigerian Electricity Distributors (ANED) in 2018/2019 (How to increase network reliability and quality of supply in manageable areas with economic considerations, March 2020: AF-Mercados EMI). NAPTIN revised and added training courses based on the results of this survey. The added training courses are shown in Table 4-3.1 .

Table 4-3.1 Training courses added based on the DisCo needs survey

No	Course name
1	ELECTRICAL FITTER A1
2	SAFETY TRAINING A3
3	POWER TOOLS AND TEST EQUIPMENT TRAINING A2
4	BASIC POWER SYSTEM PROTECTION B1
5	TRANSFORMER AND SWITCHGEAR MAINTENANCE B2
6	SAFETY AND WORK PRACTICE B3
7	MAINTENANCE AND REPAIR OF OVERHEAD LINE C1
8	TRANSFORMER AND SWITCHGEAR MAINTENANCE C2
9	POWER SYSTEM NETWORK LOSS MANAGEMENT (ATC&C LOSSES) C3
10	ENERGY AUDITING & LOAD MANAGEMENT C4
11	DISTRIBUTION NETWORK PROTECTION D1
12	POWER INFRASTRUCTURE PROJECT MANAGEMENT D2
13	INTRODUCTION TO SCADA & SMART GRID SYSTEM D3
14	SAFETY RULES AND REGULATION/STANDARD SAFETY CODES D1
15	CABLE JOINTERS/FITTERS & INSTRUMENT MANAGEMENT E1
16	HV SUBSTATION CABLE TERMINATION COURSE E3

Furthermore, for some companies participating in training, advance needs surveys are regularly conducted, the results of which then dictate the contents of training. Accordingly, the training program is customized to meet the needs of participants.

Training programs are also set up for individual training participants by conducting pre-tests and interviews with managers to ascertain the competency levels and job-related management requirements of the participants.

4-3-3 Training courses related to the business of DisCos

Technical courses are designed for professionals in power generation, transmission and distribution and as of now (2020), 112 training courses are available. Of these, 45 courses are related to the business of DisCos. There are also courses designed to meet the needs of individual companies, most of which are for DisCos and these can be taken at any of the regional training centers.

The training period is divided into long- and short-term and the short-term course comprises on-the-job training and upskilling courses. The following two long-term courses have been established:

- The NAPTIN Graduate Skill Development Programme (NGSDP)

・ NAPTIN Technical Skills Acquisition Programme (NTSAP)

The available training courses cover the technical areas shown in Table 4-3.2 in relation to the business of DisCos.

Table 4-3.2 Technical areas related to the business of DisCos

No.	Technical business areas
1	Grid operation and control
2	Grid protection (including grounding technology)
3	System monitoring and control/SCADA
4	Substation operation
5	Transformer testing, commissioning and maintenance
6	Power distribution network planning and construction
7	Construction and maintenance of power distribution lines
8	Emergency response for power distribution network
9	Training for overhead power distribution workers
10	Training for multi-skilled electricians
11	Cable connection and termination connection
12	Meter installation and metering services
13	Loss reduction technology and EMS
14	Work safety and safety regulations

Several training courses have been established for the business areas shown in Table 4-3.2 and programs with different skill levels have been prepared for each course. The following is a description of the main training courses:

(1) Training for multi-skilled electricians

In this business area, the following training course has been set up for various types of power equipment.

Basic Technicians Multi-Skill Training for New Entry Level
(Lineswork, Cable Jointing & Electrical Fitters)

(Level achieved on completion of training)

Elementary level power distribution technicians will be able to perform operations and maintenance tasks with power distribution network equipment.

(Training scope)

The target for the training is power distribution technicians over a training period of over a training period of three weeks. The types of work available for multi-skilled electrician include overhead distribution line work, cable splicing, electrical installation, distribution line maintenance work and substation operations.

(2) Cable connection and termination connection

The following three skill levels have been set for cable connection and termination connection skills:

Cable Jointing Course: Module I, Module II, Refresher Course
The contents of training for Module I are as follows:

(Level achieved on completion of training)

Participants will be able to explain the concept of cable connections and perform straight and termination connections.

(Training scope)

The target for the training is power distribution technicians (cable jointers) over a training period of two weeks.

Understand cable connection terminology, cable jointer duties and cable types.

Learn to make straight and termination cable connections for low to medium voltage (up to 11KV).

In addition, know how to replace faulty cables and acquire skills on connection testing methods, welding connection methods, work grounding and installation procedures.

(3) Construction and maintenance of power distribution lines

In this business area, the following training course has been set up specifically for power distribution equipment:

Distribution Line Construction and Maintenance: Modules I, II

(Level achieved on completion of training)

Able to determine the most cost-effective line route.

Able to correctly erect structures using manual and Hiab cranes.

Able to determine the safe working load for taut wire materials. Able to determine the conductor weight of a straight line.

Able to correctly install grounding on overhead lines subject to working power outages.

Capable of serving as a model for constructing and maintaining 11kV and 415V networks.

(Training scope)

The targets for the training are linesmen, faults men and maintenance engineers over a training period of two weeks.

Provide participants with in-depth experience and knowledge of power distribution line construction and maintenance systems. In this course, participants will learn theoretical and practical skills to construct and maintain various power distribution facilities.

The contents of training for this course include the following tasks:

Visual inspection and positioning of equipment, drilling and erection skills, installation of branch lines for safety, installation and connection of transformer primary fuses, installation and connection of lightning arrestors, grounding installation of ring main units and feeder distribution boards

(4) Grid operation and control

In this business area, the following training course has been set up specifically for grid operation and control operations.

Power System Operation and Automation,

Distribution Network Operations & Maintenance,

Advanced System Electrical Operator Course

(Level achieved on completion of training)

Able to explain the components of a power system and how they operate.

Able to operate equipment safely.

Able to communicate efficiently in grid operations.

Able to explain and operate automated power systems.

(Training scope)

The targets for the training are power system operations engineers, technologists and senior technicians over a training period of two weeks.

Participants will learn power system operation techniques, equipment operation, fault reporting, load distribution and communication during grid operations.

(5) Emergency response for power distribution networks

In this business area, the following training course has been set:

Distribution Network Dispatch and Emergency Response

(Level achieved on completion of training)

Learn insights and new behaviors for operating and monitoring substation equipment.

(Training scope)

The targets for the training are distribution engineers, technologists and senior technicians over a training period of one week.

This training course is incorporated as part of the Distribution System Operations Module II.

The course will provide an understanding of the decision-making processes required for load planning, load management, load limiting and emergency response in distribution substations, covering tasks related to equipment operation, power feed control/load management and emergency response.

(6) Power distribution network planning and construction

In this business area, the following training courses have been set:

Planning & Construction of Distribution Network

(Level achieved on completion of training)

Be able to plan and implement power distribution projects and their construction.

Endeavor to ensure safety at all times during construction.

(Training scope)

The targets for the training are distribution engineers, technologists and senior technicians over a training period of two weeks.

Participants will learn design criteria and principles, design considerations, minimum loss in design and modeling techniques.

(7) Grid protection (including grounding technology)

In this business area, the following training course has been set:

Basic Power System Protection - P1
Distribution Network Protection Course
Power Systems Protection Course Technical

(Level achieved on completion of training)

Participants will be able to perform the following tasks after completing the training:

- Read both protection and control circuits and use them to solve problems.
- Be able to apply the protection device for power transformers.
- Connect the instrument transformer correctly.
- Acquire a complete grounding system for substations.
- Correctly perform relay calibration procedures.
- Able to apply basic protection to distribution line circuits.
- Able to align relays correctly.
- Able to carry out protective wiring and commissioning at distribution substations.

(Training scope)

The targets for the training are electrical distribution protection engineers, technologists and technicians over a training period of two weeks.

In this course, participants will learn the fundamentals of power system protection and control, protection scheme design, calibration and coordination of protection relays and testing and commissioning of electrical equipment through training in the following technical elements:

(Technical elements): 1. Overview of protection, 2. Connection and use of equipment, 3. Control circuits, 4. Instrument transformers, 5. Introduction to protective relays, 6. Relay conditioning, 7. Differential protection. 8.Transformer protection, 9. System grounding, 10. Equipment grounding, 11. Relay testing and maintenance, 12. Fuses and fuse coordination, 13. Basic line protection.

(8) Transformer maintenance, testing and commissioning

In this business area, the following training course has been set up specifically for the main equipment in substations:

Distribution Transformer Testing & Commissioning
Power/Distribution Transformer Commissioning
SF6 Circuit Breaker Troubleshooting/Maintenance
Transformer Oil Test & Filtration Techniques
Transformer & Switchgear Maintenance
Workshop on Transformers Operations & Maintenance

The contents of the training course on maintaining transformers and switchgear are as follows:

(Level achieved on completion of training)

- Able to identify the different switchgears and explain the process of resolving circuit

breaker faults.

- Gain on understanding the structural features of various circuit breakers.
- Able to perform switchgear testing according to procedures.
- Able to perform the latest maintenance techniques for switchgears.

(Training scope)

The targets for the training are electrical technologists and maintenance engineers over a training period of two weeks.

Gain an understanding of the theory of switchgears and switchgear technology and acquire knowledge and deep experience in switchgear maintenance skills through practice.

4-3-4 Training courses related to DisCo business (non-technical)

(1) Structure of non-technical training

There are 49 non-technical training courses listed on the Training Portal of the NAPTIN website, which is 44% of the total number of technical training courses (112). However, of the following four areas of non-technical training, Leadership & Management and Other Non-technical & Soft Skills also feature the participation of staff from outside the distribution companies and power sector organizations and the course content is not necessarily limited to the power sector.

Table 4-3.3 Structure of non-technical training

Leadership & Management	Electricity Marketing & Customer Services	Electricity Trading, Regulation & Pricing	Other Non-technical & Soft Skills
Leadership & Management Course Strategic Communication Administrative & Logistics Course etc.	Billing and Customer Service Course Revenue Generation & Protection Course Modern Electricity Marketing Techniques Course for Distribution Companies Customer Relationship Management Course Work, Altitudinal Change and Productivity Improvement Course etc.	Incentive Regulation Course Negotiation of off-takers and Power and Gas Purchase Agreement Course Load Demand Balancing Management & Regulations Course Electricity Market Trading Course etc.	Technical for Non-technical Course Generation Professionals Course Computer & Internet Concepts & Application Course for Effective Business Operation Project Management Course Using Microsoft Project etc.

Source: NAPTIN

The following is an overview of the training courses on fee collection directly related to the power distribution sector and the training courses on customer service.

(2) Training courses related to fee collection

Table 4-3.4 shows the number of participants to date in training courses on fee collection. Both upper and lower rows of the table have been prepared based on data provided by NAPTIN. As the table above shows, the number of participants in NAPTIN training courses on fee collection has been declining. There are several possible reasons for this, including (1) DisCos developing and implementing their own training courses at their own training facilities, (2) DisCos reducing training expenditure due to poor business conditions and (3) the lack of performance improvement among trainees who participated in NAPTIN training. However, interviews with DisCos and NAPTIN will be needed to confirm this.

Table 4-3.4 Number of participants in training courses on fee collection

Type of Training	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Power System Commercialization (Metering, Sales, Collection, Client Management) Course	NIL	NIL	NIL	NIL	NIL	NIL	NIL	4	36	NIL	40
Electricity Marketing and Revenue Generation & Protection Course	133	389	50	30	20	50	40	1	20	NIL	733
Meter Installation, Tampering & Management Course	20	50	50	50	60	1,000	95	26	40	3	1,394

Training Course	No. of Trainees	2016	2017	2018	2019
Revenue Generation and Protection for Utility Company Course	Total	NIL	NIL	22	NIL
	of which from DisCos	NIL	NIL	22	NIL

Source: NAPTIN

Table 4-3.5 shows an overview of the Revenue Generation & Protection for Utility Company course. We would like to further study what case studies were conducted and what international best practices were used as benchmarks.

Table 4-3.5 Overview of the Revenue Generation & Protection for Utility Company course

Number in the training list:	41
Title:	Revenue Generation &Protection for Utility Company
Code	RG&P
Type:	Non-technical Course
Classification:	Commercial
Objectives:	After the training, participants should be able to do the following: Implement a proactive rather than passive approach to securing income Find mistakes and weaknesses to mitigate risks Improve customer service, implement good practices for fee collection and secure a competitive advantage Foster a culture of securing income throughout the organization Investigate and visualize any increase in operating costs and fee collection
Scope:	1. How to create a foundation for reducing revenue loss within your own organization. 2. Understand the various stages at which revenue loss occurs 3. Understand which actions the organization should take and prepare for implementation 4. Maintenance of customer lists 5. Installation of customer meters and reading of usage 9. Collection of fees 10. Disconnection of customers who fail to meet obligations 11. Customer rate classification and reclassification 12. Registering unregistered customers 13. Managing effective customer relationships 14. Collecting and managing accounts receivable 15. Meter operation confirmation 16. Applying good practices to maximize the effectiveness of new technologies and minimize losses 17. Effective data use and reporting 18. Safety during meter installation, inspection and disconnection with customers
Eligible participants:	Supervisors, collectors and professionals, auditors, managers, advisors, professionals, executives and other personnel at all levels working for power distribution companies who want to maximize performance and minimize power losses related to fee collection. For professional positions, holders of OND or higher qualifications
Course overview:	This course provides practical workshops on achieving seamless business performance through strategies that focus on finding, quantifying and minimizing oversight, loss and risk within an organization. Detailed methods for finding, managing and preventing threats of tampering, theft, fraud and technical and other losses are also covered. Participants will gain unique data management capabilities to maximize competitiveness and improve customer relationships using tools to promote smart meters. Practical case studies based on localized or international lessons learned will help ensure measures are deployed most effectively in their respective environments.
Period (weeks):	1
Costs (NGN):	50,000 (approximately JPY 14,000, based on the exchange rate in February 2021)
Implementing training centers:	Main Campus (Abuja), Akangba Regional Training Center

Source: NAPTIN

(3) Training courses related to customer service

Table 4-3.6 shows the number of participants in customer service-focused training courses. While the same course was offered every other year in 2016 and 2018, the number of participants was lower in 2018 than in the previous years. The causes need to be clarified, like the abovementioned training courses on fee collection.

Table 4-3.6 Number of participants in training courses related to customer service

Training Course	No. of Trainees	2016	2017	2018	2019
Customer Relationship Excellence Course	Total	15	NIL	10	NIL
	of which from DisCos	15	NIL	10	NIL

Source: NAPTIN

An overview of the Customer Relationship Excellence course is shown in Table 4-3.7. For this survey, we would also like to conduct a detailed survey on the contents of the course, investigate its effectiveness and areas of improvement to promote its effectiveness.

Table 4-3.7 Overview of the Customer Relationship Excellence course

Number in the training list:	12
Title:	Customer Relationship Excellence
Code	CRE
Type:	Non-technical Course
Classification:	Management
Objectives:	By the end of the training, participants should be able to do the following: * Develop and implement strategies to attract and acquire new customers * Understand customer requirements and maintain good relationships with customers * Build and maintain relationships with customers, satisfying and retaining them * Evaluating customer relationships as a strategy to remain competitive and maintain an edge
Scope:	a. Approach to customer relationships b. Sales targets and roles c. Sales force management d. Service quality and customer expectations e. Effective communication and motivation g. Knowing your customers
Eligible participants:	High- and mid-level management in customer service organizations
Course overview:	When managing interactions within a company while keeping a handle on current and future customers in a competitive business, the environment becomes increasingly difficult to navigate with each passing day. With this in mind, many companies are going even further to know and satisfy their customers; understanding that today's customers expect more than just satisfaction from salespeople and companies. This course focuses on a strategic approach; prioritizing the customer at the center of the business of front-line staff, sales promotion staff and customer service representatives, valuing, recognizing and respecting the customer.
Period (weeks):	1
Costs (NGN):	50,000
Implementing training centers:	Main Campus (Abuja), Akangba Regional Training Center

Source: NAPTIN

4-4 Trends in support for NAPTIN by other donors

AFD is implementing the Project on Enhancing Vocational Training Delivery for the Power Sector in Nigeria[1]. The goals are as follows:

- Support Nigeria's privatized power sector by providing qualified human resources through NAPTIN's vocational training programs.
- Make NAPTIN a financially sustainable organization capable of providing private sector-oriented and demand-driven projects.

The AFD project comprises the following three components:

① Development of training courses: Product Development (Consultancy Service)
This is to improve the existing NAPTIN training courses. The contract with the consultant has been signed and the Indian consultant will be mobilized from the week of September 20, 2021.

② Improvement of training facilities and renovation of regional training centers: Infrastructure Development (EPC Contract)
Construction of training centers and training facilities (simulated substations, simulated distribution poles, etc.) A bid opening ceremony will be held on October 11, 2021.

③ Governance and organizational reform: Corporate Development (Consultancy Service)
Consulting services to strengthen NAPTIN's organizational capacity. Evaluation of technical bids has been done and three companies have passed the review and will proceed to the price bid opening.

The power distribution, transmission and generation sector allocations for components (1) and (2) are shown in Table 4-4.1. The number of training courses and equipment maintenance numbers for the power distribution sector exceed those for the other sectors, reflecting that the focus is on improving the power distribution sector.

Table 4-4.1 Number of training courses developed and number of facilities and equipment provided by AFD's project as percentages to the power distribution, transmission, and generation sectors

	Distribution	Transmission	Generation	Total
1. Development of technical training courses (courses)	30	15	20	65
2. Development of non-technical training courses (courses)	15	5	10	30
3. Maintenance of training equipment (units)	48	7	8	63
4. Improvement of regional training centers (buildings)	8	7	3	---

Source: Project on Enhancing Vocational Training, AFD, 2017

The following are also planned with regard to the development of training facilities and equipment and improving the infrastructure of the regional training centers.

1 Project on Enhancing Vocational Training Delivery for the Power Sector in Nigeria

- Construction of classrooms and dormitories
- Establishment of a technical laboratory with simulators and training facilities
- Development of simulated power distribution and transmission systems and simulated substations
- Development of a simulated thermal power plant

The governance and organizational reforms include the following improvements to the management of power distribution companies:

- Management improvement (HR system, IT, corporate governance structure)
- Customer development and marketing
- Finance systems, management reports

The description, costs and financial resources of the AFD project are also shown in Table 4-4.2.

Table 4-4.2 Description, costs and financial resources of the AFD project

Description	Costs (EUR million)	Sales composition (%)	Financial resources (EUR million)		
			Loans	Donations	
				FEX-TE	EU
C1 Development and setting up of training assets	**5.3**	**(10.5%)**		**0.3**	**5.0**
C1.1. Development of technical training courses	3.0	(5.9%)			3.0
C1.2 Development of non-technical training and capacity-building	1.0	(2.0%)			1.0
C1.3. Training the trainers (ToT)	1.0	(2.0%)			1.0
C1.4. Training of certified electricians	0.3	(0.6%)		0.3	
C2 Improvement of NAPTIN network of regional training centers (infrastructure and equipment)	**28.0**	**(55.2%)**	**28.0**		
C2.1. Construction of workshops and laboratories	12.6	(24.8%)	12.6		
C.2.2. Acquisition of technical equipment	12.8	(25.3%)	12.8		
C.2.3. Construction of hostels and other halls	2.6	(5.1%)	2.6		
C3 Governance and organizational reform	**10.8**	**(21.3%)**	**7.4**	**0.4**	**3.0**
C3.1 Development of new procedures and policies	3.0	(5.9%)			3.0
C3.2 Strengthening of the Association of Nigerian Electricity	0.4	(0.8%)		0.4	
Distributors (ANED)	7.4	(14.6%)	7.4		
C3.3 Support to project management					
Miscellaneous and contingencies	6.6	(13.0%)	6.6		
Total	50.7	(100)	42.0	0.7	8.0

Source: Project on Enhancing Vocational Training, AFD, 2017

NAPTIN explained that they would make adjustments to ensure no overlap between AFD and JICA projects, but it is necessary to continue collecting information through NAPTIN and AFD project consultants and monitor the situation in terms of both training course development and procurement of training equipment.

Chapter 5 Current status and issues in the power distribution sector confirmed in the field survey

5-1 Overview of AEDC‘s organization and implementation work

5-1-1 Business organization structure and roles of each division

The organization of AEDC has the following three types of offices placed hierarchically according to the size of the area under its jurisdiction.

Table 5-1.1 shows the number and scale of each office and the division of roles related to technical work.

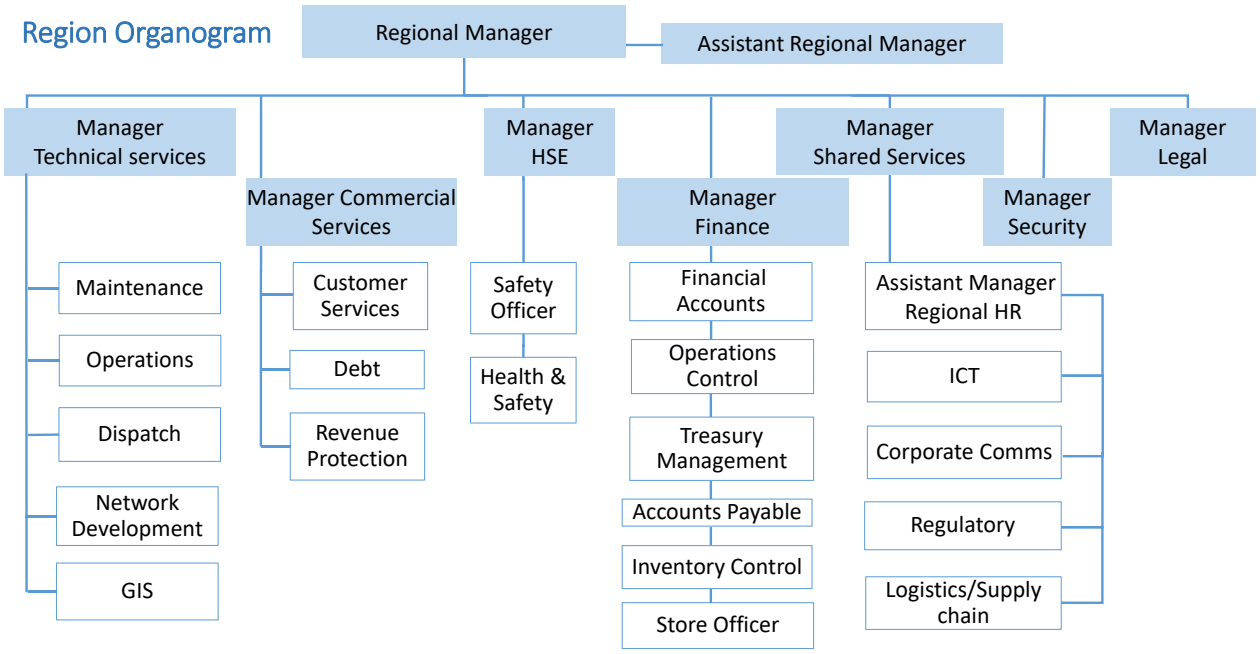
Table 5-1.1 Outline of placement of each office and their roles

Offices	Number of offices	Number of members	Roles
Regional office	9	38	Effectively implementing and managing technical activities based on strategic instructions from the head office. Maintenance activities for injection substations and 33kV feeders.
Area office	41	56	Implementing the works instructed by the regional office regarding 33kV/11kV distribution facilities. Maintenance activities for distribution substations and 11kV feeders.
Service center	254	23	Maintenance and fault recovery of low-voltage distribution facilities.

Source: Prepared by the survey team based on AEDC information

5-1-2 The business organization of the regional office and the role of technical sections

Figure 5-1.1 shows the business organization of a regional office.



Source: Prepared by the survey team based on AEDC information

Figure 5-1.1 Business organization of a regional office

The regional office has a technical section called Technical services, which houses the technical sections for each of the business roles shown in Table 5-1.2.

Table 5-1.2 Role of each technical section

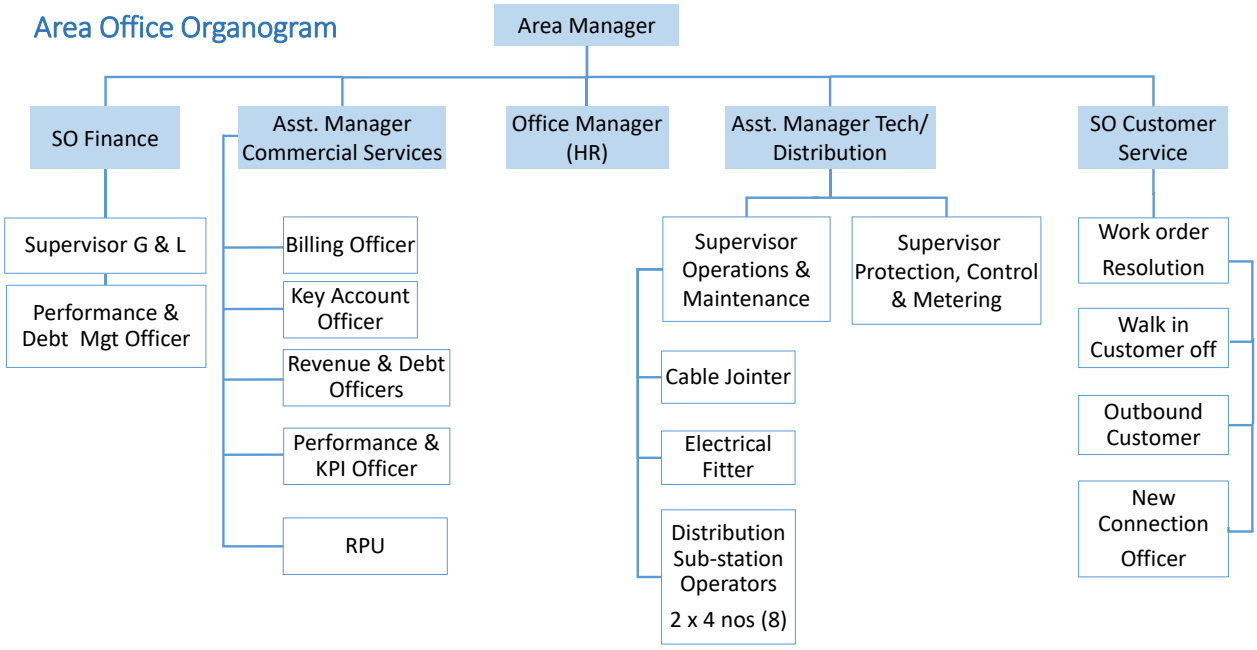
Technical section	Role (works in charge)
Manager Technical services	Supervising all technical activities within the regional office
Maintenance	Daily network maintenance work
Operations	Daily network operation
Dispatch	Coordinating network operations
Network Development	Demand projection and facilities expansion planning
GIS	ID assignment of equipment (poles, etc.), registration of location information (GPS coordinates), updating of distribution network diagram

Source: Prepared by the survey team based on AEDC information

5-1-3 The business organization of the area office and the role of technical sections

Figure 5-1.2 shows the business organization of an area office.

The area office has the Assistant Manager in the distribution department and the Supervisor in charge of Operations & Maintenance and Protection, Control & Metering under it. Table 5-1.3 shows the roles of each technical section (by business content).



Source: Prepared by the survey team based on AEDC information

Figure 5-1.2 Business organization of the area office

Table 5-1.3 The role of each technical section

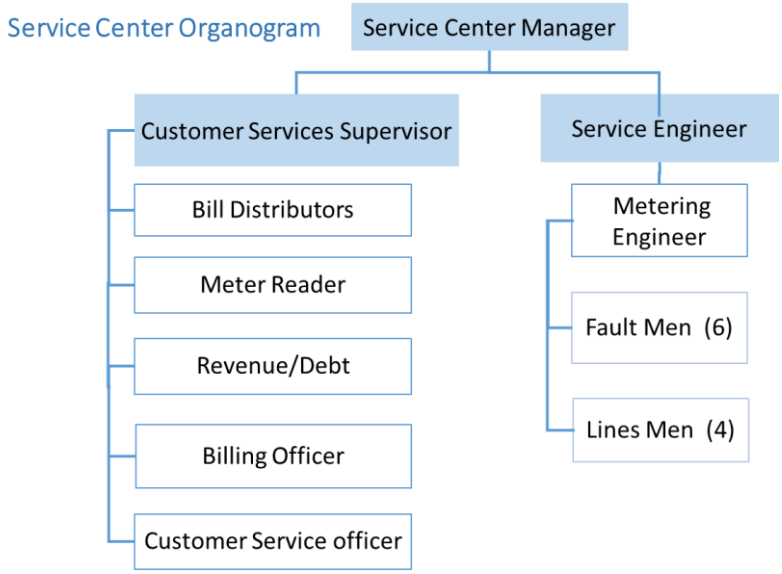
Technical section	Role (works in charge)
Tech/Distribution Asst. Manager	Coordination of all technical activities in an area office
Operations & Maintenance Supervisor	Supervising patrols of distribution facilities and clearing fault point within area office
Protection, Control & Metering Supervisor	Fault point test, deterioration diagnosis, clearing fault point within area office
Cable Jointer	Jointing cable
Electrical Fitter	Installation of switchgear and facilities maintenance
Distribution Substation Operators	Installation of switchgear and facilities maintenance

Source: Prepared by the survey team based on AEDC information

5-1-4 The business organization of service center and the role of technical sections

Figure 5-1.3 shows the business organization of a service center.

The service center has technical and customer service departments. Table 5-1.4 shows the roles of each technical section (by business content).



Source: Prepared by the survey team based on AEDC information

Figure 5-1.3 Business organization of service center

Table 5-1.4 The role of each technical section

Technical section	Role (works in charge)
Service Engineer	Clearing fault point and reporting work in a service center
Metering Engineer	Installation and maintenance of electricity meters
Fault Men	Clearing fault point
Lines Men	Network enhancement and maintenance activities

Source: Prepared by the survey team based on AEDC information

5-2 Organization in charge of fault recovery and facilities maintenance work and outline of work implementation

5-2-1 Staff in charge of works according to business flow

Table 5-2.1 shows the correspondence between the main work contents in the facilities maintenance work and the assigned technical staff.

Table 5-2.1 Staff in charge of works according to business flow

Maintenance works	Assigned technical staff
Regular patrols and inspections	Service Engineer
Replacement/repair of deteriorated, failed facilities	Fault Men and Lines Men
Accumulation and analysis of maintenance data	Service Engineer
Formulation and management of annual maintenance work	Service Engineer
Load management of transformers and feeders	Service Engineer

Source: Prepared by the survey team based on AEDC information

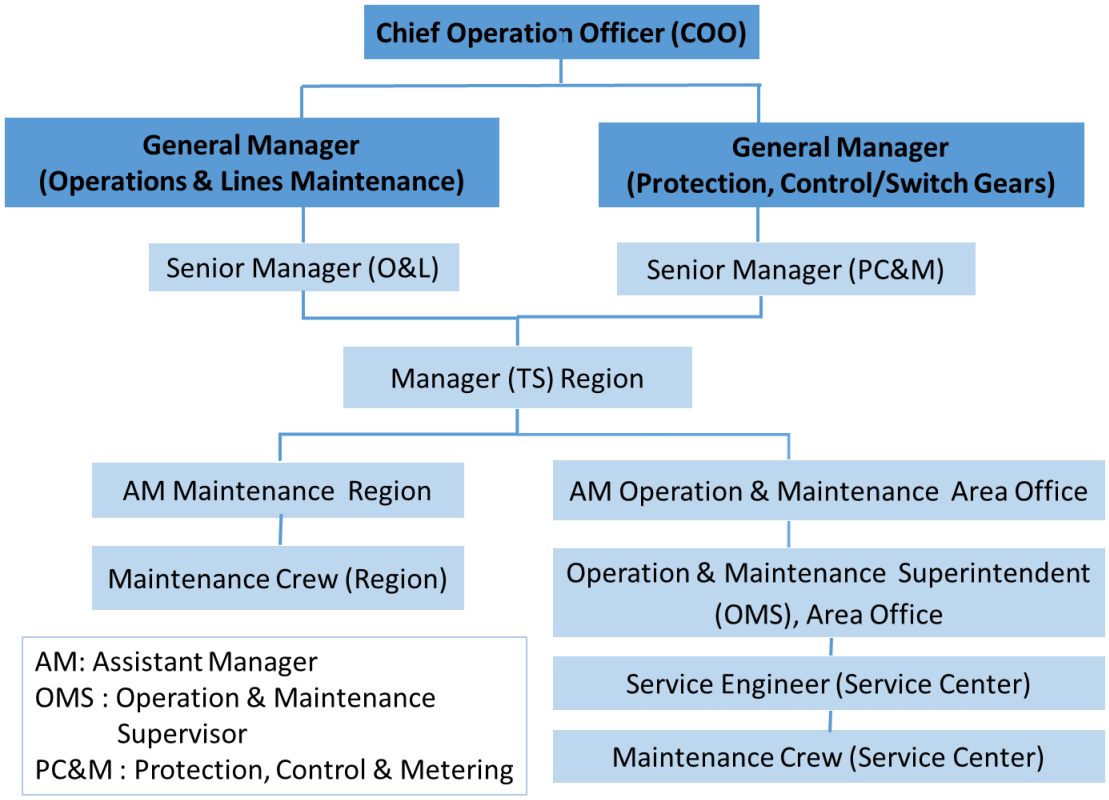
The load management of transformers and feeders shown in Table 5-2.1 is carried out according to the following method:

i. Load of the 33kV and 11kV feeders is monitored by the distribution substation operator (DSO) hourly and reported to the relevant parties by the start time of the next day.

ii. The load of the distribution transformer is measured by the service engineer with a clamp ammeter monthly and the record is reported to the regional technical manager quarterly.

iii. At the beginning of the next quarter, the Senior Manager (SM) of Network Development will consider these data and other relevant factors to summarize the load condition. The loads of the distribution substations, injection substations and feeders are then determined based on these results.

5-2-2 Organization conducting fault recovery works and implementation method



Source: Prepared by the survey team based on AEDC information

Figure 5-2.1 Organization conducting fault recovery and facilities maintenance works

Recovery of distribution line faults and facilities maintenance work are carried out by the organization (Organization conducting fault recovery and facilities maintenance works) shown in Figure 5-2.1 (based on the role of the technical staff). Comparing the organizational structures among regional offices to the service center shown in the above section reveals how the technical staff of the area office and the service center carry out the actual work.

The fault point location and restoration of distribution line faults roughly comprise the following steps:

i. Obtain station guarantee
ii. Patrol the line
iii. Locate fault point
iv. Clear fault
v. Submit the station guarantee

vi. Restore line

5-2-3 Outline of facilities maintenance work

(1) Organization to implement maintenance work and the role of each organization in work execution

- The annual maintenance plan is created by the Technical manager/Assistant manager of the O & M unit at each level from the head office (HQ) to the regional/area office.
  There are nine regional offices and 41 area offices.
- In particular, the head office (HQ) is in charge of planning 33kV substation equipment.
- Maintenance work is carried out by technicians of the Technical service team of the regional/area office. After completing the work, the maintenance staff prepare a maintenance report, which is then submitted to the area/area dispatch. If there are any problems that cannot be solved by the area/area office, the Expert engineers at the head office (HQ) (overhead line, underground line, substation, etc.) will support them.
- A monitoring team and quality control team are placed at each level from the head office (HQ) to the regional/area office and oversee the analysis and evaluation of maintenance data. In particular, the 33kV equipment is evaluated by the Expert engineer at the head office (HQ).

(2) Manual on patrol and inspection know-how (standards)

- The key points on which staff should focus while patrolling and inspecting facilities are specifically described in the maintenance plan prepared annually. In addition, the template used by staff during patrols and inspections also describes the key points.

(3) Reliability evaluation data such as fault analysis data

- Regarding fault data analysis, the fault reports have not been analyzed to determine the problems of facilities and help examine countermeasures. The analysis simply shows the yearly transition in the number of faults.
- At the central dispatch center, the fault reporting system for the distribution system has been in operation (since July 2021). In this system, information from occurrence to recovery and the type and cause of faults are input for each distribution feeder fault (Figure 5-2.2), based on which the number can be aggregated by region and cause. An example of the aggregation result is shown in Figure 5-2.3. An example of the classification items determining the cause of the accident is shown in Figure 5-2.4. However, since the distribution line accident data and the affected customer data are not interconnected, reliability indicators such as SAIFI and SAIDI cannot be calculated.

Figure 5-2.2 Information indication of each fault feeder（the central dispatch center）

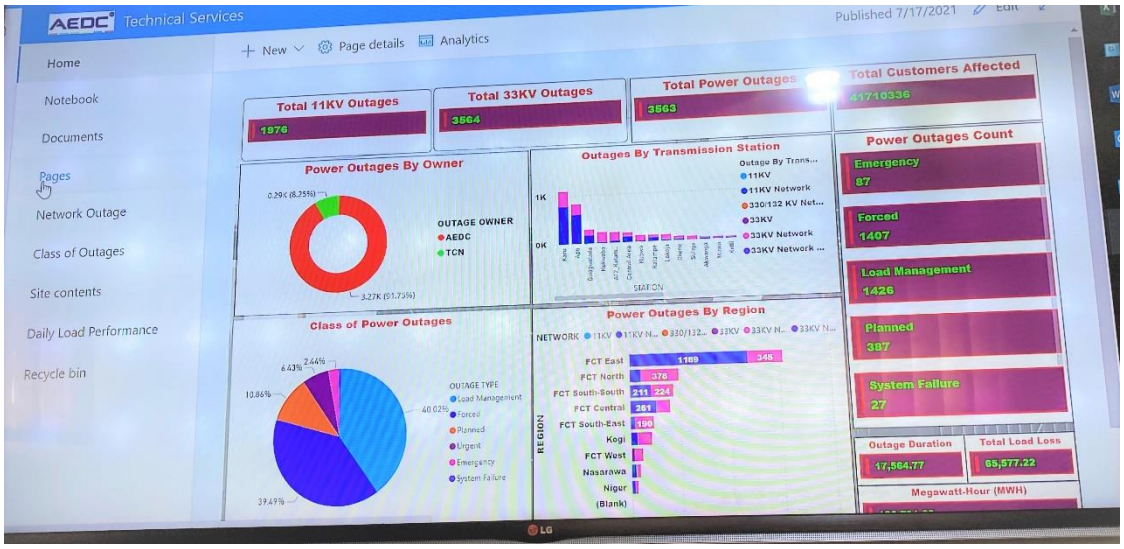


Figure 5-2.3 Aggregation results of fault data（the central dispatch center）

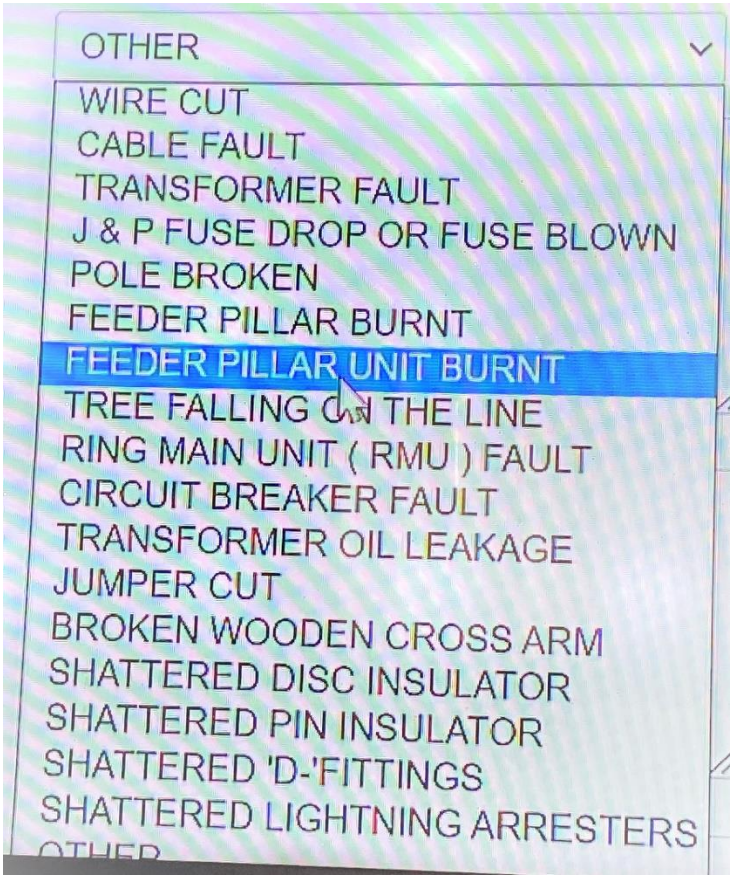


Figure 5-2.4 Example classification items on fault causes (the central dispatch center)

(4) Implementation of distribution facilities maintenance work

The daily maintenance work of distribution facilities is roughly carried out according to the following steps:

- Preparation of a Maintenance plan/Schedule
- Identification of Maintenance Requirements
- Acquisition of material/tool for maintenance
- Implementation of maintenance activities
- Impact assessment, monitoring and documentation

During the actual maintenance work on distribution facilities, the following works are carried out:

- Physical patrols of line and equipment
- Testing using test equipment
- Thermographic scanning

The abovementioned activities are carried out using the following devices and instruments:

- Ladders, chainsaws, safety belt, electrical/mechanical toolbox, etc.

Within the distribution equipment maintenance work, the following specific activities are carried out for 11kV feeders:

- Changing of weak/broken cross arms, shattered pots/discs insulators etc.
- Retensioning of sagging lines.
- Replacement of cracked/broken poles.
- Rebeaming of poles.
- Realignment of leaning poles.
- Short spanning of lengthy poles.
- Line-trace.

The following items are listed in the checklist as key points while patrolling distribution facilities (overhead lines):

- Sagged lines
- HT/LT Poles（Wooden, Cracked, Broken）
- Slanting poles
- Pole/Tower foundation
- Pin insulators
- Jumper spindles
- Tie straps
- Cross arms
- Channel irons
- Angle irons
- Disc insulators
- Lightning arrestors
- Aluminum conductors (Undersized conductors/Weak jumpers)
- D-fitting
- Vegetation control (Overgrown)
- Termination (Overhead & Cable termination)
- Others (example: Need for J&P fuse/Feeder pillar fuse etc.)

The following items are listed as measures to be taken to improve reliability. Most are general measures. However, as a concrete measure, vegetation control on overhead lines is noted. The tree trimming is carried out twice a year:

- Vegetation control on overhead lines
- Preventive maintenance on all network equipment
- Network reinforcement
- Network reconfiguration
- Network expansion/upgrade

(5) Maintenance of substation equipment

In substation equipment maintenance activities, the following main works are carried out.

- Substation maintenance
- Feeder line maintenance
- Substation earthing improvement
- Rehabilitation of underground cables
- Filtration of transformer oil
- Meter checks & maintenance (injection substation)
- Communication equipment maintenance (injection substation)

The daily maintenance work of substation equipment is roughly carried out according to the following steps:

- Plan and schedule
- Request materials
- Isolate outage
- Perform integrity test on relays and circuit breakers
- Recalibrate/coordinate relays
- Test dielectric strength of transformer coil
- Clean substation
- Replace defective components etc.

The following works are carried out as specific maintenance activities for the abovementioned works:

1 Re-calibration, coordination & functionality tests of relays
2 Maintenance and comprehensive checks/tests on:
    - Protection systems
    - Power transformers
    - Switchgear
    - Tripping units
    - Substation accessories
3 Maintenance of communication and safety systems.
4 Thermographic Camera scan for hotspots throughout the entire substation equipment like line tap, VTs, CTs, Gang-Isolator, CBs, cable length terminations, HV (33&11) kV Busbars and Power transformer terminals etc.
5 Tests of transformer oil samples.
6 Checks on earthing systems.
7 Checks on safety equipment like fire extinguishers, signage, illumination etc.
8 Checks on gantries like transformer bushings, VT, CT, gang-isolator, outdoor/indoor breakers etc.

9 Environmental and vegetation checks, evacuation of obsolete equipment etc.
10 Checks on cable terminations and exposed ends.
11 Filtration of transformer oil.
12 Meter Integrity checks and maintenance.
13 Communication Equipment checks and maintenance.

The abovementioned activities are carried out using the following devices:

1 Secondary injection tester.
2 Mustimeter.
3 Clamp-on ammeter.
4 Cable Drum.
5 Hand Blower.
6 Oil Dielectric Tester.
7 Earth Resistance tester.
8 Insulation Tester.
9 Thermographic Camera.
10 Power Logger.
11 Power Quality Energy Analyzer.
12 Generator.
13 Electromechanical Toolbox.
14 Hand Blower.
15 Cable Fault Locating Equipment.
16 Chainsaw.
17 Earthing Kit.

The following items are listed as measures to improve reliability, most of which are as general as those for distribution facilities. However specific measures include vegetation control in the switchgear yard, replacement of aging equipment and automation of substations.

- Vegetation control of substation switchyards
- Preventive maintenance on all network equipment
- Retrofitting of panels/switchgears
- Replacement and upgrading of obsolete equipment
- Automation of injection substations

5-3 Configuration of protection/sectionalizing switchgear related to distribution system operation/fault recovery response

5-3-1 33kV Feeder

- Some 33kV feeders are installed with up to two auto-reclosers.
- Some feeders are not installed with any auto-recloser.
- The total number of installed units is 60 for 91 circuits of 33kV feeders. Fifteen are unavailable. (Information obtained from Web meeting).
- No switchgears except an auto-recloser are installed on the 33kV feeder.
- The following four points are considered for the purpose of installing an auto-recloser:
  - Protection of distribution lines.
  - Clearing transient faults.
  - Switching for load control. Since the feeder capacity exceeds the circuit breaker capacity of the TCN substation, it is also important not to overload the TCN circuit breaker. Some auto-reclosers can be operated remotely for this purpose.
  - Do not increase the number of operations of TCN circuit breaker due to feeder faults. (In feeders with one auto-recloser, an auto-recloser is installed in relative proximity to the TCN substation.)

5-3-2 Installation status of the 33kV auto-recloser

A field survey was conducted to determine the actual conditions of the 33kV feeder and its protection/switchgear.

The survey feeder (LIFE CAMP FEEDER AT2) is a distribution feeder, 65 km long and demand of 12 MW outgoing from TCN‘s 132 kV/33 kV substation (Katampe S/S).

The auto-recloser (Figure 5-3.1) is installed 15 km from the TCN substation (Figure 5-3.2) (installed in around 2017). The length from the auto-recloser pole to the end of the feeder is 40 km. The load in this section is 9 MW, which is supplied by 33kV/415V transformers. Based on this status, it is clear that the auto-recloser is installed at a position biased toward the TCN substation from a load distribution perspective. One 33kV/11kV injection substation is connected to the other sections of this feeder.

In addition, some auto-reclosers can also be operated remotely for load management. The specifications are shown in Table 5-3.1.

Table 5-3.1 The specifications of the auto-recloser

Item	Specification
Nominal System Voltage	33kV
Load current	630A
Short time breaking capacity	10kA/sec
Making current (Peak)	25kA
BIL	170kV
CT ratio 600/1A	600/1A
frequency	50Hz
Interrupting medium	Vacuum

Figure 5-3.1 33kVrecloser

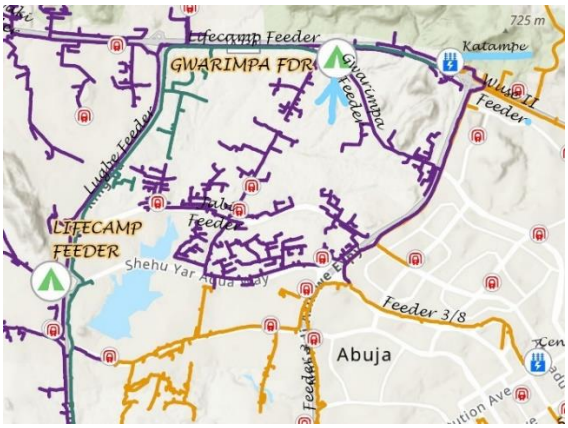


Figure 5-3.2 Location map of the recloser and TCN substation

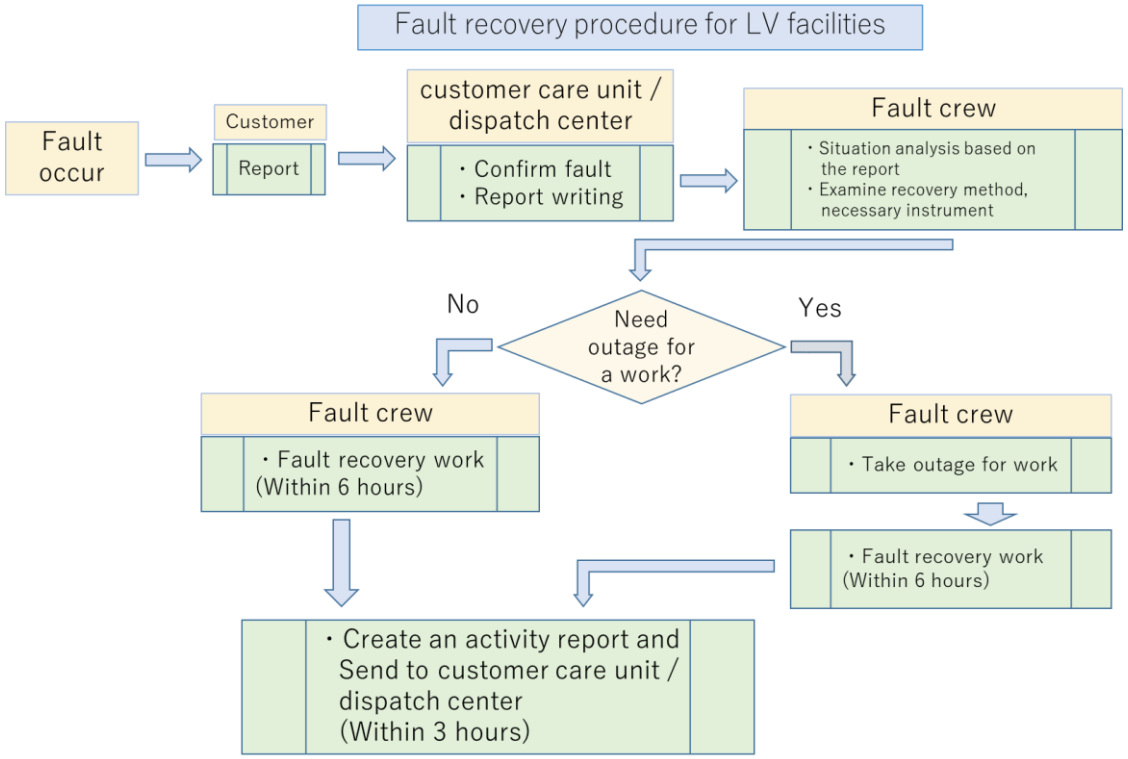
5-3-3 11kV Feeder

- Almost no sectionalizing switchgear except a circuit breaker in a substation is installed on an 11kV feeder.
- As a means of sectionalizing feeders, jumper connection points are to be placed every 500 m. Isolators are also installed in some portions of feeders.
- When sectionalizing is required during feeder faults, there must be scope to disconnect jumper connection points for the purpose of isolation.
- When an 11kV feeder malfunctions, the fault point is pinpointed by patrol. If no fault point is found during the patrol, the jumper connection points are disconnected from the substation in order and the fault section is determined with an insulation resistance measuring instrument (mega ohm meter). This series of work procedures is summarized in the manual.

5-4 Fault recovery (fault management) and power outage management of distribution system

5-4-1 Fault recovery of low-voltage distribution systems

If a low-voltage distribution feeder malfunctions, the fault recovery is carried out according to the procedure shown in Figure 5-4.1. The detection of faults depends on customer reports despite the fact that a low-voltage distribution system supplies power to a wide area with large-capacity transformers centrally installed and long feeders.



Source: Prepared by the survey team based on AEDC information

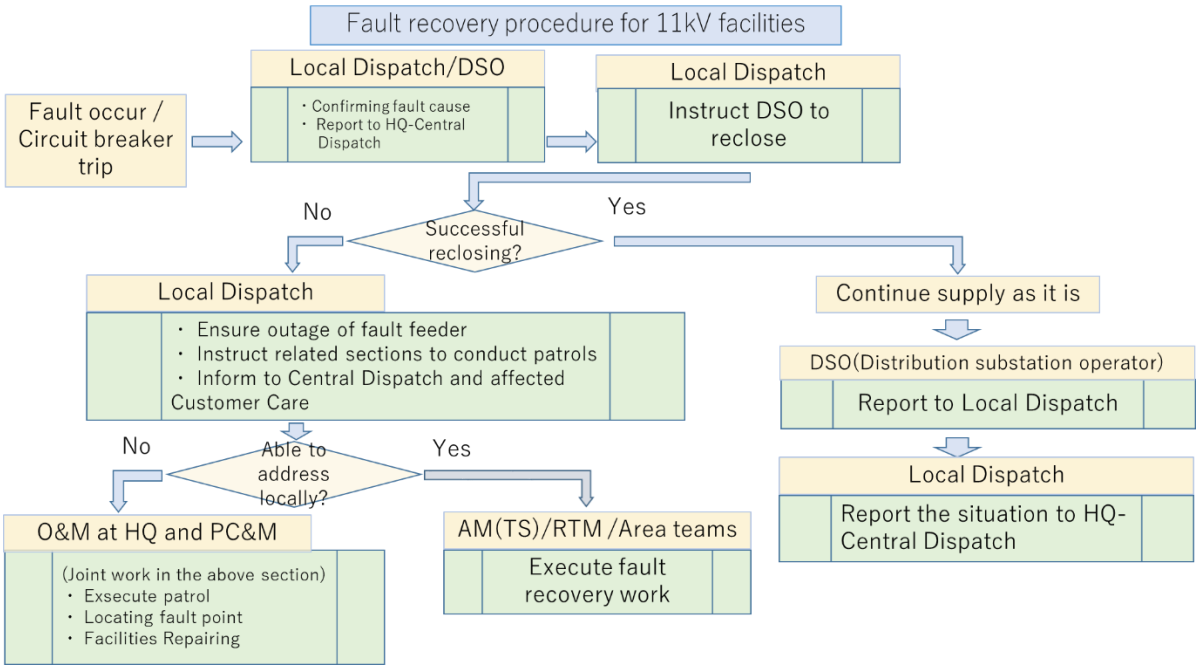
Figure 5-4.1 Fault recovery procedure in a low-voltage distribution system

5-4-2 Fault recovery of a high-voltage distribution system

In case an 11kV distribution feeder malfunctions, the fault recovery is carried out according to the procedure shown in Figure 5-4.2.

As shown in Figure 5-4.2, when an 11KV feeder malfunctions, the substation breaker does not automatically reclose the circuit, but the Local Dispatch instructs the DSO (Distribution Substation Operator) to reclose the breaker after confirming the fault situation.

If the fault is confirmed as permanent as a result of manual reclosing, Local Dispatch takes measures to cut power to the faulty feeder and instruct the relevant departments to patrol the same.



Source: Prepared by the survey team based on AEDC information

Figure 5-4.2 Fault recovery procedure in an 11kV distribution system

5-4-3 Fault current indication system of 33kV feeder

AEDC installs an FCI (Fault Current Indicator) system as an initiative to reduce the time required to pinpoint faults for 33kV feeders. The actual situation of that system was investigated.

The FCI (Fault Current Indicator) system is installed on one 33kV feeder as a pilot project. The feeder with FCI is the L32 Feeder outgoing from the TCN substation (Kubwaba S/S). The location map is shown in Figure 5-4.3.

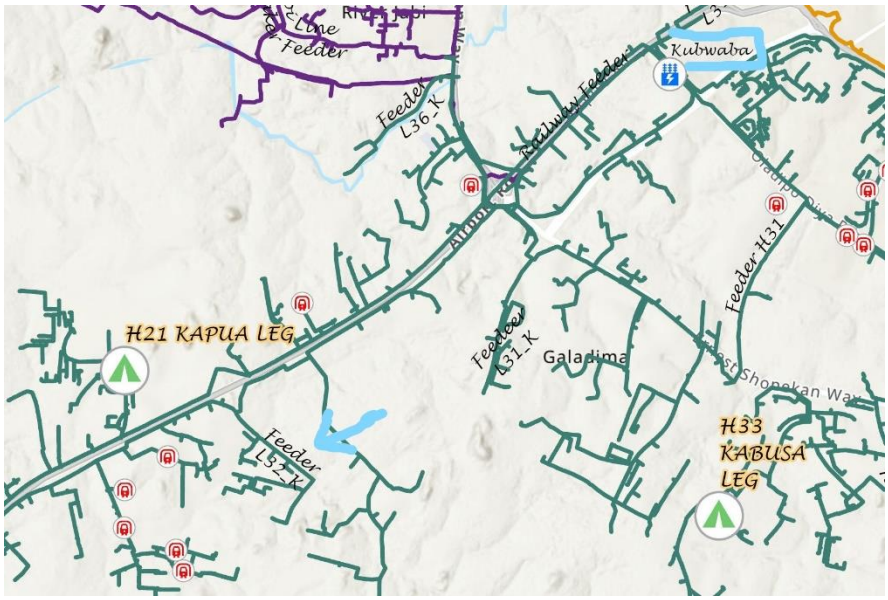


Figure 5-4.3 Location map of the TCN substation and the feeder with FCI

Five FCIs are installed in one feeder (15 in total with three-phase mounting). The installation status of FCI is shown in Figure 5-4.4 and 5-4.5.

The manufacturer of FCI is AQUIVIS (https://aquivistechnologies.com/).

The FCI has fault current detection and radio communication functions. When the FCI detects the fault current, it sends its own status data (pre-allocated position information/detected current) to the central server (Figure 5-4.6, attached to the middle part of the antenna tower). The central server then distributes these data to AEDC staff. This series of communication is performed by SMS using a mobile phone channel. AEDC staff can identify the fault section based on this information.

When a fault is detected by the FCIs, AEDC staff members standby for a 24-hour response and can respond to locate the fault point at any time.

The effect of installing the FCI system is remarkable and the regional office estimate that the time required to pinpoint faults time has decreased by 80% compared to before the installation. This means that in terms of the actual time required, the maximum of about 48 hours (before installation) has been reduced to 9.6 hours.

Future plans for FCI system deployment include installing them on five more 33kV feeders (about 100) by the end of 2021.

Figure 5-4.4 Pole with FCIs

Figure 5-4.5 FCI installation status

Figure 5-4.6 Tower with a central control terminal (server)

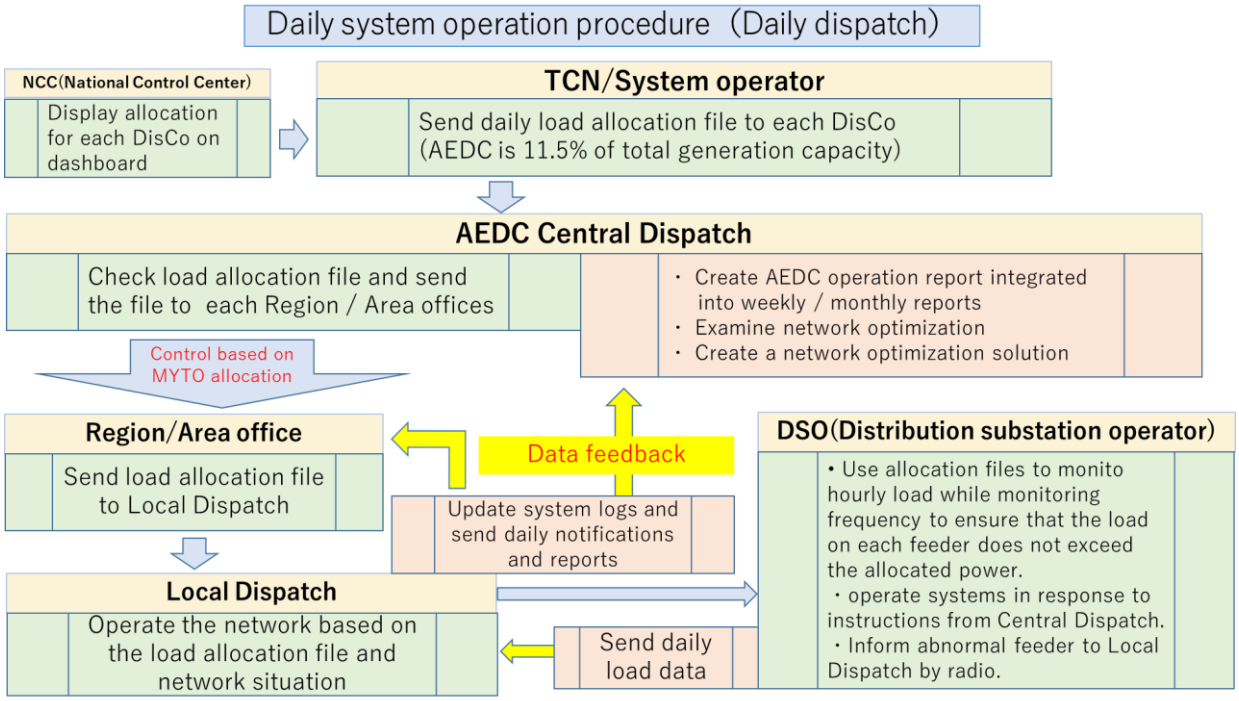
5-4-4 Daily system operation procedure

The daily system operation task involves controlling the load of the distribution system and aiming to ensure the distribution load does not exceed the power allocated to the AEDC by the TCN/system operator. The system operation procedure for this work is shown in Figure 5-4.7.

The power allocated to AEDC is set daily based on MYTO. The data sent from the TCN/system operator to the AEDC Central Power Supply Command Center (Central dispatch) is sent in order by the Central dispatch to the relevant sections below (Central dispatch ⇒ Region/Area Office ⇒ Local Dispatch ⇒ DSO).Figure 5-4.8 shows the indication (in real time) of the received power in Central dispatch. Figure 5-4.9 shows the actual load allocation to each DisCo by MYTO.

The DSO (Distribution substation operator) operates the distribution system based on the data sent while monitoring frequency to prevent the excess from the allocated power. The load monitoring reads the load current of each distribution feeder hourly (Figure 5-4.10).

The data read by DSO is input into an Excel file and reported to Local Dispatch. Local Dispatch then updates the system logs based on the data received and sends monthly reports to Central dispatch and regional area offices. Central dispatch integrates monthly reports to create company-wide operational reports, which are used to create the next network optimization solution.



Source: Prepared by the survey team based on AEDC information

Figure 5-4.7 Daily system operation procedure

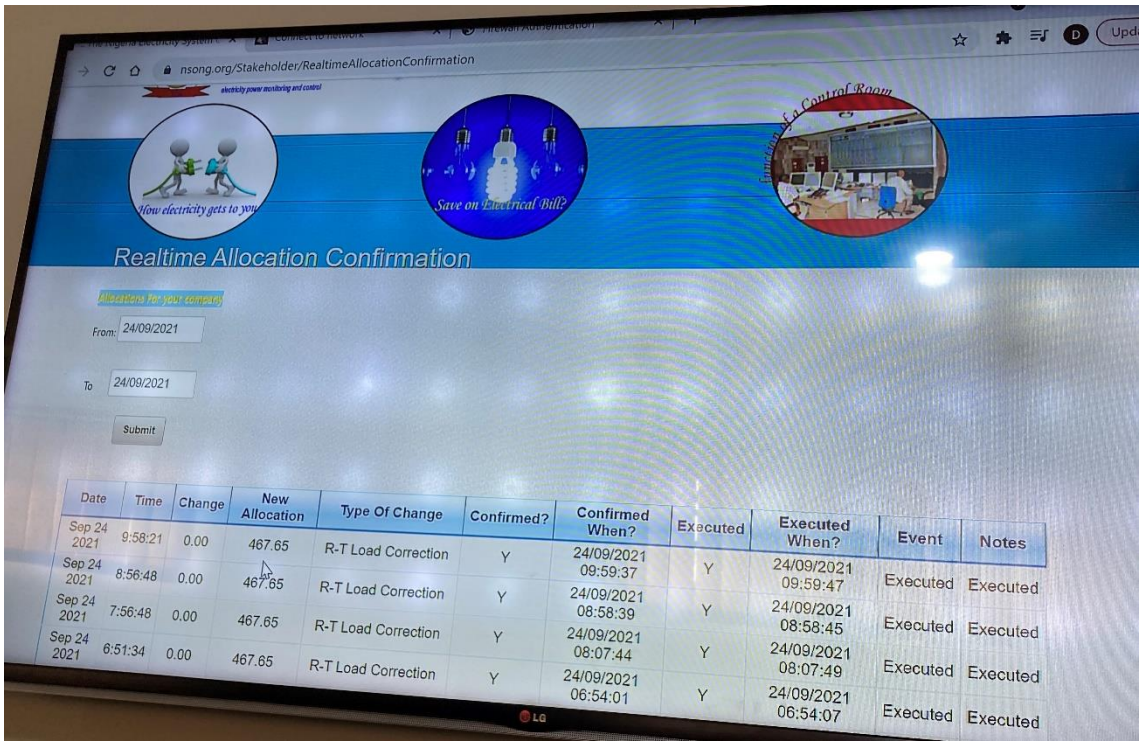


Figure 5-4.8 Real-time indication of received power at the central dispatch center

DAILY DISCOS LOAD SUMMARY FROM 7TH - 13TH JUNE 2021

DAILY DISCOS LOAD SUMMARY FOR 7/06/2021

S/N	DISCO	MAX LOAD NOMINATION (MW)	MYTO ALLOCATION (MW)	ACTUAL CONSUMPTION (MW)	UNUTILIZED LOAD (MW) MA-AC	EXCESS LOAD (MW)	% DIFFERENCE AC/MA
1	ABUJA	565.4	341.62	421.29	0.00	79.67	-23%
2	BENIN	360.1	267.35	299.58	0.00	32.23	-12%
3	EKO	441.9	426.77	356.85	69.92	0.00	16%
4	ENUGU	356.6	292.35	264.58	27.77	0.00	9%
5	IBADAN	589.2	407.18	339.44	67.74	0.00	17%
6	IKEJA	666.9	547.69	491.42	56.28	0.00	10%
7	JOS	184.8	163.39	154.37	9.02	0.00	6%
8	KADUNA	320.4	237.65	237.20	0.44	0.00	0%
9	KANO	331.7	237.65	208.69	28.95	0.00	12%
10	PORT-HARCOURT	346.2	192.63	231.04	0.00	38.42	20%
11	YOLA	115.6	103.97	97.45	6.53	0.00	-6%

Source: TCN homepage https://tcn.org.ng/index.php

Figure 5-4.9 Historical data of load power allocation by MYTO

Figure 5-4.10 11kV feeder load current recording

5-4-5 Actual fault recovery work for 11kV power distribution facilities

To determine the actual status of maintenance work, work to restore damaged facilities was inspected.

(1) Status of feeder fault

The malfunction in the 11kV distribution line feeder, which occurred on September 23, 2021, was resolved on September 24. It was due to a corroded wooden arm breaking, causing the electric wire to come into contact with the pole and resulting in a ground fault. The fault point was found by a patrol.

(2) Status of facilities restoration

Figure 5-4.11 shows the on-site situation of the fault facilities. Figure 5-4.12 shows the damage status of the cross arm. The work is carried out after the entire distribution line is out and short-circuit grounding devices (Figure 5-4.13) are attached to both sides of the work pole. The work team structure

comprises three linemen per team and one supervisor to supervise the work. One lineman is assigned to work on the pole and two are assigned to groundwork.

The wooden arm was removed (Figure 5-4.14) and replaced with an FRP arm (Figure 5-4.15). Currently, FRP arms are standard.

Figure 5-4.11 Fault facilities restoration site

Figure 5-4.12 Broken cross arm
（The right side is a 33kV line）

Figure 5-4.13 Installation of short-circuit grounding device

Figure 5-4.14 Removal of damaged arm

Figure 5-4.15 Replaced with FRP arm

(3) Skill level of lineman

The pole and ground linemen did not cooperate very closely and there was seemingly a lack of awareness at the need to proceed with the work swiftly and efficiently.

The pole lineman also seemed to start the work without considering the appropriate work order in advance and there were bottlenecks at times. During the work, some acts revealing a lack of safety awareness were observed, such as dropping pliers and throwing materials.

5-5 Status of distribution facilities faults (DisCo survey results)

5-5-1 Status of faults in distribution facilities

Distribution facility faults occur frequently, as mentioned in Section 3-2. However, it is unclear what kind of problem caused the faults because it has not been analyzed by DisCo. Although Abuja DisCo records and lists the data for each fault, the data are not analyzed to pinpoint the key problems or reflected in the maintenance plans.

According to the information provided by Eko DisCo, the following equipment are specifically listed as responsible for the distribution line fault. Among the listed equipment, many cases of underground feeder equipment failing or sustaining damage emerged.

- Bird/animal having bridged the line
- Faulty breaker
- Cable end box explosion at RMU (Ring Main Unit)
- Faulty cable and end termination
- Cable vandalized
- Broken cross arm
- Shattered disc insulator

- External fire outbreak
- Faulty gang-isolator
- External object falling on line
- Jumper cut
- Dropped J&P fuse
- Faulty lightning arrester
- LV (Low-Voltage) fault
- Loose conductors bridged
- Moisture in RMU
- Main line wire cut
- Dropped line fuse
- Overloading
- Broken pole
- Shattered pot insulator
- Relay coordination issue
- Faulty relay
- Faulty RMU
- Blown RMU fuse
- Transient fault
- Tree touching the line
- Vehicle colliding with line
- Weather condition

As mentioned above, although a wide range of equipment is prone to trigger faults in distribution facilities, Abuja DisCo categorizes the causes and accumulates data as shown in Figure 5-5.1 (Figure 5-2.4 is reprinted).

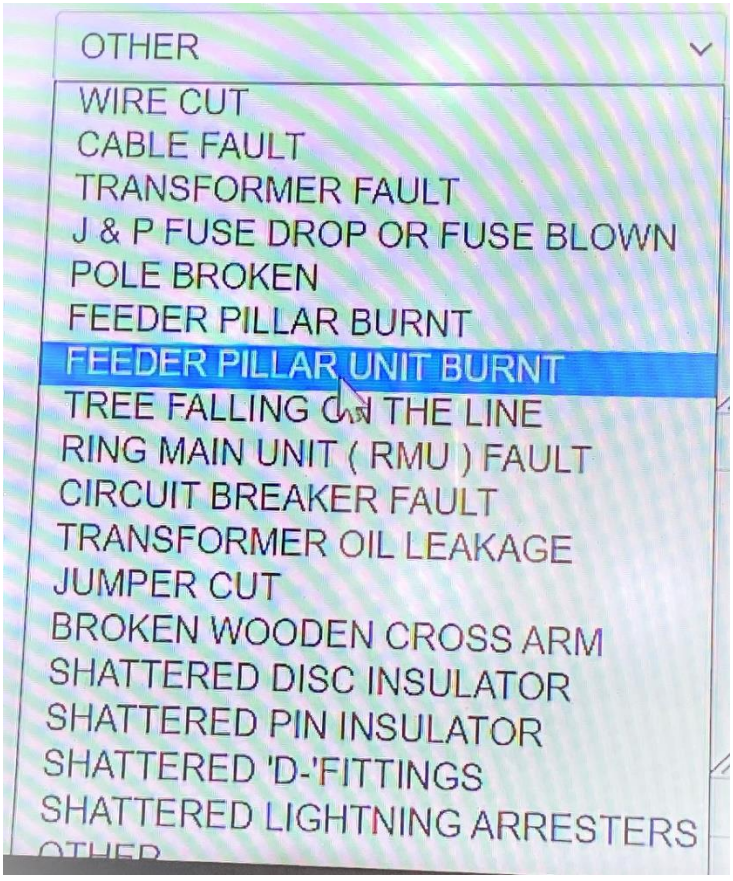


Figure 5-5.1 Fault cause classification items (Fault information input system of AEDC)

5-5-2 Analysis example of power distribution equipment fault (research literature)

Since the fault situation analysis data (e.g. SAIFI, SAIDI, analysis of major fault causes, etc.) that can help improve maintenance work could not be obtained from the DisCo surveyed, a literature survey was conducted. The following describe the summary on *"**Power Outages in Port Harcourt City: Problems and Solutions**" (IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) e-ISSN: 2278-1676, p-ISSN: 2320-3331, Volume 10, Issue 2 Ver . III (Mar - Apr. 2015), pp. 59-66 www.iosrjournals.org)* as an example of fault data analysis on distribution facilities.

(1) Background

In Port Harcourt, power outages occur frequently due to various factors, from power generation to distribution and frequent power outages have impacted seriously on citizens‘ lives and in socioeconomic ways. However, there is no improvement in sight. In response, the cause of the frequent power outages was investigated and countermeasures were proposed.

(2) Methodology

The survey collected data as primary sources through personal observations, interviews and

discussions with city residents. Data from organizations such as the National Bureau of Statistics (NBS) and the Nigerian Manufacturers' Association (MAN) were used as secondary sources. The study period for related data was 12 months and reference was also made to current relevant academic literature. The study used a simple, descriptive, nonparametric percentage method to analyze the data collected above and draw conclusions.

The survey area is within the PHED (Port Harcourt Electricity Distribution plc) jurisdiction.

（JICA Survey Team Note: As mentioned above, the analysis of this document was not conducted directly using actual fault or facilities data.）

(3) Analytical result

Among the problems faced from the perspective of ensuring a reliable power supply in the PHED jurisdiction, the analytical results of distribution facilities were as follows:

a. Weakness and damage on transmission and distribution networks：
Weak and aged facilities (Figure 5-5.2) were one of the main causes of frequent power outages. Currently, power networks have difficulty expanding facilities to meet increasing demand. As a result, many networks suffer from overload, large voltage drops and instability.

Source: The above literature

Figure 5-5.2 Broken pole due to insufficient strength

b. Lack of good maintenance culture：
Nigeria has insufficient records of its activities to maintain existing power facilities. Most transmission lines, distribution transformers and other equipment have been in use for extended periods beyond their useful life. Even today, an inadequate maintenance culture precludes scope to maintain these facilities and operate disposal and enhancement. This lack of maintenance means the performance of the facilities cannot be maintained and leads to power outages.

c. Climatic conditions, storms, lightning strikes:
Weather conditions in the Port Harcourt area are worsened by rainfall from April to July, causing

power outages due to system failures. E.g. very large fallen trees can destroy transmission towers, resulting in power outages for more than two weeks. In many cases, power outages occur in multiple areas simultaneously due to large storms that destroy multiple transmission towers.

d. Inadequate infrastructure facilities:
Many distribution facilities are unable to supply the rated capacity due to age-related deterioration.

e. Vandalism:
Cases of power infrastructure vandalism have been reported throughout Nigeria. These occur mostly in rural areas such as Port Harcourt.

f. Unpruned trees under transmission lines: (*JICA Survey Team Note: This situation is considered to be the same for distribution facilities.*)

g. Lack of skilled human resources:
The lack of skilled technical staff is one of the challenges facing the Nigerian power industry. There is currently a great shortage of technical experts capable of applying the latest advanced technology to power sector production activities.

h. Overload of transformers and electrical equipment：
Most distribution networks are overloaded due to transformer capacity limitations, which often leads to the distribution transformer failing or the protective device melting. In addition, insufficient supply voltage (low voltage) may prevent electrical equipment from functioning normally. This situation occurs in most densely populated urban areas.

i. Illegal connection:
Electricity theft due to illegal connection not only results in a loss of electricity company‘s tariff revenue, but also technically affects demand forecasting and facilities planning. In addition, illegal connections often result in small conductors being loosely connected to distribution lines, causing short-circuit faults due to the wires overheating, which, in turn, may seriously damage low-voltage distribution lines and distribution transformers.

(4) Conclusions and recommendations

From the above analytical results, the following conclusions and recommendations were obtained:

a. Frequent inspection and planned maintenance efforts are required for all power installations. E.g. regular monitoring and management of trees near power lines is required.

b. To meet increasing demand, it is necessary to immediately upgrade transmission and distribution facilities. It is particularly important to avoid overloading transmission lines and distribution transformers.

c. The government must initiate legislative measures in response to vandalism and illegal connections.

d. The utility workforce should be reviewed periodically to ensure only qualified and technically competent personnel are engaged to ensure power systems operate efficiently and sustainably.

The above analytical results are findings obtained from the data in the PHED area. When applying this to AEDC facilities, the differences in the background of each region must be considered. However, since the privatization of the power industry was relatively recent, no significant differences are apparent in the specifications of individual equipment and the deterioration status between the two companies. However, the following points may differ due to regional factors:

- Since the load density is lower in the PHED area than the AEDC, the feeder length may become much longer. Accordingly, the number of faults per feeder may be higher in the PHED area.
- The climatic conditions (wind and rain) are harsher in the PHED area.
- The PHED area is at higher risk of vandalism.

When estimating the fault occurrence aspect in the AEDC area, these differences must be taken into consideration and corrections made.

5-6 Understanding the current status of distribution facilities

Since AEDC did not provide standards such as design manuals, the situation obtained during the site inspection is shown below.

5-6-1 Condition of standard installation

The facilities status that is considered to have been installed based on the design standard is shown below.

Figure 5-6.1 Ground-mounted transformer pole

Figure 5-6.2 Pole mounted transformer

Figure 5-6.3 Standard arrangement for straight line

Figure 5-6.4 Jumper connection

All poles are square poles (Figure 5-6.5) and the steel frame seems to be covered in concrete.

Figure 5-6.6 shows a 33kV line with transmission line specifications. Both the support and the arrangements differ completely from the 33kV track in line with Nigeria‘s domestic specifications and it was seemingly constructed with development assistance funds. The aspects that differ from the domestic specifications in Nigeria include the high strength of support and the extended installation span, plus dampers attached to the conductors and an overhead ground wire installed on top of the support.

Figure 5-6.5 Square utility pole

Figure 5-6.6 33kV line with transmission line specifications

Figure 5-6.7 shows a new type of low-voltage line - a double conductor line.

Figure 5-6.7 New type (arrangement) low-voltage pole

5-6-2 Defective facilities (example facilities with problems from the maintenance work perspective)

The current situation of distribution facilities sees some cases where first aid and repair points are outstanding. Presumably, there are certain circumstances in which first aid and repairs remain incomplete due to financial difficulties, despite the fact they are aware of the problems.

The technical factor precluding progress in first aid and repairs is the fact that although maintenance work must be carried out while power has been cut off, the distribution line is not installed with any switchgears that can isolate the work section appropriately. Accordingly, it is considered difficult to initiate power outages for maintenance work.

The followings are examples of facilities with problems from a maintenance perspective that emerged during the site inspection. Figure 5-6.8 shows poles with a large inclination, as well as the conductors shown in Figure 5-6.9, which have large sag. Many such sagged conductors are seen in all 33kV, 11kV and 415V lines. Since the wires are bare conductors, they are considered prone to short-circuit and broken conductor faults due to strong winds.

Figure 5-6.8 Tilted poles

Figure 5-6.9 Large sag of conductors

In Figure 5-6.10, angles are connected to concrete poles to raise two 33kV circuits and the strength of this support presumably declines due to such material changes, leading to the breakage as shown in Figure 5-6.11. In addition, in Figure 5-6.11, the support points of the stay wires are also inappropriate.

Figure 5-6.10 Raising poles by angle

Figure 5-6.11 Broken angle for prolonging pole

In Figure 5-6.12, the weak arms bend and the insulator comes off the arm and is close to the pole.

Figure 5-6.13 shows the repair of broken conductor on an 11kV line. The connection is a manual binding connection. There are many such repair points on both high- and low-voltage lines. In this photo, the connections appear to be made as prescribed manner, but most similar connections are left in a crude emergency repair state.

Figure 5-6.12 Arms bent・Insulator detached from arm

Figure 5-6.13 Repair of broken conductor on an 11kV line

In Figure 5-6.14, the bolt of the tie strap fixing the arm has been removed and the arm is tilted. In Figure 5-6.15, a substandard tie strap is used. There are many such pillars.

Figure 5-6.14 Tilted arm

Figure 5-6.15 Substandard arrangement（Tie strap）

Figure 5-6.16 shows large sag conductors and tilted insulators.

Figure 5-6.16 Large sag conductors and tilted insulators

Figure 5-6.17 shows the poles for a ground-mounted transformer, with two low-voltage feeders to the left. Arresters are installed, but not connected to the conductors and the ivy is also rolled up halfway through the stay wire.

Figure 5-6.18 shows a 33kV/415V transformer without fuse protection, with the fuse link portion directly connected by conductors. Figure 5-6.17 shows the same situation of transformer protection. Such alternative measures for fuses with conductors are thought to offer insufficient overload protection to the transformer, rendering it prone to burnout or shortening its service life.

Figure 5-6.19 shows a tilted pole. Of the 33kV and 11kV parallel lines, the 11kV pole is inclined to the 33kV side. Figure 5-6.20 shows a tilted pole on a 33kV line.

Figure 5-6.17 Poles for transformer （without arrester leads）

Figure 5-6.18 33kV transformer directly connected by conductor

Figure 5-6.19 Inclination of 11kV pole to the 33kV line side

Figure 5-6.20 Inclination of 33kV pole

Figure 5-6.21 and 5-6.22 show the state where equipment no longer in use is discarded at the site and left

unattended.

Figure 5-6.21 RMU discarded on site

Figure 5-6.22 11kV cable discarded on site

5-7 Human resources development and training system for AEDC technical staff

5-7-1 Education and training system for AEDC employees

Training is conducted using an education/training system based on the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) which combines the following training methods:

1. Instructor-led classroom training
2. Computer-based and e-learning training
3. Experiential hands-on learning
4. Coaching and mentoring
5. Mandatory Professional development

5-7-2 Training plan for new employees

(a) The following training is provided through orientation and practical training as essential education for new employees:

- Introduction to Company Policies and General Procedures
- Familiarization with company history, vision, mission and values
- Acclimatization with AEDC's Workplace Culture
- Acquaintance with relevant regulatory Laws & Compliance requirements

(b) Regular training will be provided to continuously improve the knowledge and skills of employees. (Implemented with the above ADDIE model)

(c) Ability maintenance measures through compensation and awards for outstanding performers

(d) PIP: Performance Improvement Plan

Designed to give employees with substandard performance (such as behavior-related concerns or failure to meet specific job goals) the opportunity to succeed and regain good standing with the organization.

5-7-3 AEDC‘s own training

(Training courses and contents prepared by AEDC that employees can take)

(a) Training course by ability

Training that is incorporated into the training needs of each department, which are periodically confirmed.

(b) Training courses targeting specific goals:

- Integrated Commercial Management System (InCMS) Training for all staff - particularly customer-facing;
- Distribution Systems Operations and Authorization (DSOA) Training for, specifically, Technical Services and other designated levels of personnel;
- Health, Safety and Environmental (HSE) Training for all employees;
- Line workers’ training with emphasis on safety practices;
- Customer Service training to enhance the customer-centric focus of the organization.

(c) Example training courses by ability

Annex 1 shows examples of AEDC‘s own training in the technical sections.

The target period is 13 months from June 2019 to June 2020. During this period, 113 training programs were conducted throughout AEDC, including training in non-technical departments.

The training is conducted by invited external and in-house facilitators.

5-7-4 Utilization status of NAPTIN training

AEDC partners NAPTIN and other agencies such as the Association of Power Utilities of Africa (APUA) and the Association of Nigerian Electricity Distributors (ANED) as part of efforts to develop capacity in the electricity distribution sub-sector.

A comprehensive list of training courses enrolled by AEDC in collaboration with other DisCos is shown in Table 5-7.1. The curriculum for each of the training courses shown in Table 5-7.1 is shown in Annex 2.

In the abovementioned training, NAPTIN plays a role as learning infrastructure for ANED accreditation programs. The training course here is aimed at line workers and customer service employees and the program provides an environment in which to develop, classify and recognize the abilities (skills, knowledge, comprehension and abilities) required for participants from DisCos throughout Nigeria.

Table 5-7.1 Training courses registered by AEDC (accredited by ANED)

	PROPOSED COURSE TITLE (Home Page)
1	ELECTRICAL FITTER TRAINING D2
2	SAFETY TRAINING A3
3	POWER TOOLS AND TEST EQUIPMENT TRAINING A2
4	BASIC POWER SYSTEM PROTECTION TRAINING B1
5	TRANSFORMER AND SWITCHGEAR MAINTENANCE B1
6	SAFETY AND WORK PRACTICE B1
7	TRANSFORMER AND SWITCHGEAR MAINTENANCE C1
8	MAINTENANCE AND REPAIR OF OVERHEAD LINE C1
9	TRANSFORMER AND SWITCHGEAR MAINTENANCE C1
10	POWER SYSTEM NETWORK LOSS MANAGEMENT (ATC&C LOSSES) C1
11	ENERGY AUDITING & LOAD MANAGEMENT C1
12	DISTRIBUTION NETWORK PROTECTION D1
13	POWER INFRASTRUCTURE PROJECT MANAGEMENT D2
14	INTRODUCTION TO SCADA & SMART GRID SYSTEM D3
15	SAFETY RULES AND REGULATIONS/STANDARD SAFETY CODES D1
16	CABLE JOINTERS/FITTERS & INSTRUMENT MANAGEMENT E1
17	CABLE JOINTING REFRESHER COURSE E2
18	HV SUBSTATION CABLE TERMINATION COURSE E1

Source: AEDC document

5-7-5 ANED Certification Guidelines of AEDC

(Source: AEDC's ANED Certification Guidelines)

(1) Background

The ANED certification program aims to establish industry standards for the distribution sector and promote its efficiency, effectiveness and safety. This training course is aimed at line workers and customer service employees. The program provides an environment to develop, classify and recognize the abilities (skills, knowledge, comprehension and abilities) required for participants from DisCos throughout Nigeria.

The ANED certification program is operated by the following organizations working in cooperation and based on their respective roles:

- Sponsor: Each DisCo.
- Learning infrastructure: NAPTIN.
- Evaluation system （National Occupational Standard, NOS): Approved by the NBTE (National Board for Technical Education).
- Certificate body: ANED.
- Training participants.

(2) Composition and role of certification committee

The certification committee comprises the following committees:

① DisCos Assessment Committee: DAC
The DAC comprises two members each from human resources development, technical services and commercial services (six in total) and creates a list of nominated candidates for participation in the certification program.

② Senior Certification Committee: SCC
The SCC comprises three senior members (experts in each field) belonging to DAC and verifies the eligibility of certification candidates.

③ ANED Assessment Committee: AAC
AAC comprises SCC members and evaluate and verify the certification process through training and certification by ANED.

④ Eligibility for Certification
AEDC nominates employees for each ANED certification cycle. Employees must meet the following criteria to qualify for nomination:
- Must be a permanent and confirmed member of AEDC staff
- Must have spent a minimum of one year with AEDC
- Must not have a poor performance record and/or any disciplinary issues

(3) Certification Sponsorship

- Nominated candidates will be sponsored by AEDC for the certification.
- AEDC will pay certification fees for an employee only once a year. If the employee wishes to undertake higher levels of certification the same year, he/she will do so with his/her own resources.

(4) Career Progression and Redeployment

- ANED Certification is not a guarantee of automatic promotion or career progression. However, it may be considered as one of the eligibility criteria for promotion nomination and career growth.
- Promotion will be solely guided by AEDC's Rules & Regulations on career progression.
- Employees redeployed to roles requiring ANED certification shall be given one year to acquire certification for the new role.

5-8 Current status of NPTIN

5-8-1 Summary of the survey results

Regarding the technical and non-technical training courses in the distribution sector, the survey team have confirmed the details of the training content (syllabus, curriculum, teaching materials), instructor, NAPTN training center in charge and training equipment owned.

In the distribution technology field, a series of training sessions is provided, such as reduction of distribution loss, fault point location, distribution network design/operation and maintenance of substation/distribution equipment. However, there are many basic and comprehensive training contents and training on practical skills and applications is not conducted. At the NAPTIN headquarters in Abuja, lecture-based training is conducted.

The syllabi of the training courses obtained from the field survey and the corresponding time tables for each are shown in Annex 3.

5-8-2 Details of the survey results

Regarding the expected technical cooperation project, the survey team has confirmed the current status of NAPTIN regarding training courses in fields that are expected to be developed at NAPTIN.

(1) Training course on loss reduction

- Currently, the existing training course, “DISTRIBUTION NETWORK POWER LOSS MANAGEMENT COURSE”, is provided for a period of 10 days.
- The content comprehensively includes knowledge on reducing losses generated in the power system as ATC & C losses as well as technical losses.
- As for the contents of technical loss, NAPTIN teaches relevant knowledge and techniques from the loss generation characteristics of individual equipment to applied training (case study of loss evaluation in distribution network planning). The specific training items are as follows:
  - Loss generation mechanism and characteristics of individual equipment
  - Loss calculation method
  - Loss generation characteristics in power system
    The following contents are included:
    Characteristics of iron (fixed) loss and copper (variable) loss (including contents such as loss due to harmonics), concept of comparative (comprehensive) evaluation considering iron and copper loss characteristics and benchmarking the loss situation in other developing countries etc.
  - Based on the above basic knowledge, NAPTIN conducts case studies using system simulators to develop applied skills.
- The above case study is conducted using the power system simulator (installed at local training centers in Kainji and Ijora) and the software simulator (NEPLAN).

The power system simulator can simulate from generator to distribution system. Since various parameters such as line constants and system configuration can be changed, certain network variations can be handled.

- The software simulator uses NEPLAN. A free (student) version of NEPLAN is distributed to training participants, while NEPLAN is also distributed by WAPP to member companies.
- During the training, NAPTIN teaches the basics of power flow calculation related to loss assessment by NEPLAN.
- NAPTIN conducts site visits on reactive power compensators at TCN substation.

(2) Training course on fault location skills

- Training to improve fault location skills is not provided in the form of independent courses. As part of the "POWER DISTRIBUTION NETWORK DESIGN & OPERATIONS COURSE", NAPTIN sets up the section (purpose) of "Locate and Clear faults in distribution network" for the training.
- The training is conducted via lectures with video material and does not include any practical training.
- The training contents include the type of fault cause, the aspect and characteristics of the fault, know-how of fault location, etc.
- If a simulated distribution facility is constructed with the support of AFD, NAPTIN intends to provide practical training using the same. Currently, NAPTIN's regional training centers (Kainji and Kaduna) have simulated overhead distribution facilities with five spans between poles.
- The need for fault point location training in underground cable systems was confirmed.
  Many of Nigeria's underground lines are short, with a length not exceeding 20m or so. Accordingly, fault locators are not used to locate fault points in underground cables and few DisCos are thought to own them.
  NAPTIN does not provide training using fault locators. (However, the syllabus includes a section to demonstrate fault locators)
  In the cable fault point location for cable at DisCos, the fault point is sought by direct excavation after the fault point resistance is detected by an insulation resistance meter (5kV mega ohm meter). Alternatively, the entire fault cable is replaced without repairs such as removing the fault points and reconnecting.

(3) Training course on distribution planning

The "POWER DISTRIBUTION NETWORK DESIGN & OPERATIONS COURSE" is provided as an existing training course.

(4) Training facilities of substation supported by AFD

The transformer capacity is 1,000 kVA for each voltage class and each transformer is supplied from a

33kV source. The latter is boosted from 415V, which, in turn, is stepped down from 33kV via an AEDC commercial line. Moreover, transformer voltages of 11 and 132 kV are respectively transformed from 33kV. The simulated substation will be used for training when operating, protecting and maintaining the substation. Simulated distribution lines will also be connected to the 33kV and 11kV transformers respectively. An image of a simulated substation is shown in Figure 5-8.1.

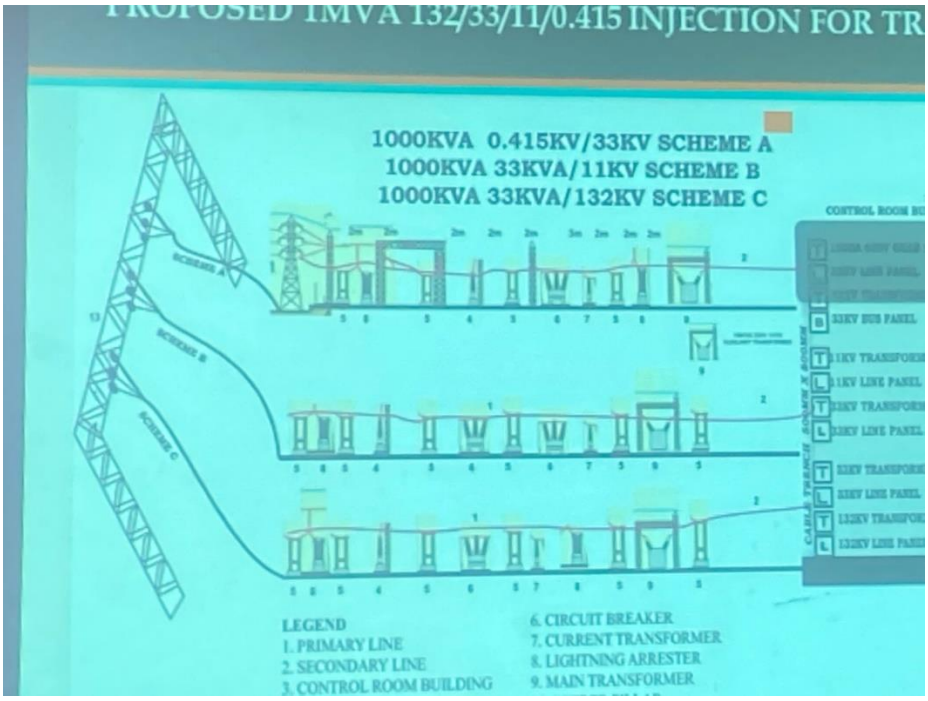


Figure 5-8.1 Substation image to be constructed

(5) NAPTIN‘s training course for DisCos certified by ANED

NAPTIN proposes training courses for DisCos that reflect their needs and are ANED-accredited. These accredited training courses will then be the basis for forming each DisCo’s accredited training course. Each DisCo will select appropriate courses from the NAPTIN‘s training course and add further training courses according to its own needs. Through this process, each DisCo forms its own accredited training courses (certified by ANED upon application by DisCos).

NAPTIN‘s training courses included in such certification system are outlined below. As for the training course, several courses are set for each technical job for the following technical jobs:

- ELECTRICAL FITTER
- PROTECTION CONTROL & METERING (PC & M)
- LINES WORKERS
- CABLE JOINTERS
- DISTRIBUTION SERVICE OFFICERS (DSOs)

The training course for each technical job is outlined in Table 5-8.1 to 5-8.5.

Table 5-8.1 Outline of training course for ELECTRICAL FITTER

Target job：ELECTRICAL FITTER		
Course name		Training items
1	ELECTRICAL FITTER	・INTRODUCTION ・SIMPLE ELECTRICAL SYMBOL & UNIT ・TRANSFORMER ・DIELECTRIC MEDIA ・SAFETY RULES 100
2	SAFETY AND WORK PRACTICE/SAFETY TRAINING	・JOB SAFETY REQUIREMENTS ・STANDARD PROTECTION CODE ・INDUSTRIAL FIRST AID ・ELECTRICAL SAFETY AWARENESS ・HAZARDS OF ELECTRIC SHOCK ・HAZARD PREVENTION
3	POWER TOOLS AND TEST EQUIPMENT TRAINING	・INTRODUCTION TO ELECTRICAL INSTRUMENTS ・ELECTROMECHANICAL INDICATING INSTRUMENTS ・ELECTRODYNAMOMETER INSTRUMAIL ・BRIDGES AND THEIR APPLICATION

Source: Created by the survey team from NAPTIN‘s documents

Table 5-8.2 Outline of training course for
PROTECTION CONTROL & METERING (P C & M)

Target job: PROTECTION CONTROL & METERING (P C & M)		
Course name		Training items
1	BASIC POWER SYSTEM PROTECTION	・General Introduction to protection ・Instrument Connection and uses ・Control Circuit ・Instrument Transformers ・Introduction to Protective Relays ・Relay Settings ・Differential Protective Relays ・Protection of Transformers ・System Earthing ・Equipment Grounding ・Testing and Maintenance of Relays ・Fuse and Fuse Coordination ・Basic Line Protection ・Fault Study, Analysis and Short-Circuit Calculation ・Auto-reclosing Schemes ・System Stability

Target job: PROTECTION CONTROL & METERING (P C & M)		
Course name		Training items
		・Over Voltage and Surge Protection
2	TRANSFORMER AND SWITCHGEAR MAINTENANCE	・INTRODUCTION ・TRANSFORMER ・SWITCHGEARS ・FAULT INVESTIGATION ・HEALTH, SAFETY and ENVIRONMENT/STANDARDS PROTECTION CODE・
3	SAFETY AND WORK PRACTICE	・JOB SAFETY REQUIREMENTS ・STANDARD PROTECTION CODE ・INDUSTRIAL FIRST AID ・ELECTRICAL SAFETY AWARENESS ・HAZARDS OF ELECTRIC SHOCK ・HAZARD PREVENTION

Source: Created by the survey team from NAPTIN s documents

Table 5-8.3 Outline of training course for LINES WORKERS

Target job: LINES WORKERS		
Course name		Training items
1	MAINTENANCE AND REPAIR OF OVERHEAD LINES	・OVERVIEW OF MAINTENANCE STRATEGIES ・TRANSMISSION LINE CONSTRUCTION AND REPAIR ・INSULATORS FOR OVERHEAD LINES ・PROTECTION FEATURES OF TRANSMISSION LINE ・DISTRIBUTION LINE MAINTENANCE ・SAFETY/SITE SKILLS
2	TRANSFORMER AND SWITCHGEAR MAINTENANCE	・INTRODUCTION ・TRANSFORMER ・SWITCHGEARS ・FAULT INVESTIGATION ・HEALTH, SAFETY and ENVIRONMENT/STANDARDS PROTECTION CODE
3	DISTRIBUTION NETWORK PROTECTION COURSE	・General induction to protection ・Fault calculations ・Relay studies, setting and calibration ・Elements of relay coordination particularly at injection substations ・Reading and interpretation of control circuits ・Transformer protection ・Basic line protection

Target job: LINES WORKERS		
Course name		Training items
		・Earthing/equipotential bonding ・Equipment grounding ・Transformer commissioning and testing procedures ・Case studies on operation under emergency ・Network splitting
4	SAFETY AND WORK PRACTICE/OCCUPATION HEALTH AND SAFETY	・JOB SAFETY REQUIREMENTS ・STANDARD PROTECTION CODE ・INDUSTRIAL FIRST AID
5	POWER SYSTEM NETWORK LOSS MANAGEMENT (ATC&C LOSSES)	・Introduction; Power system fundamentals - Generation, Transmission, Distribution and Consumption ・ Losses in Electricity Industry - Technical and Non-technical ・Power Losses in Developing countries - Case studies ・Power Loss estimation and evaluation - Technical loss, Non-technical loss, Causes of Losses ・Power Loss Reduction Techniques - How to reduce technical losses, How to reduce non-technical losses ・Power Loss Reduction Technologies - AMR (Automatic Meter Reading)/AMI (Automatic Meter Infrastructure), CIS (Customer Information System)/CRM (Customer Relationship Management), GIS (Geographic Information System), PSAT (Power System Analysis Tool), DMS/OMS/SCADA. ・Strategies for management plan on Power loss reduction ・Power system Reliability - SAIDI, SAIFI, MAIFI, CAIDI, KPIs ・Power system Automation and Smart Grid
6	ENERGY AUDITING & LOAD MANAGEMENT	・Fundamentals of Energy in relation to the Power Sector ・Overview of Power Sector Losses ・Types of Losses ・Nature of losses ・Identification & Evaluation of Losses ・Energy Audit

Target job: LINES WORKERS		
Course name		Training items
		・Typical Illustrations of Potentials of Energy savings/Loss reductions ・Loss mitigation Strategies ・Specific Power loss reduction Techniques & Technologies ・Introduction of Adaptation of ISO 50001 Standards to Transmission & Distribution

Source: Created by the survey team from NAPTIN s documents

Table 5-8.4 Outline of training course for CABLE JOINTERS

Target job: CABLE JOINTERS		
Course name		Training items
1	CABLE JOINTING REFERESHER COURSE	・INTRODUCTION - CABLE JOINTING ・STANDARD PROTECTION CODE (SPC)
2	ADVANCE CABLE JOINTING	・FUNDAMENTAL OF CABLES AND APPLICATION ・HIGH-VOLTAGE CABLE TERMINATION ・TECHNIQUES OF SOLDERING ELECTRICAL COMPONENTS ・ELASTIMOLD ELBOW TERMINATION ・FEEDER PILLAR ・EARTHING ・ELECTRIC CABLE CONDUCTOR ・APPLICATION OF CONNECTOR・

Source: Created by the survey team from NAPTIN s documents

Table 5-8.5 Outline of training course for DISTRIBUTION SERVICE OFFICER (DSO)

Target job: DISTRIBUTION SERVICE OFFICER (DSO)		
Course name		Training items
1	DISTRIBUTION NETWORK PROTECTION COURSE	・ General induction to protection ・Fault calculations ・ Relay studies, setting and calibration ・ Elements of relay coordination particularly at injection substation ・Reading and interpretation of control circuit ・ Transformer protection ・ Basic line protection ・ Earthing/equipotential bonding ・ Equipment grounding ・ Transformer commissioning and testing procedures ・ Case studies on operation under emergency

Target job: DISTRIBUTION SERVICE OFFICER (DSO)		
Course name		Training items
		・ Network splitting
2	POWER INFRASTRUCTURE PROJECT MANAGEMENT	・ Soil Investigation ・ Laboratory Testing ・ Design Of Tower And Substation Equipment Foundation ・ Surveying ・ Introduction To Global Positioning System (GPS) ・ Setting Out Operations ・ Portable Water Supply In Substations ・ Design For HV Towers And Transmission Lines ・ Construction Of Transmission Line ・ High-Voltage Power Substation ・ Site Inspection And Quality Control ・ Concrete Technology ・ Project Resource Quantities Estimates ・ Project Management cycles and skills Safety and occupational health
3	INTRODUCTION TO SCADA & SMART GRID SYSTEM	・ Definition of SCADA ・ SCADA Network ・ SCADA Applications in Distribution Network system ・ Uses of SCADA in Power system ・ Functional Units of SCADA ・ Components of SCADA System ・ SCADA Network communication configuration ・ Automation of Distribution Network System ・ Substation Control Using SCADA ・ Feeders Control Using SCADA ・ Smart Grid ・ Characteristics of smart ・ Components of smart grid ・ Smart Grid stakeholders ・ Communication Infrastructure deployed in Smart Grid ・ Smart Grid Communication Standards ・ Advanced Metering Infrastructure (AMI)
4	SAFETY AND WORK PRACTICE	・ JOB SAFETY REQUIREMENTS ・ STANDARD PROTECTION CODE

Target job: DISTRIBUTION SERVICE OFFICER (DSO)		
Course name		Training items
		・ INDUSTRIAL FIRST AID ・ ELECTRICAL SAFETY AWARENESS ・ HAZARDS OF ELECTRIC SHOCK ・ HAZARD PREVENTION ・
5	TRANSFORMER AND SWITCHGEAR MAINTENANCE	・ INTRODUCTION ・ TRANSFORMER ・ SWITCHGEARS ・ FAULT INVESTIGATION ・ HEALTH, SAFETY and ENVIRONMENT/STANDARDS PROTECTION CODE ・

Source: Created by the survey team from NAPTIN s documents

5-9 Issues and Measures Taken for Business Improvement

5-9-1 Reasons for Persisting High Technical/Commercial Loss and Bill Collection Loss

Technical and commercial loss is defined as the ratio of energy for which electricity bills are not delivered to the customers relative to the total energy received from the Transmission Company of Nigeria (TCN) and the technical and commercial losses cannot be separately measured in precise terms. Technical and commercial losses for Abuja DisCo (AEDC) in the second quarter of 2020 were 45% (according to the data provided by AEDC in the survey period in Nigeria for the latest technical and commercial losses, the average for the six months from March to August 2021 was 35%), 13% for Eko DisCo (EKEDC) and 30% for Port Harcourt DisCo (PHED) (Source: NERC Quarterly Report).

Bill collection loss is defined as the ratio of the amount of uncollected bills relative to the total bills delivered to the customers. Bill collection loss on the second quarter was 4.5% for AEDC (the latest bill collection loss, the average for the six months from March to August 2021 was 16% according to the data provided by AEDC in the survey period in Nigeria), 15% for EKEDC and 47% for PHED. The weighted average of all DisCos of the same quarter was 26% (Source: NERC Quarterly Report), which was very high compared to the average of 12.5% of 39 countries in Sub-Saharan Africa (August 2016, the World Bank.

AEDC responses to the questionnaire sent by the Survey Team highlighted the major reasons for high technical/commercial loss and bill collection loss as follows:

(1) Energy Theft and Illegal Connection/Consumption

There are various types of unauthorized electricity use, such as illegal connections at community level, meter tampering and bypassing, etc. Conspiracies seem to occur involving meter readers and customers, whereby customers bribe meter readers, who then report to the company less energy than was actually used by the customer. Although diverse measures to detect such problems are taken, DisCos face many challenges, such as lack of capable staff and equipment, existence of “Difficult-to-

Manage Areas in informal settlements, lack of regulation and order by the police and judiciary, etc.

(2) Wrong Customer Classification

Many customers were allegedly registered as "Residential", but actually use electricity for commercial or industrial purposes. From MYTO 2020, however, the classifications of "Residential", "Commercial" and "Industrial" were abolished and the customer classification was changed to a "Tariff Band" where customers are classified by "Service Hours" per day, as shown in Chapter 2, Section 2-4-4 (3), preventing this type of irregular use. In EKEDC, customers have been classified with "single/three-phase" and level of energy consumption ("Non-Maximum Demand" and "Maximum Demand" users) and the same tariffs have been applied for "Residential", "Commercial" and "Industrial" customers.

(3) Large Metering Gap and Numbers of Obsolete Meters

As described in Chapter 3, Section 3-3-1 (3), the ratio of metered customers as a proportion of total customers for the second quarter of 2020 was 53% for AEDC, 51% for EKEDC, 39% for PHED and 46% for the weighted average of all DisCos. Given this low ratio of metered customers, effective management of the electricity supply business, which sells invisible goods by volume, would not be possible.

(4) Reluctance to Pay of Customers

Many customers still consider electricity supply as a service to be rendered by the government free of charge. At the time of the Nigeria Electric Power Authority (NEPA) until 2005, politicians generally shared electrification projects with their constituencies to earn votes from residents. NEPA did not go out of its way to collect bills and the norms of that period are still thought to remain.

The low tariff, high technical and commercial losses and low bill collection rate have prevented sufficient investment in distribution infrastructure. Moreover, given the problems facing generation and transmission sub-sectors due to the low remittance rate from DisCos, the power sector fails to supply stable and quality electricity to customers, leading to low satisfaction and reluctance to pay. Wide metering gaps of customers mean DisCos frequently issue estimated bills prepared based on the consumption estimated by DisCos from consumption data in the previous months, leading to many customer complaints and exacerbating their reluctance to pay.

(5) Other Reasons

* Insufficient capable personnel makes precise meter reading and timely bill distribution to customers difficult.
* NERC sets upper limits for estimated billing as "Capped Billing". From DisCos' perspectives, they underline the difficulty in claiming payment corresponding to the electricity consumption to their customers with estimated billing.
* Inability to access all customers due to poor road conditions in rural areas where all-weather roads are not well developed, causing low bill collection efficiency.

5-9-2 Progress of Measures taken by DisCos to Raise Bill Collection Rates and Problems/Constraints for Implementation of the Measures

(1) Customer Enumeration Programme

The Customer Enumeration Programme is a programme promoted by NERC to obtain exact customer data. With the programme, Distribution Voltage Type (11kV/415V or 33kV/415V) No. - DisCo No. - Sub-DisCo No. - DisCo Injection Substation No - Power Transformer No. - 11kV Feeder No. - 11kV Distribution Pole No. - 11kV/415V Transformer No. - Upriser No. - Service Pole No. - Service Wire No. - Customer No. (in case of 11kV/415V supply) are recorded and saved. Though the Programme has allegedly been completed, many unregistered customers (illegal connections) seemingly persist in informal settlements.

(2) Installation of Meters (Customer Meters and Feeder Meters)

As mentioned in Chapter 2, Section 2-1-4 (4), meter installation and replacement were promoted with the enforcement of MAP Regulations in 2008. However, the percentage of metered customer relative to the total customer base estimated at around 6.5 million, during the period from August 1, 2019 to July 30, 2021 was less than 10%. This is primarily attributable to the lack of funds available to DisCos and the few customers wishing to have meters with upfront payment. To solve the funding problems, a National Mass Metering Programme (NMMP) will be launched by the Federal Government in cooperation with the Central Bank, which will involve low-interest loans to DisCos and eliminating the need for customers to pay for the meter installation. The NMMP intends to install meters for all unmetered customers in the coming two or three years. This will considerably reduce the number of unmetered customers and is expected to solve most of the problems on estimated bills. Once the installation of customer meters via NMMP is complete, the installation of feeder meters will be planned and implemented.

(3) Improvement of Customer Database and Billing System

In many DisCos, a customer management system is available, generally comprising a contract management system, a customer database, a billing system and an arrear/receivable management system. Figure 5-9.1 shows the composition of modules of the Integrated Commercial Management System (InCMS) introduced by AEDC.

Source: AEDC

Figure 5-9.1 Composition of Modules of InCMS introduced by AEDC

(4) Promotion of the Prepaid System

Most DisCos plan to install meters for prepaid systems in the meter installation by NMMP, except those for maximum demand customers, most of which have already had meters installed. To date, prepaid systems have been adopted for a substantial portion of the customers. According to the statistics from the National Bureau of Statistics (NBS), prepaid systems were applied to 44% of all customers in the second quarter of 2018. Assuming that the same percentage of customers use prepaid systems at present and almost all the 6.5 million meters to be installed by NMMP will be those for prepaid systems, prepaid meters will be installed for nearly 80% of all customers, which will then reach over 10 million by the end of the NMMP. If meters for prepaid systems are deployed as estimated above, it is envisaged that the bill collection rate will soar and the bill collection process will be substantially streamlined. Reflecting past concerns, the procurement of reliable and quality meters, featuring local content of more than 30%, will be an important factor to be carefully monitored. It should be noted that bill collection work of DisCos employees will change considerably.

(5) Diversification and Improvement Payment Methods

Various modes of bill payment are prepared by most DisCos, applying communication technology via personal computers, mobile phones and smartphones. As NERC points out, the impacts on people in poverty, who are unable to buy mobile phones or smartphones, should be a key concern, with relevant countermeasures carefully prepared and implemented.

(6) Establishing and Strengthening a Revenue Protection Team

All three DisCos, namely AEDC, EKEDC and PHED, which are target DisCos of this survey, have a Revenue Projection Team or are implementing and enhancing a Revenue Protection Project to combat the irregular use of electricity and to improve the bill collection process. The activities of the Revenue Protection Unit (RPU) in AEDC include e.g. initiating the following procedures: a) Inspections (Searching for doubtful cases through checking of customer database, etc. and surveillance, - b)

Findings (Requesting explanation about and confirming irregular use cases with the customer or their representative. In case of the confirmation, notifying disconnection), - c) Resolution (Agreeing with the customer on recovery method and payment of the cost though dialog of the Customer Desk and RPU with the customer, - d) Recovery (Paying an energy charge for irregular use (energy recovery bill) by the customer and implementing recovery works by AEDC) - e) Reconnection (Confirming payment, reconnecting, meter sealing and restarting the electricity supply). RPU activities are implemented with the following support: i) AMR (Automated Meter Reading) Back Office (Finding phenomenon accompanying irregular uses by monitoring meters and other measuring devices and detecting irregular uses), ii) Data Analytics (Analyzing sales data, finding misconducting customers, identifying irregular uses and preparing evidence documents), iii) Customer Service (Engaging in dialog, negotiating and concluding contracts with customers, planning on payment installments and enforcing the plan by the customers), iv) Finance (Confirming payment by customers and notifying the payment to related sections of AEDC accordingly), v) Legal (Review of misconduct on the part of customers and preparing indictment for customers who repeat misconduct).

(7) Implementation of a Campaign to Raise Awareness and Promote Bill Payment of the Customers

All DisCos acknowledge dialog and relations with customers as one of the key elements for business management. DisCos accept customer complaints concerning infrequent and irregular electricity supplies as well as billing and payment problems, etc. and receive requests for meter installation and replacement from customers. They also request that customers cease and refrain from energy theft, etc.,. Many DisCos conduct campaigns utilizing mass media, such as newspapers, radio and TV broadcasting and social media. NERC promotes dialog between DisCos and customers when it examines proposals for new regulations/orders and modification of existing regulations/orders. The dialog promoted by NERC might also help raise awareness of customers substantially.

(8) Measures to Improve Customer Relations

All DisCos prioritize improvement of “Customer Care”, Customer Services” or “Customer Relations” above all other aspects and deploy human and other resources as much as they can. AEDC, for example, is implementing comprehensive improvement measures which include i) developing and improving policies/standards/charters/manuals, ii) promoting upskilling and customer efforts to reinvent their behavior/attitude (conducting training and workshops), iii) improving responses to customer complains (improving database on records of customer complaints in InCM, etc.), iv) improving related organizations and work environment (strengthening of organizations related to customer relations, increasing area offices), etc. Recently, the ratio of unsolved customer complaints to the total customer complaints has decreased, which could reflect the improvement measures. Conversely, the number of complaints per customer is increasing, which might show the need for further measures to boost customer relations.

5-10 Current Status of Training to Raise the Bill Collection Rate and Improve Customer Relations by DisCos and NAPTIN

(1) Issues on Training to Raise Bill Collection Rate and Improve Customer Relations by AEDC

Following the survey in Nigeria, the following were identified by AEDC as problems regarding training to raise the bill collection rate and improve customer relations:

* Currently AEDC does not conduct specific off-the-job training (Off-JT) to raise the bill collection rate. Training activity for the purpose by AEDC is limited to OJT, namely so-called 'Knowledge Transfer' (including speeches on points to be noted by the supervisors).
* The budget for human resource development of AEDC is as small as NGN 200 million (JPY 40 million).
* Scope to train as part of efforts to boost the bill collection rate and improve customer relations might be low.
* AEDC has a good plan for a training course on customer care/attention comprising the following modules:
  Module 1: Required attitudes for customer care/attention
  Module 2: Expectations of customers
  Module 3: Effective communication
  Module 4: Knowledge on emotion and basics of customer care/attention
  Module 5: Response to irritating customers
  Module 6: Etiquette for conversations including telephone conversations.

(2) Capability of NAPTIN to Conduct Training Courses to Raise the Bill Collection Rate and Improve Customer Relations and Related Issues

Current situations regarding training courses to raise the bill collection rate and improve customer relations are described in Chapter 4 Section 4-3-4. As a result of the survey in Nigeria, the survey team found an additional training course for this purpose, the contents of which are shown in Table 5-10.1. The additional training can be evaluated as more practical compared to the others, as it introduces case studies and site observation. However, the training duration of two weeks might be too long for managers, as most are busy and it would be very difficult for them to leave their workplace for as long as two weeks.

The AEDC staff overseeing human resource development and training on business management highlighted the following issues on NAPTIN training courses to boost the bill collection rate and improve customer relations:

* Lecturers teach only principles and training courses do to elicit practical means of raising the bill collection rate.
* It would be more effective to assist AEDC directly than to do so though NAPTIN.
* NAPTIN says only authenticity and does not listen to the opinions of DisCos or trainees.

* AEDC is unwilling to pay tuition for NAPTIN training courses. This opinion mainly emerges due to the insufficient budget for developing human resources, in addition to issues regarding the quality of NAPTIN's training courses.

From the survey team perspective, NAPTIN's capability to conduct training courses on business management would be low compared to the capability to conduct technical training courses. When the survey team recommended the effective utilization of external resources to conduct training courses to boost the bill collection rate and improve customer relations, the General Manager answered that NAPYIN has already been planning to utilize external resources via a so-called "Adjunct Faculty".

Table 5-10.1 Outline of NAPTIN's Training Course on Metering and Revenue Protection Course

COURSE DURATION	2 Weeks (10 Days)
COURSE PARTICIPANTS	Customer Service Managers, Sales Supervisors & Representatives, Linemen Electricians, Meter Fitters & Readers
COURSE OBJECTIVES	Identify the types of energy meters for domestic and commercial premises
	Install single phase and three phase energy meter in domestic and commercial premises
	Access customers load requirement
	Prepare customers records
	Communicate efficiently with clients in appropriate manner
	Negotiate efficiently with the clients without affecting their sensibility
	Exert self-control in dispute situations with customers
	Build team spirit
	Interpret corporate policies and values in a convincing manner to clients
COURSE CONTENTS	**METERING, AND BILLING OF DISTRIBUTION SYSTEMS**
	i. Sale Techniques and Management of Electricity,
	ii. Metering and Billing,
	iii. Accounting.
	iv. Credit Control
	CUSTOMER RELATIONS OF DISTRIBUTION SYSTEMS
	I Security, Health, Environment Issues of Distribution Systems
	ii. Effective Communication and Listening Skills
	iii. Quality Service
	iv. Customer Needs and Wants
	v. Team Work and Productivity
	vi. Attitudinal Change and Productivity
	vii. Customer Complaints
	viii. Visit to a Call Centre (attachment).
COURSE METHODOLOGY	**COURSE DELIVERY SHALL INCLUDE:**
	Class Room Instruction
	Case Study
	Field Visitation
	Practical Demonstration at Meter Test Station
	Assignment/ Group Work
CONTACT DETAIL	**FOR FURTHER ENQUIRIES**
	E-mail: support@naptinportal.com
	Telephone: +2348060844971 or +2348033543304 or +2347067777559

Annex 1 - Examples of AEDC own training (technical section)

No.	Region	Function	Type of Facilitation	Training course title	Number of trainees
1	Cross Region	Technical Services	External Resource	Training on AMI acquisition of Mojec Energy meters	30
2	FCT Central	Technical Function	External Resource	Linesmen training	45
3	Cross Region	Technical Function	External Resource	Network Complaints Order Training	13
4	Head office	Cross Function	External Resource	Project Management Training(Basic)	30
5	Cross Region	Technical Function	Internal Resource	Network Complaints Order Training	40
6	Cross Region	Technical Function	Internal Resource	Network Complaints Order Training	40
7	Cross Region	Technical Function	Internal Resource	Electrical Safety Sensitization for TS	50
8	FCT South	Technical Function	Internal Resource	Electrical Safety Sensitization for TS	175
9	FCT Central	Technical Function	Internal Resource	Electrical Safety Sensitization for TS	64
10	Head office	Technical Function	Internal Resource	Electrical Safety Sensitization for TS	59
11	Cross Region	Technical Function	Internal Resource	Training on visibility access on PENTHAHO	38
12	FCT Central	Technical Function	External Resource	Linesmen Safety training	60
13	Niger Region	Technical Function	Internal Resource	Electrical Safety Sensitization for TS	104
14	Nasarawa Region	Technical Function	Internal Resource	Electrical Safety Sensitization for TS	95
15	Niger Region	Technical Function	External Resource	Linesmen Safety training - Bida Area Office	84
16	Kogi Region	Technical Function	Internal Resource	Electrical Safety Sensitization for TS	109
17	Cross Region	Technical Function	Internal Resource	Training on Calculation of Technical Loss	16
18	Cross Region	Technical Services	Internal Resource	Accident Curbing Sensitization	121
19	Cross Region	Technical Services	External & Internal Resource	Refresher training on AMI acquisition of DT Energy meters	64
20	Cross Region	Technical Services	Internal Resource	Metering Engineers in the Outsourced cluster	26
21	Cross Region	Technical Service	Internal Resource	Outstanding DSOA training	39
22	Cross Region	Technical Service	Internal Resource	AMI Software training for Metering Engineers & Executive Interaction	44
23	Cross Region	Technical Service	Internal Resource	Safety Workshop for Supervisors	62
24	Cross Region	Technical Service	Internal Resource	Safety Workshop for Supervisors	55
25	Cross Region	Technical Service	Internal Resource	Safety Workshop for Supervisors	59

Source: Prepared by the survey team based on AEDC information

Annex 2 - The curriculum of the training courses accredited by ANED

Course Title: ELECTRICAL FITTER TRAINING D2			
Course is Designed forElectrical Fitters			
Duration : Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the course, participants should be able to;			
Correctly use and maintain the tools of the trade including power tools, test equipment and measuring instruments	**INTRODUCTION** • Basic Electrical and Mechanical tools • Identification of power Tools and Usage • Care and house-keeping of tools and instruments • Measuring tools	Class room presentations	Projector
Install all types of commonly used wiring and wiring accessories	**SIMPLE ELECTRICAL SYMBOL & UNIT** •Electrical Current •Voltage (emf & p.d) •Resistance •Ohm's law •Capcitance •Conductors and Insulators	Case studies	Power System Simulator
Install electrical equipment such as motor starters, controllers, switchgears, switchboards, busbars, transformers and control panels	**TRANSFORMER** • Working principles of a transformer • Introduction to switchgears	Site visitations	Engineering Laboratory
Locate and repair faults in electrical installations and equipment	**DIELECTRIC MEDIA** • Function and properties of dielectric media • Transformer oil	Exercises/Hands -on practical	
Carry out mechanical fitting and assembling works relevant to heavy current equipment, and machine or fabricate parts for such equipment.	**SAFETY RULES 100** • Employees Knowledge of Rules • General Duties of all Employees • Radio Communications • Safe working method • Improve Safety of the Work Place		
Inspect, test, commission and maintain electrical installation and equipment			
Use safety equipment, and protective devices and equipment			
Correctly instruct, supervise and transfer skill to any apprentice and semi-skilled worker assigned to him to ensure safety and quality of work			

Course Title: SAFETY TRAINING A3			
Course is Designed for Electrical Fitters Officers			
Duration : Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the training, participants should be able :			
To explain some terms in connection with safety and work place practice such as: First aid/box contents, Artificial Resuscitation/CPR, bleeding, fractures etc.	**JOB SAFETY REQUIREMENTS** • Handling of tools and materials at site • Handling of testing equipment at site • Temporary grounding practice • Underground and man-hole hazards • Hazards due to chemicals, acids, glass fib • res etc • Safe working methods • Rules and approved procedures • Use of barriers in work areas • Housekeeping and care of tools	Class room presentations	Projector
To identify different forms of protection which may be provided.		Case studies	Power System Simulator
To identify various Occupational Health and safety rules in use in work place		Site visitations	Engineering Laboratory
To identify hazard associated to work place		Exercises/Hands -on Praactical	
	STANDARD PROTECTION CODE • Definitions • Protection guarantees • Work and test permits • Station guarantees • Application procedures • Implementation procedures		
	INDUSTRIAL FIRST AID • Definitions of basic terms • Aims and objectives of first aid • Golden rule of first aid • Structure and functions of the body • Scope of first aid • Qualities of a good first aider • Triangular bandage: Usage • Types of injuries at site/office/home • Artificial respiration • The Schafer method • Holger – Nielson method • Oral resuscitation		
	ELECTRICAL SAFETY AWARENESS • Nature of Electricity • Stop and Touch Potentials • Role of resistance in the source-body-ground circuit • Classification of Limits of approach		
	HAZARDS OF ELECTRIC SHOCK • Electrical Shock Conditions • Basic Hazards to the human body • The mechanism of Electric shock • Physiological effects of electric shock • Hazards due to flash over		
	HAZARD PREVENTION • Safe working environment • Periodic inspection and tests • Preventive maintenance • Use of correct tools • Use of permit and tags		

Course Title: POWER TOOLS AND TEST EQUIPMENT TRAINING A2			
Course is Designed for Electrical Fitters			
Duration: Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the training, participants should be able to:			
Correctly use and maintain the tools of the trade including power tools, test equipment and measuring instruments	**INTRODUCTION TO ELECTRICAL INSTRUMENTS** • Experimental Data and Errors • Measurement recording and reporting • Precision and accuracy • Resolution and sensitivity • Errors in measurement • Statistical evaluation of measurement data and errors	Class room presentations	Projector
Installs, tests, maintains and operate electrical installations in accordance with regulations and specifications	**ELECTROMECHANICAL INDICATING INSTRUMENTS** • Suspension Galvanometer • Torque and deflection of the Galvanometer • Damping mechanisms • Permanent magnet moving coil mechanism (PMMC) • Temperature compensation • DC Ammeters (Shunt Resistor) • DC Voltmeters (multiplier resistor) • Multi-range voltmeter • Voltmeter sensitivity • Series type ohmmeter	Case studies	Power System Simulator
	ELECTRODYNAMOMETER INSTRUMENTS • Introduction: Construction and principles of operation • Rectifier type instrument • Multimeter circuits • Watthour meter	Site visitations	Engineering Laboratory
	BRIDGES AND THEIR APPLICATION • Introduction: Wheat stone bridge • Basic operation • Measurement errors • Thevenin equivalent circuit	Exercises/Hands-on Practical	

Course Title: BASIC POWER SYSTEM PROTECTION TRAINING B1			
Course is Designed for PC&M Engineers			
Duration : Three weeks (15 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the training, participants should be able to:			
Design Protection Schemes for Power Transformer	General Introduction to protection	Class room Presentations	Projector
Solve any problem relating to Protection of Power Transformer	Instrument Connection and uses	Case studies	Power System Simulator
Effectively carry out fault study analysis and calculate short circuit currents in the system.	Control Circuit	Site visitations	Engineering Laboratory
Correctly select appropriate circuit breakers for particular location.	Instrument Transformers	Exercises/Hands-on Practical	
Effectively set and coordinate relays.	Introduction to Protective Relays		
Read control circuits and use it to solve problems.	Relay Settings		
Provide protection for Lines.	Differential Protective Relays		
Co-ordinate fuse effectively.	Protection of Transformers		
Tests and calibrate relays.	Equipment Grounding		
Correctly Set Relays	Testing and Maintenance of Relays		
	Fuse and Fuse Co-ordination		
	Basic Line Protection		
	Fault Study, Analysis and Short Circuit Calculation		
	Auto-re closing Schemes		
	System Stability		
	Over Voltage and Surge Protection		

Course Title: TRANSFORMER AND SWITCHGEAR MAINTENANCE B1			
Course is Designed forTransformer,Switchgear Maintenance Engineers			
Duration: Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of course, the trainees shall be able to Identify Power system components			
Explain, operate and maintain power/Distribution transformer	**TRANSFORMER** • Definition, Types, Applications and Principles of Operation and Construction • Tap-Changer • Paralleling of Transformers • Instrument Transformers • Protective Switchgears 1 (over-voltage) • Grounding and Grounding Transformers • Protection Scheme 2 (over-current and earth fault) • Commissioning Testing procedures • Maintenance Checklist	Class room Presentations Case studies Site visitations Exercises/Hands-on Practical	Projector Power System Simulator Engineering Laboratory
Explain, operate and maintain different types of switchgears in the power system	**SWITCHGEARS** • Definition, Necessity and Examples • Circuit Breakers: Definition, functions, classification • CBs : Arc-extinction media, current interruption modes, fault clearing process • CBs: Materials used in construction of circuit breakers • CBs: Rated characteristics of circuit breakers • CBs: Constructional features: interrupter units • CBs: Constructional Features: operating Mechanisms • Dielectric oil: properties, functions, sampling, testing, treatment procedures, purification plant operations • SF6 gas: properties, leakages and filling-in methods • Isolators: Definition, functions and types • Earthing switches: Definitions, functions, sequence of operation • Lighting arresters; Definitions, types and operation • Neutral grounding, station grounding and general earthing methods, practices and advantages • System over-voltage; causes and control method • Reactor: type, application and advantages • High voltage bushings • Ring Main Units (RMUs): types, functions, advantages and maintenance procedures • Feeder pillars: types, functions, advantages and maintenance • Fuses: types, operation, HRC-fuses: operations, advantages and applications • Control panels and boards: types, functions and		
	FAULT INVESTIGATION • Test & measurement instruments • Routine and preventive maintenance • Maintenance checklist • Tests and measurements		
Manage power system equipment at a minimal cost	HEALTH, SAFETY, AND ENVIRONMENT/ STANDARDS PROTECTION CODE		

Course Title: SAFETY AND WORK PRACTICE B1			
Course is Designed for PC&M/Distribution Safety Officers			
Duration: Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the course, participants should be able to			
To explain some terms in connection with safety and work place practice such as: First aid/box contents, Artificial Resuscitation/CPR, bleeding, fractures etc.	**JOB SAFETY REQUIREMENTS** • Handling of tools and materials at site • Handling of testing equipment at site • Temporary grounding practice • Underground and man-hole hazards • Hazards due to chemicals, acids, glass fibres etc • Safe working methods • Rules and approved procedures • Use of barriers in work areas • Housekeeping and care of tools	Class room Presentations	Projector
To identify different forms of protection which may be provided.	**STANDARD PROTECTION CODE** • Definitions • Protection guarantees • Work and test permits • Station guarantees • Application procedures • Implementation procedures	Case studies	Power System Simulator
To identify various Occupational Health and safety rules in use in work place]	**INDUSTRIAL FIRST AID** • Definitions of basic terms • Aims and objectives of first aid • Golden rule of first aid • Structure and functions of the body • Scope of first aid • Qualities of a good first aider • Triangular bandage: Usage • Types of injuries at site/office/home • Artificial respiration • The Schafer method • Holger – Nielson method • Oral resuscitation	Site visitations	Engineering Laboratory
Hazard associated to work place.	**ELECTRICAL SAFETY AWARENESS** • Nature of Electricity • Stop and Touch Potentials • Role of resistance in the source-body-ground circuit • Classification of Limits of approach	Exercises/Hands-on Practical	
	HAZARDS OF ELECTRIC SHOCK • Electrical Shock Conditions • Basic Hazards to the human body • The mechanism of Electric shock • Physiological effects of electric shock • Hazards due to flash over		
	HAZARD PREVENTION • Safe working environment • Periodic inspection and tests • Preventive maintenance • Use of correct tools • Use of permit and tags		

Course Title: MAINTENANCE AND REPAIR OF OVERHEAD LINE C1			
Course is Designed for Line Workers			
Duration: Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the course, participants should be able to			
Explain Distribution network of the Power system value chain	**OVERVIEW OF MAINTENANCE STRATEGIES** • Introduction • Breakdown maintenance • Time base maintenance • Condition based maintenance • Reliability centred maintenance • Comparative advantages and disadvantages • Case studies on optimal maintenance strategy for a given distribution network	Class room Presentation	Projector
Exert knowledge and skills required to resolve maintenance issues relating to power distribution lines		Case studies	Power System Simulator
Schedule power outages and maintenance plan of Distribution overhead lines		Site Visitations	Engineering Laboratory
Organize and ensure the routine maintenance of the network	**TRANSMISSION LINE CONSTRUCTION AND REPAIR** • Types of towers and functions • Line structures and tower foundations • Transmission lines conductors and current carrying capacity of conductors • Transmission lines operation • Failure modes of transmission lines • Repair and maintenance of transmission lines • Safe working procedures	Exercises/Hands-on Pratical	Engineering Laboratory
	INSULATORS FOR OVERHEAD LINES • Material and types • Testing of insulators • Insulators pollution level • Remedial measure to overcome problem due to pollution • Live line Maintenance		Engineering Laboratory
	PROTECTION FEATURES OF TRANSMISSION LINE • Protection against lightning • Protection against overcurrent • Earth fault • Distance protection • Overhead line		Engineering Laboratory
	DISTRIBUTION LINE MAINTENANCE • Components of distribution power line • Overhead distribution system medium and low voltages • Identification, care and use of linesman hand tools • Fault tracing/ location in 11kv and 33kv network • Feeder pillars: types, function, maintenance • Fuses: types, function, operations and coordination • Ring Main Unit (RMUs): function, advantage, maintenance procedure • Insulators; definition, functions and types • Management and utilization of maintenance data • Practical sessions		Engineering Laboratory
	SAFETY/SITE SKILLS • Standard protection code • Safety rules 100 series • Safety rules 200 series • First Aid		

Course Title: TRANSFORMER AND SWITCHGEAR MAINTENANCE C1			
Course is Designed for Line Workers			
Duration: Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the course, participants should be able to			
Identify Power system components	**INTRODUCTION** • Definition and basic concepts of power system	Classroom Presentations	Projector
Explain, operate and maintain power/Distribution transformer	**TRANSFORMER** • Definition, Types, Applications and Principles of Operation and Construction • Tap-Changer • Paralleling of Transformers • Instrument Transformers • Protective Switchgears 1 (over-voltage) • Grounding and Grounding Transformers • Protection Scheme 2 (over-current and earth fault) • Commissioning Testing procedures • Maintenance Checklist	Case Studies	Power System Simulator
Explain, operate and maintain different types of switchgears in the power system	**SWITCHGEARS** • Definition, Necessity and Examples • Circuit Breakers: Definition, functions, classification • CBs : Arc-extinction media, current interruption modes, fault clearing process • CBs: Materials used in construction of circuit breakers • CBs: Rated characteristics of circuit breakers • CBs: Constructional features: interrupter units • CBs: Constructional Features: operating Mechanisms • Dielectric oil: properties, functions, sampling, testing, treatment procedures, purification plant operations • SF6 gas: properties, leakages and filling-in methods • Isolators: Definition, functions and types • Earthing switches: Definitions, functions, sequence of operation • Lighting arresters; Definitions, types and operation • Neutral grounding, station grounding and general earthing methods, practices and advantages • System over-voltage; causes and control method • Reactor: type, application and advantages • High voltage bushings • Ring Main Units (RMUs): types, functions, advantages and maintenance procedures • Feeder pillars: types, functions, advantages and	Site Visitations	Engineering Laboratory
Manage power system equipment at a minimal cost	**FAULT INVESTIGATION** • Test & measurement instruments • Routine and preventive maintenance • Maintenance checklist • Tests and measurements	Exercises/Hands-on Practical	
	HEALTH, SAFETY, AND ENVIRONMENT/ STANDARDS PROTECTION CODE		

Course Title: POWER SYSTEM NETWORK LOSS MANAGEMENT (ATC&C LOSSES) C1			
Course is Designed for Distributinon Service Officer			
Duration: Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the course, participants should be able to	**Topics to be treated, but not limited to:**		
Explain the concept of power loss and its effect as it relates to power system	Introduction; Power system fundamentals – Generation, Transmission, Distribution and Consumption	Classroom Presentations	Projector
Classify power losses and identify the causes and effects of each class	Losses in Electricity Industry – Technical and Non-technical	Case Studies	Power System Simulator
Evaluate and estimate technical and technical losses	Power Losses in Developing countries – Case studies;	Site/Field Visitations	Engineering Laboratory
Undertake Distribute network maintenance, re-configuration and re-enforcement to reduce losses	Power Loss estimation and evaluation – Technical loss, Non-technical loss, Causes of Losses	Discussion of Result of Research work & Practical/Field	Live Equipment
Explain and execute power loss reduction techniques, as well as design action plan for power loss reduction	Power Loss Reduction Techniques – How to reduce technical losses, How to reduce Non-technical losses		
Explain and appreciate Power loss reduction technologies and Distribution automation	Power Loss Reduction Technologies – AMR/AMI, CIS/CRM, GIS, PSAT, DMS/OMS/SCADA.		
	Strategies for management plan on Power loss reduction		
	Power system Reliability – SAIDI, SAIFI, MAIFI, CAIDI, KPIs		
	Power system Automation and Smart Grid		

Course Title: ENERGY AUDITING & LOAD MANAGEMENT C1			
Course is Designed for Energy Auditors, Managers			
Duration: Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the course, participants should be able to			
Understand the Electricity value chain with focus on types & nature of losses across the value chain	Fundamentals of Energy in relations to the Power Sector	Classroom Instruction	Multimedia Projector
Define the information obtained by performing an Energy Audit	Overview of Losses in the Power Sector	Case Studies	Power System Simulator
Characterize the different types of Audit	Types of Losses	Site/Field Visitations	Engineering Laboratory
Prepare data for an Audit	Nature of losses	Discussion of Results of Research work & Practical/Field Session	Life Equipment
List the activities and steps in an Energy Audit	Identification & Evaluation of Losses		
Carryout a simple Energy Audit	Energy Audit		
Identify measures in addressing the losses, and	Typical Illustrations of Potentials of Energy savings/Loss reductions		
Assess the financial viability of the different measures of addressing the energy losses	Loss mitigation Strategies		
	Specific Power loss reduction Techniques & Technologies		
	Introduction of Adaptation of ISO 50001 Standards to Transmission & Distribution		

Course Title: DISTRIBUTION NETWORK PROTECTION D1			
Course is Designed for Distribution Service Officers			
Duration: Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the course, participants should be able to			
Understand why protection is needed	Introduction to Protection	Classroom Presentations	Projector
Recognize and principles and elements of the protection system	Fault Calculation	Case Studies	Power System Simulator
Know basic protection schemes applicable to distribution network	Relaying Coordination	Site Visitations	Engineering Laboratory
Digital relay advantages and enhancements	Device Number and Control Circuits	Exercises/Hands-on Practicals	
	Transformer Protection		
	Basic Line Protection		
	Earthing and Equipotential Bonding		
	Grounding of Electrical Equipment		
	Transformer Tests and Inspection for Faults		

Course Title: POWER INFRASTRUCTURE PROJECT MANAGEMENT D2			
Course is Designed for Distribution Service Officers			
Duration: Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the course, participants should be able to			
Conceptualize, design and plan power projects	Soil Investigation	Classroom Instruction	Projector
Execute power projects in line with the plan, exerting all required skills in project management	Laboratory Testing	Case Studies	Power System Simulator
Identify loop holes in project execution and correct them effectively	Design Of Tower And Substation Equipment Foundation	Site Visitations	Engineering Laboratory
Manage, supervise and control projects effectively	Surveying	Exercises/Hands-on Practicals	
	Introduction To Global Positioning System (GPS)		
	Setting Out Operations		
	Portable Water Supply In Substations		
	Design For HV Towers And Transmission Lines		
	Construction Of Transmission Line		
	High Voltage Power Substation		
	Site Inspection And Quality Control		
	Concrete Technology		
	Project Resource Quantities Estimates		
	Project Management cycles and skills		
	Safety and occupational health		

Course Title: INTRODUCTION TO SCADA & SMART GRID SYSTEM D3			
Course is Designed for Distribution Service Officers			
Duration:Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the course, participants should be able to	**Topics to be treated include, but not limited to;**		
Understand SCADA and Smart Grid System	Definition of SCADA	Classroom Presentations	Projector
Understand type of SCADA and Smart Grid technologies	SCADA Network	Case Studies	Power System Simulator
Know the benefits of SCADA, Smart Grid and AMI on Distribution network	SCADA Applications in Distribution Network system	Site/Field Visitations	Engineering Laboratory
	Uses of SCADA in Power system	Discussion of Results of Research work & Practical/Field	Live Equipment
	Functional Units of SCADA		
	Components of SCADA System		
	SCADA Network communication configuration		
	Automation of Distribution Network System		
	Substation Control Using SCADA		
	Feeders Control Using SCADA		
	Smart Grid		
	Characteristics of smart		
	Components of smart grid		
	Smart Grid stakeholders		
	Communication Infrastructure deployed in Smart Grid		
	Smart Grid Communication Standards		
	Advanced Metering Infrastructure (AMI)		

Course Title: SAFETY RULES AND REGULATION/STANDARD SAFETY CODES D1			
Course is Designed for Distribution Service Officers			
Duration: Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the course, participants should be able to			
To explain some terms in connection with protection guarantee (PG).	**JOB SAFETY REQUIREMENTS** • Handling of tools and materials at site • Handling of testing equipment at site • Temporary grounding practice • Underground and man-hole hazards • Hazards due to chemicals, acids, glass fibres etc • Safe working methods • Rules and approved procedures • Use of barriers in work areas • Housekeeping and care of tools	Classroom Presentation	Projector
To identify different forms of protection which may be provided.	**STANDARD PROTECTION CODE** • Definitions • Protection guarantees • Work and test permits • Station guarantees • Application procedures • Implementation procedures	Case Studies	Power System Simulator
To identify various Occupational Health and safety rules in use	**INDUSTRIAL FIRST AID** • Definitions of basic terms • Aims and objectives of first aid • Golden rule of first aid • Structure and functions of the body • Scope of first aid • Qualities of a good first aider • Triangular bandage: Usage • Types of injuries at site/office/home • Artificial respiration • The Schafer method • Holger – Nielson method • Oral resuscitation	Site/Field Visitations	Engineering Laboratory
		Discussion of Results of Research work & Practical/Field Session	Life Equipment

Course Title: CABLE JOINTERS/FITTERS & INSTRUMENT MANAGEMENT E1			
Course is Designed for Cable Jointers			
Duration: Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the course, participants should be able to			
Appreciate their roles as Cable Jointers	**INTRODUCTION – CABLE JOINTING** • Care and uses of Cable Jointing tools • Instruction on caring for tools, Use of tools, Cleanliness, Orderliness • Jointing Metals and soldering materials Introduction: To solder a cable socket • Diagram, Inserting prepared cable into cable socket • Making up level of socket • Procedure • Technique of soldering Electrical component Tinning, Cable laying techniques • Basic safety rules and rules on underground cable	Classroom Presentations	Projector
Apply and observe various safety measures	**STANDARD PROTECTION CODE (SPC)** • Introduction • Agent, Alive, Approval, Apparatus, Authorized, Caution Tag, De-energize, District, Ground or Earth, Hold-off, isolated, lines, • Protection Guarantee, Station Guarantee, Work-permit, Work and Test permit	Case Studies	Power System Simulator
Care and maintain tools used in jointing		Site/Field Visitations	Engineering Laboratory
Identify various Electrical Equipment's, parts of cables and their functions		Discussion of Results of Research work & Practical/Field Session	Life Equipment
Carryout various low voltage termination and joints with minimal supervision		Assignment/Group work	
Make use of jointing and soldering materials.			

Course Title: CABLE JOINTING REFRESHER COURSE E2			
Course is Designed for Cable Jointers			
Duration: Two weeks (10 days)			
Course Objectives:	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the course, participants should be able to			
To replace faulted cables sections-maintenance.	**FUNDAMENTAL OF CABLES AND APPLICATION** • Introduction • Shapes of conductor • Concentric round • Compact concentric round • Annular concentric • Segmental • Sector conductor • Hollow core • Main requirements of a joint • Tools/materials required to prepare tee joint and Preparation • Jointing procedure	Classroom Presentations	Projector
Know how to professionally terminate cable	**HIGH VOLTAGE CABLE TERMINATION** • Introduction • Improving the Electrical characteristic • Raychem premolded/prestressed component and function • Parts of Elastimold and functions • Contents of 3m pole mounted termination and function • Test on Cable Jointing: Head Test, Moisture Test, Potential test, Insulation Resistance test, Capacitance test, • High potential test/acceptance test (Hipo 1) continuity test	Case Studies	Power System Simulator
Know all termination types	**TECHNIQUES OF SOLDERING ELECTRICAL COMPONENT** • Introduction: Tinning • Application of insulation materials • Heat shrinkable material • B.I.C.C Bundy • Elastimold and 3 M	Site/Field Visitations	Engineering Laboratory
Comprehend all termination procedures	**ELASTIMOLD ELBOW TERMINATION** • Introduction • Preparation • Installation of Adaptor • Installation of the Elbow on bushing • Content of the kits Elbow Housing • 3m pole mounting terminating: Introduction • Content of the kit • Preparation of the Cable • Application of Material • Raychem Indoor and Outdoor termination • General Instruction, Contents of the kit, Terminating Instruction, Application of Jointing Materials	Discussion of Results of Research work & Practical/Field Session	Live Equipment
	RAYCHEM STRAIGHT THROUGH JOINT FOR BELTED 3 – CORE MIND PAPER INSULATED CABLE 12KV. • General Instruction • Cable Preparation • Size of conductor (mm2) • Location of part in crutch Area • Dimensions of connection Area, Dimension in (mm2) • Location of parts in complete joint • Completion of joint		
	FEEDER PILLAR • Definition, Types of feeder pillar, Parts of Feeders, Description • Causes of faults on feeder pillar		

	EARTHING • Introduction; Reason for earthing • Earthing tool and material • Earth procedure • Earth terms • Limit of Approach • Introduction • Normal voltage range and distance • Absolute limit of approach • For qualified personnel		
	ELECTRIC CABLE CONDUCTOR • Introduction • Conductor, Stranding, • Grounding of Cables and sub-station equipment's • Tools and materials • Earthing of grounding • Electric device and equipment		
	APPLICATION OF CONNECTOR • **Introduction** • Types of connectors and sizes • Application		

Course Title: HV SUBSTATION CABLE TERMINATION COURSE E1			
Course is Designed for Cable Jointers			
Duration: Two weeks (10 days)			
Course Objectives	**Course Contents**	**Methodology**	**Instructional Tools**
At the end of the course, participants should be able to			
Carryout all high voltage joints and terminations without supervision	**Electric Cable Conductor** • Introduction • Conductor • Stranding • Cross – sectional area	Classroom Presentations	Projector
Plan and construct an outdoor distribution sub-station	**Insulating materials for wire and cable** • Thermoplastic • Polyvinyl – Chloride • Polyethylene • Thermosetting • Natural rubber • Styrene – Butadiene Rubber • Isobutylene Isoprene Rubber • Chloroprene rubber • Silicon Rubber	Case Studies	Power System Simulator
Carryout improvisation in Cable Jointing	**Mineral** • Mica • Asbestos • Magnesium oxide	Site/Field Visitations	Engineering Laboratory
Be conversant with all distribution electrical equipment's and their operations	**Test on Cable Jointing** • Moisture Test • Insulation resistance test • Capacitance test • High potential acceptance test	Discussion of Results of Research work & Practical/Field Session	Live Equipment
	High voltage cable termination • Improving the electrical characteristic		
	Transition joint • Jointing Instruction • Cable preparation • Completion of joint • Improvisation of material in Cable Jointing		
	Differentiating HV Cables from LV Cable/Material • Use of HV Cable/Material for low voltage • Use of combination of substituting of premoulded, prestretched, thermosttting (etc) materials in single or multicore cable. • Use of Raychem materials (Angle Bushing) on single or multicore cable in absence in Elbow Housing vit on Plug – in transformer. • Straight jointing of large size single core cables • 33KV Termination (Out-door) • Termination Instruction • Application of jointing materials • 33KV straight through joint		

Source: Prepared by the survey team based on AEDC documents

Annex 3 - The syllabus and timetable of the training courses

1. C1 - Syllabus and timetable of "SUBSTATION MAINTENANCE"

COURSE TITLE: POWER TRANSMISSION NETWORK AND SUBSTATION OPERATIONS AND MAINTENANCE:

THIS COURSE IS DESIGNED FOR:

- Transmission Engineers and Technologists
- Senior Transmission Technicians

COURSE OBJECTIVES: At the end of the course, participants should be able to:

- Explain transmission networks as they relate to power systems
- Leverage the knowledge and skills required to resolve maintenance issues relating to power transmission lines
- Schedule power outages and maintenance plans
- Operate and maintain substation equipment effectively
- Organize and ensure the routine substation maintenance

DURATION: Two weeks (10 days)

COURSE CONTENTS:

- **INTRODUCTION**
  - ✓ Power system fundamentals - Generation, Transmission, Distribution and Consumption

- **TRANSMISSION LINE CONSTRUCTION AND REPAIR**
  - ✓ Types Of Towers and Functions
  - ✓ Line Structures and Tower Foundations
  - ✓ Transmission Lines Conductors and Current Carrying Capacity of Conductors
  - ✓ Transmission Lines Operation
  - ✓ Failure Modes of Transmission Lines
  - ✓ Repair And Maintenance of Transmission Lines
  - ✓ Safe Working Procedures and Safety Rules
- **INSULATORS FOR OVERHEAD LINES**
  - ✓ Materials and Types
  - ✓ Testing of Insulators
  - ✓ Insulators Pollution level
  - ✓ Remedial measures to overcome Problems due to Pollution

- **LIVE LINE MAINTENANCE**
- **PROTECTION FEATURE OF TRANSMISSION LINES**
  - ✓ Protection against Lightning
  - ✓ Protection against Overcurrent
  - ✓ Earth Fault
  - ✓ Distance Protection
  - ✓ Overhead line
  - ✓ Underground cable/conductor

- **SUBSTATION OPERATION/MAINTENANCE:**
  - ✓ Overview of substation equipment

  - ✓ Diagnostic Techniques for Distribution Substations
  - ✓ Transformer maintenance
  - ✓ Transformer maintenance check list
  - ✓ Transformers: insulation & cooling system
  - ✓ Transformer commissioning and testing procedure
  - ✓ Introduction to circuit breakers
  - ✓ Circuit breaker constructional features and operating mechanism
  - ✓ Dielectric oil: properties, functions, sampling, testing
  - ✓ Tripping unit; types, functions, applications and maintenance
  - ✓ Switchgears: Application and maintenance
  - ✓ Substation fault documentation
  - ✓ Corrective action/Preventive maintenance in Transmission Substation

- **PROTECTION OF SUBSTATIONS**
  - ✓ Transformer Protection Scheme
  - ✓ Overvoltage protection - Lightning/surge arrestors
  - ✓ System Earthing

- **METHODOLOGY:**
  - ✓ Classroom presentations
  - ✓ Case studies
  - ✓ Site visitations
  - ✓ Exercises

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NAPTIN'S TIMETABLE/TRAINING SCHEDULE

PROGRAMME TITLE: MAINTENANCE OF POWER TRANSFORMERS AND SWITCHGEARS
CLIENT/SPONSORS: ASSOCIATION OF POWER UTILITIES IN AFRICA (APUA)
TRAINING VENUE: REGIONAL TRAINING CENTRE, IJORA, LAGOS

DAYS	TIME						
	09.00 – 10.30	10.30 – 11.00	11.00 – 12.30	12.30 – 13.00	13.00 – 14.00	14.00 – 15.30	16.00 – 17.30
	TOPICS		TOPICS			TOPICS	TOPICS
DAY 1	Introduction, definition and basic concepts of a power system (Engr, TCN)	TEA BREAK	History and trends in Nigeria (Ewetumo)	History and trends in Nigeria **(Ewetumo)**	LUNCH BREAK	History and trends in Nigeria (Ewetumo)	Class Discussion/Interactive Section (Engr, TCN)
DAY 2	Transformer definition, types, applications and principles of operations (Ewetumo)		Transformer definition, types, applications and principles of operations (Ewetumo)	Transformer Construction (Patric)		Transformer Construction (Patric)	Cooling systems, designation and auxiliaries **(Khalil)**
DAY 3	Tap-changers **(Bhadmus)**		Paralleling transformers (Engr, TCN)	Instrument transformers (Patric)		Instrument transformers (Patric)	Protective switchgears 1 (over-voltage) **(Khalil)**
DAY 4	grounding and grounding transformers (Engr S O)		Protection schemes 2 (over-current and earth fault) **(Khalil)**	Site Visitation Plan (Bhadmus)		On Site Transformer Commissioning test procedures (Bhadmus)	On Site Transformer Commissioning test procedures (Bhadmus)
DAY 5	Class Discussion/Interactive Section (Engr, S O)		Transformer maintenance checklist (Engr S O)	Transformer maintenance checklist (Engr S O)		Course Review **(All)**	Health, Safety, and Environment **(Ewetumo)**
DAY 6	Switchgears: definition, necessity, and examples **(Ewetumo)**		Switchgears: definition, necessity, and examples **(Ewetumo)**	Circuit breakers (CBs): definition, functions, classification (Patrick)		Circuit breakers (CBs): definition, functions, classification (Patrick)	CBs: Arc-extinction media, current interruption modes, fault clearing process (Engr, TCN)
DAY 7	CBs: Arc-extinction media, current interruption modes, fault clearing process (Engr, TCN)		CBs: Materials used in construction of circuit breakers (Nonso)	CBs: Rated characteristics of circuit breakers **(Ewetumo)**		CBs: Rated characteristics of circuit breakers **(Ewetumo)**	CBs: Constructional features: interrupter units (Bhadmus))
DAY 8	CBs: Constructional features: operating mechanisms **(Engr, TCN)**		Dielectric oil: properties, functions, sampling, testing, treatment procedures, purification plant operations (Engr S O)	SF6 gas: properties, leakages and filling-in methods (Bhadmus)		SF6 gas: properties, leakages and filling-in methods (Bhadmus)	Isolators: definition, functions and types (Ewetumo)
DAY 9	Earthing switches: definition, functions, sequence of operations (Engr S O)		Lightning arresters: definition, types and operations **(Ewetumo)**	Site Visitation Plan (Engr, TCN)		On Site Commissioning test procedures (Engr, TCN)	On Site Commissioning test procedures (Engr, TCN)
DAY 10	Neutral grounding, station grounding and general earthing methods, prac-tices and advantages **(Engr S O)**		Reactor: types, applications and advantages **(Patric)**	Switchgear maintenance checklist **(Bhadmus)**		Course Review **(All)**	CLOSING

2. C2 - Syllabus and timetable of "DISTRIBUTION MAINTENANCE"

POWER DISTRIBUTION NETWORK MAINTENANCE AND

COURSE DURATION	2 Weeks (10 Days)
COURSE PARTICIPANTS	**(i)** Distribution Engineers and Technologist **(ii)** Senior Distribution Technicians
COURSE OBJECTIVES	**(i)** Operate and maintain distribution network **(ii)** Adequately protect distribution lines and sub-station equipment
	(iii) Put in place a preventive maintenance plan for distribution network **(iv)** Locate and clear faults in distribution network
COURSE CONTENTS	**OVERVIEW OF MAINTENANCE STRATEGIES**
	(i) Introduction **(ii)** Breakdown Maintenance **(iii)** Time Based Maintenance **(iv)** Condition Based Maintenace
	(v) Reliability centered maintenance **(iv)** Comparative advantages and disadvantages
	(v) Case Studies on Optimal maintenance strategy for a given distribution network
	SAFETY/SITE SKILLS
	(i) Standard protection code **(ii)** Safety rules 100 series **(iii)** Safety rules 200 series **(iv)** First Aid
	DISTRIBUTION LINE MAINTENANCE
	(i) Components of distribution power line **(ii)** Overhead distribution system medium and low voltages
	(iii) Identification, care and use of linesman hand tools **(iv)** Fault tracing/location in 11kv and 33kv network
	(v) Feeder pillars: type, function, maintenance **(vi)** Fuses: types, functions, operations and coordination
	(vii) Ring main unit (RMUs) functions, advantages, maintenance procedure **(viii)** Isolators: definition, functions and types
	(ix) Management and utilization of maintenance data **(x)** Practical sessions
	SUBSTATION MAINTENANCE
	(i) Overview of substation equipment **(ii)** Diagnostic Techniques for Distribution Substations **(iii)** Transformer maintenance
	(iv) Transformer maintenance check list **(v)** Transformers: insulation & cooling system
	(vi) Transformer commissioning and testing procedure **(vii)** Introduction to circuit breaker
	(viii) Circuit breaker constructional features and operating mechanism **(ix)** Dielectric oil: properties, functions, sampling, testing
	(x) Switchgears: Application and maintenance **(xi)** Substation fault documentation
	(xii) Corrective action/ Preventative maintenance in Distribution Network Systems
	UNDERGROUND CABLE MAINTENANCE
	(i) Fundamentals of cables and application **(ii)** Introduction to cable jointing **(iii)** Clamps and connectors
	(iv) Care and use of cable jointing tools **(v)** Jointing metals and soldering materials **(vi)** Cable jointing techniques and procedure
	(vii) High voltage cable termination **(viii)** Raychem pre-molded/pre-stressed component and function **(ix)** Test on Cable Jointing
	(x) Application of insulation materials **(xi)** Elastimold Elbow Termination **(xii)** Raychem indoor and outdoor termination
	(xiii) Raychem Straight Through Joint for Belted 3 – core MIND paper insulated cable **(xiv)** Cable laying techniques
	(xv) Simple Calculation on Cable Installation and Management **(xvi)** Preparation of cable ground **(xvii)** Types of cables, fault and failures
	(xviii) Cable Jointing Accessories **(xix)** Insulating materials for wires and cables **(xx)** Various tests on cable/Joints
	(xxi) Transition joint **(xxii)** Practical Demonstration with a Cable Fault Locator **(xxiii)** Network
	DISTRIBUTION NETWORK PROTECTION (ELECTRICAL GRADUATE ENGINEERS)
	(i) General introduction to protection **(ii)** Fault Calculations **(iii)** Reading and Interpretation of Control circuit
	(iv) Transformer protection **(v)** Basic line protection **(vi)** Earthing **(vii)** Equipment grounding
	(viii) Transformer commissioning and testing procedure **(ix)** Operation under emergency **(x)** Network sectionalizing
COURSE METHODOLOGY	**(i)** Class Room Instruction **(ii)** Case Study **(iii)** Case Study **(iv)** Field Visitation **(v)** Practical Demonstration
INSTRUCTIONAL TOOLS	**(i)** Projector **(ii)** Power System Simulator **(iii)** Live Equipment **(iv)** Engineering Laboratory
CONTACT DETAIL	**FOR FURTHER ENQUIRIES**
	E-mail: support@naptinportal.com

		DISTRIBUTION NETWORK MAINTENANCE AND REPAIRS	
	TIME	**TOPICS**	**TRAINERS**
MONDAY	0900HRS - 1030HRS	INDUCTION/INTRODUCTION	ALL
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	SAFETY/SITE SKILLS - SAFETY RULES	KADIRI SHAMSU
	1230HRS - 1330HRS	SAFETY/SITE SKILLS - SAFETY RULES	KADIRI SHAMSU
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	SAFETY/SITE SKILLS - SPC	KADIRI SHAMSU
	1600HRS - 1730HRS	SAFETY/SITE SKILLS - FIRST AID	KADIRI SHAMSU
TUESDAY	0900HRS - 1030HRS	DISTR. LINE MAINTENANCE - COMPONENTS	IBE OKOSOBO
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	DISTR LINE MAINTENANCE - OVERHEAD SYSTEM	IBE OKOSOBO
	1230HRS - 1330HRS	HAND TOOLS/ FAULT TRACING	IBE OKOSOBO
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	FEEDER PILLAR, RMU, ISOLATORS AND FUSES	IBE OKOSOBO
	1600HRS - 1730HRS	MAINTENANCE MANAGEMENT	IBE OKOSOBO
WEDNESDAY	0900HRS - 1030HRS	OVERVIEW OF SUBSTATION EQUIPMENT	ABDULLAHI ALIYU
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	DIAGNOSTIC TECHNIQUES	ABDULLAHI ALIYU
	1230HRS - 1330HRS	TRANSFORMER MAINTENANCE/CHECKLIST	ABDULLAHI ALIYU
	1330HRS - 1400HRS	LUCH BREAK	ALL
	1400HRS - 1600HRS	TRANSFORMER COOLING SYSTEM	ABDULLAHI ALIYU
	1600HRS - 1730HRS	TRABSFORMER COOLING/INSULATION	ABDULLAHI ALIYU
THURSDAY	0900HRS - 1030HRS	TRANSFORMER TESTING/COMMISSIONING	EWETUMO A
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	CIRCUIT BREAKER - INTRO	EWETUMO A
	1230HRS - 1330HRS	CIRCUIT BREAKER - CONSTRUCTION	EWETUMO A
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	DIELECTRIC OIL	EWETUMO A
	1600HRS - 1730HRS	SWITCHGEARS - APPLICATIONS/MAINTENANCE	EWETUMO A
FRIDAY	0900HRS - 1030HRS	TRIPPING UNIT	ABDULLAHI A
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	SUBSTATION FAULT DOCUMENTATION	IBE OKOSOBO
	1230HRS - 1330HRS	MAINTENANCE OF DISTRIBUTION NETWORK	ABDULLAHI A
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	REVIEW/EVALUATION	
	1600HRS - 1730HRS	REVIEW/EVALUATION	

	TIME	TOPICS	TRAINERS
MONDAY	0900HRS - 1030HRS	FUNDAMENTALS OF CABLES	A OMIKA
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	INTRO TO CABLE JOINTING	A OMIKA
	1230HRS - 1330HRS	JOINTING TOOLS	A OMIKA
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	JOINTING AND SOLDERING TECHNIQUES/MATERIALS	A OMIKA
	1600HRS - 1730HRS	HV TERMINATION/RAYCHEM	A OMIKA
TUESDAY	0900HRS - 1030HRS	CABLE INSTALLATION/MANAGEMENT	A OMIKA
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	CABLES, FAULTS AND FAILURE	A OMIKA
	1230HRS - 1330HRS	CABLE TEST	A OMIKA
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	FAULT LOCATOR	A OMIKA
	1600HRS - 1730HRS	PRACTICAL DEMONSTRATION	A OMIKA
WEDNESDAY	0900HRS - 1030HRS	INTRO TO PROTECTION	ABDULLAHI A
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	FAULT CALCULATION	ABDULLAHI A
	1230HRS - 1330HRS	FAULT CALCULATION	ABDULLAHI A
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	CONTROL CIRCUIT	ABDULLAHI A
	1600HRS - 1730HRS	CONTROL CIRCUIT	ABDULLAHI A
THURSDAY	0900HRS - 1030HRS	TRANSFORMER PROTECTION	ABDULLAHI A
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	TRANSFORMER PROTECTION	ABDULLAHI A
	1230HRS - 1330HRS	BASIC LINE PROTECTION	ABDULLAHI A
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	EARTHING	ABDULLAHI A
	1600HRS - 1730HRS	EQUIPMENT GROUNDING	ABDULLAHI A
FRIDAY	0900HRS - 1030HRS	OPERATION UNDER EMERGENCY	VINCENT A
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	NETWORK SECTIONALIZING	VINCENT A
	1230HRS - 1330HRS	REVIEW/EVALUATION	
	1330HRS - 1400HRS	REVIEW/EVALUATION	

3. C3 - Syllabus and timetable of “DISTRIBUTION NETWORK DESIGN-PLANNING”

COURSE DURATION	2 Weeks (10 Days)
COURSE PARTICIPANTS	**(i)** Engineers and Technologist **(ii)** Senior Distribution Technicians
COURSE OBJECTIVES	**(i)** Use and configure GPS for the layout of lines **(ii)** Identify materials for 11KV, 33KV or their respective equivalent
	(iii) Design 11KV and 33KV lines network **(iv)** Design 33KV/11KV and 11KV/0.415KV substations
	(v) Apply SCADA systems for the operations of power distribution networks
	(vi) Observe necessary safety rules and standard protection code
COURSE CONTENTS	POWER DISTRIBUTION NETWORK DESIGN CONSIDERATIONS
	(i) Reliability of distribution network **(ii)** Sizing conductors for load and for voltage drop **(iii)** Planning Distribution Networks
	(iv) Technical Considerations of Equipment **(v)** HV Networks and Substations **(vi)** Distribution Substations and LV Networks
	(vii) Network Voltage Performance **(viii)** Computer Based Planning
	GENERAL PRINCIPLES
	(i) Equipment & Circuit Ratings **(ii)** Project Design **(iii)** Fault Levels **(iv)** Short Circuit Rating **(v)** Interconnections **(vi)** Costs
	(vii) Asset Replacement **(viii)** Voltage Limits **(ix)** Load Balancing **(x)** Load Flow **(xi)** System Assessments
	(xii) Reinforcement Methods **(xiii)** Load Growth Trends and Analysis **(xiv)** Design and Planning V & kV
	POWER DISTRIBUTION NETWORK DESIGN
	(i) 11 kV and 33 kV overhead line (pole lines) construction, rehabilitation and Maintenance
	(ii) 11 kV and 33 kV Underground Cable installation, operation and maintenance
	(iii) 33/11 kV substation installation, testing and commissioning
	(iv) 11/0.415 kV distribution transformer testing, repairs and maintenance
	SYSTEM PROTECTION
	(i) Substations and Protection **(ii)** Switchgear **(iii)** Line Protection **(iv)** Transformer Protection **(v)** Feeder Protection
	(vi) Bus Bar Protection **(vii)** Distribution substations and LV networks
	(viii) Comparison of low-voltage networks and distribution systems operating at higher voltage Levels
	SMART GRID OVERVIEW
	(i) Smart Grid for distribution systems **(ii)** Definitions of smart Grid **(iii)** Benefits of the smart Grid on distribution systems
	SAFETY
	(i) Safety Protection Code **(ii)** Safety Rules 100 Series **(iii)** Safety Rules 200 Series **(iv)** First Aid
COURSE METHODOLOGY	**(i)** Class Room Instruction **(ii)** Case Study **(iii)** Case Study **(iv)** Field Visitation **(v)** Practical Demonstration
INSTRUCTIONAL TOOLS	**(i)** Projector **(ii)** Power System Simulator **(iii)** Live Equipment **(iv)** Engineering Laboratory
CONTACT DETAIL	FOR FURTHER ENQUIRIES
	E-mail: support@naptinportal.com

4. C4 - Syllabus and timetable of “DISTRIBUTION LOSS MANAGEMENT”

DISTRIBUTION NETWORK POWER LOSS MANAGEMENT COURSE

COURSE DURATION	2 Weeks (10 Days)
COURSE PARTICIPANTS	**(i)** Distribution Engineers and Technologist **(ii)** Senior Distribution Technicians
COURSE OBJECTIVES	**(i)** Explain the Concept of Power Loss and its Effect as it Relates to Power System
	(ii) Classify Power Losses and Identify the Causes and Effects of Each Class **(iii)** Evaluate and Estimate Technical and Technical Losses
	(iv) Undertake Distribute Network Maintenance, Re-Configuration and Re-Enforcement to Reduce Losses
	(v) Explain and Execute Power Loss Reduction Techniques, as well as Design Action Plan for Power Loss Reduction
	(vi) Explain and Appreciate Power Loss Reduction Technologies and Distibution Automation
COURSE CONTENTS	**INTRODUCTION TO POWER SYSTEM FUNDAMENTALS**
	(i) Generation **(ii)** Transmission **(iii)** Distribution **(iv)** Consumption
	LOSSES IN ELECTRICITY INDUSTRY
	(i) Technical **(ii)** Non-Technical
	POWER LOSSES IN DEVELOPING COUNTRIES – CASE STUDIES
	(i) Latin America **(ii)** South Asia **(iii)** East Asia **(iv)** Former Soviet Union **(v)** Sub-Saharan Africa
	POWER LOSS ESTIMATION AND EVALUATION
	(i) Technical loss **(ii)** Non-technical loss **(iii)** Causes of Losses
	POWER LOSS REDUCTION TECHNIQUES
	(i) How to reduce technical losses **(ii)** How to reduce Non-technical losses
	POWER LOSS REDUCTION TECHNOLOGIES
	(i) AMR/AMI **(ii)** CIS/CRM **(iii)** GIS **(iv)** PSAT **(v)** DMS/OMS/SCADA.
	STRATEGIES FOR MANAGEMENT PLAN ON POWER LOSS REDUCTION
	(i) General Discussion
	POWER SYSTEM RELIABILITY
	(i) SAIDI **(ii)** SAIFI **(iii)** MAIFI **(iv)** CAIDI **(v)** KPIs
	DISTRIBUTION AUTOMATION AND SMART GRID
COURSE METHODOLOGY	**(i)** Class Room Instruction **(ii)** Case Study **(iii)** Case Study **(iv)** Field Visitation **(v)** Practical Demonstration
INSTRUCTIONAL TOOLS	**(i)** Projector **(ii)** Power System Simulator **(iii)** Live Equipment
CONTACT DETAIL	**FOR FURTHER ENQUIRIES**
	E-mail: support@naptinportal.com
	Telephone: +2348060844971 or +2348033543304 or +2347067777559

		DISTRIBUTION NETWORK POWER LOSS	
	TIME	**TOPICS**	**TRAINERS**
MONDAY	0900HRS - 1030HRS	INDUCTION/INTRODUCTION	ALL
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	INTRO; POWER SYSTEM FUNDAMENTALS	KHALIL Y A
	1230HRS - 1330HRS	INTRO; POWER SYSTEM FUNDAMENTALS	KHALIL Y A
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	INTRO; POWER SYSTEM FUNDAMENTALS	KHALIL Y A
	1600HRS - 1730HRS	INTRO; POWER SYSTEM FUNDAMENTALS	KHALIL Y A
TUESDAY	0900HRS - 1030HRS	POWER SYSTEM LOSSES	KHALIL Y A
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	POWER SYSTEM LOSSES	KHALIL Y A
	1230HRS - 1330HRS	LOSSES IN DEVELOPING NATIONS	KHALIL Y A
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	EXERCISE ON LOSSES	KHALIL Y A
	1600HRS - 1730HRS	EXERCISE ON LOSSES	KHALIL Y A
WEDNESDAY	0900HRS - 1030HRS	POWER LOSS EVALUATION	MIKE EZUGWU
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	POWER LOSS EVALUATION	MIKE EZUGWU
	1230HRS - 1330HRS	LOSS EVALUATION/ESTIMATION	MIKE EZUGWU
	1330HRS - 1400HRS	LUCH BREAK	ALL
	1400HRS - 1600HRS	EXERCISE; LOSS CALCULATION	MIKE EZUGWU
	1600HRS - 1730HRS	EXERCISE; LOSS CALCULATION	MIKE EZUGWU
THURSDAY	0900HRS - 1030HRS	POWER LOSS REDUCTION	KHALIL Y A
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	POWER LOSS REDUCTION	KHALIL Y A
	1230HRS - 1330HRS	LOSS REDUCTION TECHNIQUES	KHALIL Y A
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	LOSS REDUCTION TECHNIQUES	KHALIL Y A
	1600HRS - 1730HRS	EXERCISE ON LOSS REDUCTION	KHALIL Y A
FRIDAY	0900HRS - 1030HRS	WEEK'S REVIEW	ALL
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	EVALUATION	ALL
	1230HRS - 1330HRS	SAFETY	ALL
	1330HRS - 1400HRS	EVALUATION	ALL
	1400HRS - 1600HRS	EVALUATION	ALL
	1600HRS - 1730HRS	EVALUATION	ALL

	TIME	TOPICS	TRAINERS
MONDAY	0900HRS - 1030HRS	LOSS REDUCTION - AMR/AMI	MIKE EZUGWU
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	LOSS REDUCTION - AMR/AMI	MIKE EZUGWU
	1230HRS - 1330HRS	LOSS REDUCTION - AMR/AMI	MIKE EZUGWU
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	LOSS REDUCTION - CIS/CRM	MIKE EZUGWU
	1600HRS - 1730HRS	LOSS REDUCTION - CIS/CRM	MIKE EZUGWU
TUESDAY	0900HRS - 1030HRS	LOSS REDUCTION - PSAT	KHALIL Y A
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	LOSS REDUCTION - PSAT	KHALIL Y A
	1230HRS - 1330HRS	POWER SYSTEM RELIABILITY	KHALIL Y A
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	SITE VISITATION	ALL
	1600HRS - 1730HRS	SITE VISITATION	ALL
WEDNESDAY	0900HRS - 1030HRS	MANAGEMENT IMPROVEMENT PLAN	MIKE EZUGWU
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	MANAGEMENT IMPROVEMENT PLAN	MIKE EZUGWU
	1230HRS - 1330HRS	EXERCISE; PLAN	MIKE EZUGWU
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	EXERCISE; PLAN	MIKE EZUGWU
	1600HRS - 1730HRS	EXERCISE; PLAN	MIKE EZUGWU
THURSDAY	0900HRS - 1030HRS	DISTRIBUTION AUTOMATION	KHALIL Y A
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	DISTRIBUTION AUTOMATION	KHALIL Y A
	1230HRS - 1330HRS	DISTRIBUTION AUTOMATION	KHALIL Y A
	1330HRS - 1400HRS	LUNCH BREAK	ALL
	1400HRS - 1600HRS	DISTRIBUTION AUTOMATION	KHALIL Y A
	1600HRS - 1730HRS	DISTRIBUTION AUTOMATION	KHALIL Y A
FRIDAY	0900HRS - 1030HRS	SMART GRID	MUAZU A
	1030HRS - 1100HRS	TEA BREAK	ALL
	1100HRS - 1230HRS	REVIEW/EVALUATION	ALL
	1230HRS - 1330HRS	REVIEW/EVALUATION	ALL
	1330HRS - 1400HRS	REVIEW/EVALUATION	ALL

Chapter 6 Considerations on assistance measures by JICA

As it would be difficult to conduct financial cooperation projects such as concessional loan or grant aid projects for the DisCos, entities that have already been privatized, this chapter considers support measures focused on technical cooperation.

6-1 Challenges faced by the DisCos and countermeasures to address them (technical aspects)

6-1-1 Challenges in improving the DisCos' business foundations

Problems related to the business foundations of the Nigerian distribution companies (DisCos) were extracted from the information obtained from the PIP and the field survey. Table 6-1.1 summarizes the problems pointed out and the measures to be taken in the future for each major task.

Table 6-1.1 Challenges and problems in the distribution sector

Major challenges	Specific problems / Countermeasures
1. Reduction of power loss	
(1) Technical loss reduction	A. Reconfiguring the low-voltage system
	B. Upgrading the conductor size
	C. Adopting a new type of conductor
	D. Appropriately placing the substation
	E. Increasing the network supply capacity
	F. Installing a capacitor bank for power factor improvement
(2) Commercial loss reduction	A. Disseminating electricity meters (prepaid meters / smart meters)
	B. Disseminating electricity meters (Feeder meters / transformer meters)
	C. Applying overhead cable (ABC: Aerial Bundled Cables)
	D. Strengthening the RPD (Revenue Protection Department) team
	E. Developing a database to detect electricity theft
	F. Electricity metering system for the entire network (Detection of theft areas)
2. Securing (increasing) supply capacity	A. Substation construction・capacity increase
	B. Constructing new feeders and increasing the feeder capacity
	C. Increasing the installation and upgrading the capacity of the distribution transformers
3. Low supply reliability (Frequent fault outages) (Frequent planned outages)	A. Enhancing the capacity of the facilities
	B. Planned replacement of failed/aged equipment
	C. Improving the fault recovery method (including the adoption of sectionalizing switchgear and fault detectors)
	D. Implementing preventive maintenance (measures based on fault analysis)
	E. Reducing the fault recovery time by the distribution automation system
	F. Improving the network configuration (e.g., increasing redundancy through RMU installation)
	G. Ensuring the adequacy of the protection system
4. Insufficient work standards ・ not standardized work implementation procedures	A. Improving worker morale and quality
	B. Non-standardized network design
	C. Non-compliance with the design standards in the initial design (pole strength, etc.)
	D. Developing standard procedures for work implementation
	E. Properly maintaining the voltage quality (installation of boosters)
	D. Eliminating difficulties in maintenance

Major challenges	Specific problems / Countermeasures
5. Low quality of work implementation (Including culture (working culture, lack of discipline, lack of accountability, etc.))	A. Lack of discipline
	B. Working culture
	C. Non-compliance with processes and procedures
	D. Lack of accountability
6. Lack/incompleteness of safety awareness (including safety measures)	A. Refurbishing hazardous facilities
	B. Safety Training for Workers
	C. Sufficient deployment of protective gear
	D. Improving human resources development
	E. Sharing accident information and accident-prevention measures
	F. Protecting the energized part and maintaining safety clearance
	G. Safety training for substation operation
	H. Deep understanding of the Distribution Code

Source: Created by the survey team

6-1-2 Technical cooperation themes to address the challenges in improving the business foundations

This section examines efforts to improve the work implementation with a view to solving the issues faced in the work to improve the DisCos' business foundations (shown in Table 6-1.1 in the previous section). Table 6-1.2 (left column) shows the themes of the initiatives in the actual works to address the challenges and problems listed in Table 6-1.1. Table 6-1.2 (right column) shows the activity plans required in these themes when the themes are set as technical cooperation plans.

The basic system for implementing the technical cooperation will directly support NAPTIN. Improving and strengthening NAPTIN's training capabilities to enhance the DisCos' human resources and improve the DisCos' work implementation capabilities is expected to contribute to the improvement of the DisCos' business foundations. A pilot project for the DisCos will be set as a target for evaluation by reflecting the effect of support for NAPTIN in actual work. As a pilot project, it is assumed that the equipment performance will be improved by introducing new technology and that the work implementation capacity will be improved through OJT.

Table 6-1.2 Technical cooperation themes and activity plans to address the issues faced in improving the business foundation

Content that can support countermeasures / problems extracted from the PIP and survey	
Themes that can be cooperatively linked with the measures/problems	Project activity plan (Addressing the problems shown in Table 6-1.1)
1. Distribution planning for facility standardization	A. Development of facility planning standards
	B. Learning (improvement) of work methods based on specific examples
	C. Establishment of the concept of optimal facility formation
	D. Planning and design in consideration of maintenance work
2. Rationalization, dissemination, and compliance with design standards	Revision of design standards in consideration of the following viewpoints
	A. Facility design considering loss reduction and appropriate voltage
	B. Standardized design considering strength (safety factor) and the Nigerian Electrical Installation Guideline Manuals
	C. Thorough compliance with design standards (development of requirement examination tools)
	D. Implementation / grasping the effect of the pilot project adopting a multi-transformer system and low-loss transformer (amorphous transformer)

Content that can support countermeasures / problems extracted from the PIP and survey	
3. Improvements in work methods to achieve preventive maintenance	A. Review and enhancement of the patrol/inspection manual
	B. Establishment of a system for accumulating and analyzing maintenance data (Data-based, priority-oriented efforts)
	C. Establishment of work implementation discipline (thorough compliance with work procedures and requirements)
	D. Database-based scientific efforts through the introduction of various deterioration-detection devices (focusing on cost-effective issues)
	E. Development of a load management method for the distribution transformer using the feeder metering system by SCADA
	F. Nationwide deployment with the participation of NAPTIN instructors
4. Improvements in technology to reduce the fault recovery time	A. System configuration modification to reduce the fault location time (introduction of a sectionalizing switch, fault current indicator, location device by pulse reflection) / Construction of pilot facilities and verification of effectiveness
	B. Standardization for locating fault points / recovery procedures (technology transfer / developing manuals)
	C. Installation of simulated facilities at NAPTIN (20 poles, 9 switches, 3 circuit breakers)
	D. Skill-improvement training with NAPTIN-simulated facilities / Training for large-scale network by the NAPTIN simulator
	E. Nationwide deployment with the participation of NAPTIN instructors
5. Repair of defect-protection devices and training on relay setting / coordination	A. Repair of improper protection devices
	B. Training for relay setting and coordination according to the type of device repair
6. Improvements in substation maintenance works	A. Inspection work training at a simulated full-scale substation
	B. Development of maintenance manuals and standardization of work practices
	C. Lecture and training on inspection for each type of equipment
	D. Installation of a simulated substation (on the premises of NAPTIN)
7. Enhancement support for injection substation / TCN substation	A. Loans or grants for facility construction

Source: Created by the survey team

6-2 Proposal of a plan for implementing the technical cooperation project (technical aspects)

The themes that go the furthest in improving the business foundation of the DisCos are selected from among the technical cooperation themes and activity plans for addressing the issues faced in improving the management base (shown in Table 6-1.1). The ease with which the effects of the activities can be evaluated is also taken into account when selecting the themes. The proposed technical cooperation plan for the selected themes is indicated below.

According to the PIP of each DisCo, a high loss rate is cited as a major factor deteriorating the management of the distribution companies. The total distribution loss rate (total of technical loss, commercial loss, and tariff collection loss), that is, the ATC & C (Aggregate Technical, Commercial and Collection) Loss, averaged 52% for the 11 distribution companies in the first quarter of 2020. Tariff collection losses accounted for a large proportion of ATC & C Loss. One of the main factors contributing to the tariff collection losses was customer dissatisfaction caused by power outages.

As an example of the seriousness of the supply disruptions, EKO electricity distribution company (EKEDC), the company responsible for power distribution in Lagos, reported in an interview that its fault recovery time was 16 hours on average. Consequently, the DisCo customer has no choice but to accept long power outages when faults occur. The distribution system in Nigeria has very long fault recovery times, as the system lacks a facility configuration to minimize a fault section or enable early detection of a fault point. In addition, insufficient equipment maintenance has led to more frequent faults.

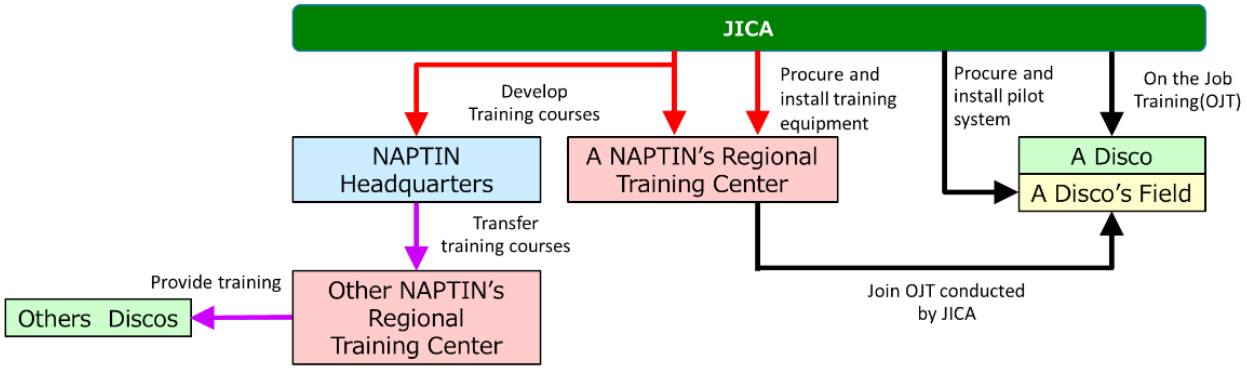
In response to the abovementioned background, "3. Improvements in work methods to achieve preventive maintenance" and "4. Improvements in technology to reduce fault recovery times" (indicated in Table 6-1.2) are proposed as technical cooperation themes. Work on those themes can improve the technical aspects of the business foundations.

6-2-1 System for implementing technical cooperation projects, and counterpart organizations

In order to directly express the effects of the project efforts, the project will be conducted under the implementation system shown in Figure 6-2.1. Of the companies with jurisdiction over the Abuja metropolitan area and Lagos province (AEDC, Abuja Electricity Distribution Company; IKEDC, Ikeja Electricity Distribution Company; EKEDC, Eko Electricity Distribution Company), the DisCo selected under the project will be AEDC for the following reasons. Two counterpart organizations will take part in the project: NAPTIN and AEDC.

- Since AEDC supplies electricity to the metropolitan area and is required to provide the highest reliability, the project effect can be expected to be larger in the area AEDC serves than in the other areas.
- AEDC’s supply area spreads from the urban area (FCT Abuja) into the suburbs and rural areas. AEDC therefore faces challenges in both urban and rural areas. Under this condition, it is easy to obtain universal knowledge about the method of approach and results of the project for nationwide deployment.

・ Since AEDC is located in the FCT Abuja and close to the NAPTIN headquarters, the Federal Ministry of Power, NERC, etc., it can easily communicate and collaborate with other organizations related to the power sector.



Source: Created by the survey team

Figure 6-2.1 Scheme for technical cooperation activities

6-2-2 Measures to improve the power supply reliability

In order to achieve the project goal of "improving supply reliability," the issue in the distribution sector that can be expected to have significant improvement effects is extracted. Table 6-2.1 shows the extracted issue alongside the related efforts and evaluation indexes.

Table 6-2.1 Issue and evaluation indexes expected to be improvable

Issue	Efforts	Evaluation indexes
Low supply reliability	Reducing the fault recovery time	Fault recovery time
	Implementing preventive maintenance of facilities	Number of faults

(1) Reducing the fault recovery time

Table 6-2.2 shows the specific activities for reducing the fault recovery time. The distribution system in Nigeria will be drastically modified to a configuration suitable for reducing the fault recovery time. The expected system configuration is shown in Figure 6-2.2. The expected system is equipped with automatic sectionalizing switches, a manual sectionalizing switch, drop-off fuses, fault current indicators, etc. for minimizing the fault section. And by appropriately combining these equipment components, a distribution system configuration suitable for the actual situation in Nigeria will be resolved. As this equipment is rarely installed in the current distribution system in Nigeria, AEDC takes an average of 6 hours to recover from a fault.

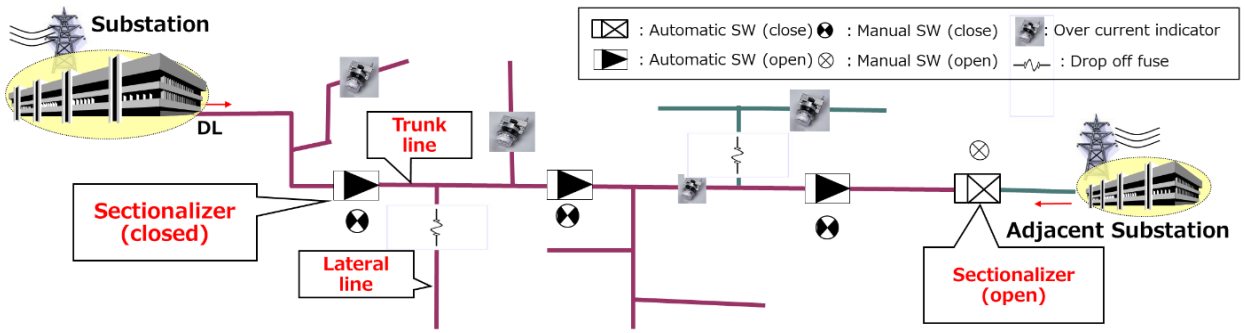
As part of the activity, first, the system configuration shown in Figure 6-2.2 will be constructed as the pilot project in the DisCo. In parallel with the introduction of this equipment, the introduction of a fault-detection device that can quickly determine the fault point will expedite the fault point location and restoration work to sound sections. The degree to which the recovery time is shortened by conducting system operations that integrate these technologies will then be verified. In the above

activities, this technology will be established by preparing a standard work manual in line with the implementation of on-site technical guidance as technology transfer. At the same time, that technical capabilities are expected to be maintained through technical training on practice by NAPTIN.

In order to deploy this technology throughout Nigeria, NAPTIN will work with the DisCos to develop training courses that are directly linked to practice. Since the training at NAPTIN is expected to be simulated on-the-job training using full-scale facilities, the development of training courses using the simulated distribution facilities to be constructed at NAPTIN is planned. The improvements attained in the technologies and skills of the DisCo engineers and technicians will lead to much faster responses to feeder faults.

Table 6-2.2 Summary of activities to reduce the fault recovery time

Counterpart	Method	Activities
DisCos	Pilot project	Construct and operate a reliable distribution system Evaluate the effect of the applied distribution system
	Technical transfer	Improve the method for locating a fault point and restoring the fault
	Capacity development	Develop/improve the standard work procedure manuals such as the operation manuals, design standards, installation manuals, etc. Dispatch technical staff to NAPTIN (participation in training)
NAPTIN	Technical transfer	Develop training courses that incorporate the contents of the technical transfer to the DisCos Conduct training for the 11 DisCos using the developed training courses
	Procurement of facilities	Procure and install a simulated distribution network for training (both overhead and underground lines and a mock substation)



Source: Created by the survey team

Figure 6-2.2 An example of a system configuration to which sectionalizing switchgears are applied

(2) Implementation of preventive maintenance for facilities

Table 6-2.3 shows the specific activities for preventive maintenance of the facilities (substation / distribution). Distribution facility faults and personal injuries often occur in Nigeria due to aging facilities and inadequate maintenance. To solve this problem, it will be necessary to prevent distribution facilities faults and eliminate dangerous parts by carrying out reliable maintenance work without fail. To meet this condition, the project will conduct the following activities.

The activities for the DisCos include the following: improving work implementation methods, on-site guidance aimed at the accumulation and analysis of data and know-how related to patrol/inspection

work, and developing/improving the work manuals.

NAPTIN, meanwhile, will develop training courses that reflect the activities at the DisCos. In developing the courses, NAPTIN should cooperate with the DisCos and keep in mind that the training content should reflect the key points of their practical work. In addition, a simulated substation used in the abovementioned training will be constructed on the premises of the NAPTIN headquarters in Abuja. This simulated substation will be used to conduct on-the-job training on substation maintenance work (patrol, inspection, equipment testing, etc.).

Furthermore, the measuring instruments required for other distribution line maintenance work will be procured.

Table 6-2.3 Summary of activities to introduce preventive maintenance

Counterpart	Method	Activities
DisCo	Technical transfer	Develop inspection/patrol manuals Develop work procedures to accumulate and analyze maintenance data
	Capacity development	Execute operation and maintenance works in compliance with the manuals and standard work procedures Detect facility defects using the deterioration data accumulated Improve inspection work by introducing deterioration-detection devices Manage the loading of the distribution transformers using the distribution line metering system
NAPTIN	Technical transfer	Develop training courses on standardized work procedures, data analysis to detect deterioration of equipment, maintenance planning, etc. Carry out the training developed through the project for the DisCos
	Facility construction	Procure and install simulated facilities for training (distribution facilities, injection substation, etc.)

6-3 Recommendations Related to Bill Collection and Customer Relations

6-3-1 NAPTIN

(1) Development and improvement of training courses through dialogs with the DisCos through the Association of Nigerian Electricity Distributors (ANED)

NAPTIN takes pride in being the leader of training institutes of the power sector in Nigeria. It tends to be authoritarian, and its training courses might acquire a product-out quality, with little concern for the needs of the trainees. NAPTIN should always make efforts to make its training courses more practical and effective with a view to actually contributing to the performance improvement of the DisCos. As an example of the current situation, the course outline for the "Customer Relations Excellency Course" lists "understanding customer requirements" as one of the course objectives, and lists "middle- to high-ranking managers in charge of customer relations" as the target trainees. It is the middle- to high-ranking managers who receive customer complaints on a daily basis and are expected to provide reasonable explanations on the circumstances that prevent the DisCos from meeting the customers' requirements or solving the customers' problems. As such, the lecturer in the training course is expected to teach the principles underlying customer requirements. Besides, AEDC's plan for its training course for customer care/attention (mentioned in Chapter 5, Section 5-10) includes modules on "how to understand customers' emotions" and "how to communicate with irritating customers." The difference in the practicability of the two training courses is quite obvious.

It will be necessary for NATIN to fully take the DisCos' needs into account through ANED-mediated consultations and discussions with the DisCos.

(2) Making Training Courses More Practical by Introducing Case Studies and Exercises

To raise the bill collection rate or improve customer relations, it is often necessary to flexibly respond to the actual situations. While lectures on theories and principles are important, more practical training focused on the introduction of case studies and exercises is essential. Such training will enable trainees to actually raise their bill collection rates and improve their customer relations after the training courses in their workplaces.

(3) More Effective Utilization of External Resources

Many of the lecturers and staff members in charge of training course development seem to lack experience in bill collection or customer service. It can be argued that knowledge alone about an actual situation or experience cannot make a good lecturer. To make utmost use of the capacity for the development of training courses and implementation of the training, NAPTIN should more effectively use external persons who have tangible experience in raising bill collection rates and improving customer relations.

(4) Enhancement of Training Management (Improvement in the Development of Curriculums and Training Materials, the Management Training Portal Site, etc.)

The course names in the questionnaire answer sheets from the survey team and those in the NAPTIN Training Portal Site were not exactly the same. When the survey team requested lists of training materials, NAPTIN sent the actual training materials instead of the lists. With the materials alone, the survey team could not ascertain whether NAPTIN develops curriculum and training materials by training course or by module. It would be more efficient to develop and improve the curriculum and training materials by module, and then to combine the curriculum and training materials thus developed and improved.

Many of the training courses offered through NAPTIN's Training Portal Site have little to no course descriptions. There are also discrepancies between the content of the Training Portal Site and content on the Training Calendar on NAPTIN's website. The Training Portal Site will be an important information source for prospective trainees.

NAPTIN will need to enhance its training management, i.e., its management of curriculum / training material development and improvement, and its management of the Training Portal Site itself.

6-3-2 AEDC (Abuja DisCo)

(1) Conducting Training for OJT Trainers and Developing an Off-JT Taring Course for Bill Collection

AEDC conducts only simple OJT regarding bill collection, the most essential element of the business management of AEDC. OJT is critically important to raise the bill collection rate, and training for the OJT trainer is an immediate need for AEDC. Judging from the current capacity of AEDC, it is recommended that AEDC dispatch a prospective OJT trainer to Train-the-Trainers for training conducted by an external organization, such as NAPTIN. It is also recommended that AEDC jointly develop an Off-the-Job-Training (Off-JT) course with an external organization. A combination of OJT and Off-JT would be effective in raising the bill collection rate.

(2) Realizing the Plan for the Training on Customer Services

The plan for the training on customer services (outlined in Chapter 5, Section 5-10) can be evaluated as practical and useful for improving customer relations. Training courses should be developed and implemented based of the existing plan. Two types of training courses will be required: one for training the AEDC trainers and another conducted by the AEDC trainers for training the AEDC customer service staff. With these two types of training, AEDC can improve customer relations in all areas of its franchise.

(3) Effective Use of External Resources for the Improvement of Training on Bill Collection and Customer Services

AEDC has few sufficient staff members with abundant experience in developing, conducting, or

improving training. It will be essential for AEDC to have good partners to work with in the development and implementation of the training to raise the bill collection rate and improve customer relations. NAPTIN may be the best candidate partner.

(4) Developing a System for Responding to Customers through Interaction between the Customer Service Section and the Sections Assigned to Problem Solving and Troubleshooting

The best approach to improving customer relations and responding to customer complaints is to solve the problems that cause the customer complaints. As it may take substantial time to solve such problems, the customer service staff needs to explain the countermeasures being taken by the sections in charge of solving the problems and preempting future problems. The customer service staff should be supported with real-time information provided by those section. The development of a coordinated system that enables real-time information exchange between the customer service section and the sections in charge of solving the problems and preempting future problems is a recommended approach to improving customer relations.

Appendix-1 Member List of the Study Team

(1) First Work in Japan

Name	Assignment	Organization
Kyoji FUJII	Chief Consultant/ Power Development Planning	Yachiyo Engineering Co., Ltd.
Takamu GENJI	Distribution Planning	Yachiyo Engineering Co., Ltd. (NEWJEC Inc.)
Hiroki KAJINO	Substation Planning	Yachiyo Engineering Co., Ltd.
Naoki HARA	Economic Evaluation/Management and Business Administration	Yachiyo Engineering Co., Ltd.
Masataka SATO	Assistant to Distribution Planning / Coordinator	Yachiyo Engineering Co., Ltd.

(2) First Field Survey in Nigeria

Name	Assignment	Organization
Kyoji FUJII	Chief Consultant/ Power Development Planning	Yachiyo Engineering Co., Ltd.
Takamu GENJI	Distribution Planning	Yachiyo Engineering Co., Ltd. (NEWJEC Inc.)
Naoki HARA	Economic Evaluation/Management and Business Administration	Yachiyo Engineering Co., Ltd.

Appendix-2 Study schedule

(1) First Field Survey

No.	Date		Fujii (Team Leader/ Technical)	Genji (Distribution)	Hara (Non-technical)	Remark	Place of Stay
1	9/7	Tue.	Narita (22:30)→Doha(04:00+1) QR807	Same as left	Same as left		on board
2	9/8	Wed.	Doha (08:00)→Abuja (16:25) QR1417	Same as left	Same as left		Abuja
3	9/9	Thu.	10:00~ [NAPTIN-Online] - Explanation of Interim Report - Clarification of answers to the questionnaire 12:00~ [AEDC-Online] - Explanation of Interim Report - Clarification on answers to the questionnaire	Same as left	Same as left	1st day of quarantine	Abuja
4	9/10	Fri.	12:00 [AEDC, Online] - Discussion on Answers to the Questionnaire 15:00~ 16:00 [AFD, Online] - Interview on Progress of vocational training project for NAPTIN	Same as left	Same as left	2nd day of quarantine	Abuja
5	9/11	Sat.	Internal Meeting	Same as left	Same as left	3rd day of quarantine	Abuja
6	9/12	Sun.	Internal Meeting	Same as left	Same as left	4th day of quarantine	Abuja
7	9/13	Mon.	10:00 [NAPTIN, Online] - Data collection on technical training courses for electricity distribtion 13:00~13:30 [World Bank, Online] - Interview on Progress of DISREP PM [ANED, Online] - Data collection on technical/non-technical training courses for electricity distribtion	Same as left	10:00-12:00 **NAPTIN** (with Persons in charge of Non-technical Training and Programme Development, on Contents of trainings for Raising Bill Collection Rate and Improvement of Customer Relations・Employment of External Trainers) 14:00-16:00 **ANED** (with Persons in charge of Capacity Development of DisCos, on ANED's support to DisCos for Raising Bill Collection Rate and Improvement of Customer Relations・Traing Needs of DisCos for the Purposes・Opinions regarding NAPTIN's Training Courses for the Purposes, Intension for Coordination with NAPYTIN for the Purposes)	5th day of quarantine	Abuja
8	9/14	Tue.	10:00~12:00 [NERC, Online] Data collection on the approved PIP and Disco's CAPEX Plan PM [AEDC, Online] Follow up to the answer to the questionnaire	Same as left	10:00-12:00 **NERC** (with persons in charge of the topics of the interview, on Provisions to JICA Team of final PIP and Investment Plans of DisCos・Major modifications from draft PIPs・Plans of Minor Review of the Tariff・Response to Customer Complaints by NERC) 13:30-15:30 **AEDC** (with Persons in charge of Bill Collection and Customer Relations and Training staff for Raising Bill Collection Rate and Improvement of Customer Relations, on Reasons why Commercial/Collection Loss is not reduced・AEDC's approaches for Raising Bill Collection Rate and Improvement of Customer Relations)	6th day of quarantine	Abuja
9	9/15	Wed.	[AEDC, Online] Follow up to the answer to the questionnaire PM: COVID Test	Same as left	10:00-12:00 **NAPTIN** (with Persons in charge of Non-technical Training and Programme Development, on Recognition of problems of DisCo for Raising Bill Collection Rate and Improvement of Customer Relations・Grasping Training Needs of DisCos for the Purposes・Discissions with DisCos for the Improvement of Training Courses of NAPTIN for the Purposes) PM: COVID Test	7th day of quarantine	Abuja
10	9/16	Thu.	AM: Analysis of Collected Data/Information PM [PHED, Online] Tentative Operation, maintenance, fault recovery work, etc.	Same as left	13:00-16:00 Port Harcourt DisCo (with Persons in charge of Bill Collection and Customer Relations and Training staff for Raising Bill Collection Rate and Improvement of Customer Relations, on Reasons why Commercial/Collection Loss is not reduced・PHEDC's approaches for Raising Bill Collection Rate and Improvement of Customer Relations ・Status of Training by PHEDC for the Purpoises・Participation to NAPTI's Training Courses for the Purposes ・Opinions regarding NAPTIN's Training Courses for the Purposes ・Improvement Plan of PHED'sTraining Courses for the Purposes ・Expectation to NAPTIN)	End of quarantine	Abuja
11	9/17	Fri.	10:00~12:00 [NAPTIN@Headquarters] (1) Progress of AFD assistance project (2) Details of disctibution training courses (Distribution loss reduction, distribution network planning, substation maintenance, distribution equipment maintenance, falut recovery, etc.)	Same as left	10:00-12:00 **NERC** (with persons in charge of the topics of the interview, on Status of enforcement of MAP Regulation・Problems on enforcement of the Regulation・Measures to solve the Problems, Supports by NERC to DisCos for Raising Bill Collection Rate and Improvement of Customer Relations) 13:30-15:30 **AEDC** (with Persons in charge of Bill Collection and Customer Relations and Training staff for Raising Bill Collection Rate and Improvement of Customer Relations, on Status of Training Courses by AEDC for the Raising Bill Collection Rate and Improvement of Customer Relations・Participation to NAPTI's Training Courses for the Purposes ・Opinions regarding NAPTIN's Training Courses for the Purposes ・Improvement Plan of AEDC'sTraining Courses for the Purposes ・Expectation to NAPTIN)	1st day of field survey	Abuja
12	9/18	Sat.	Internal Meeting	Same as left	Same as left	2nd day of field survey	Abuja
13	9/19	Sun.	Internal Meeting	Same as left	Same as left	3rd day of field survey	Abuja
14	9/20	Mon.	10:00~ [NAPTIN] - Visit NAPTIN's existing training equipment and candidate site for a model substation - How to obtain ANED's attestation for distribution training courses - NAPTIN Kainji regional training center joins the meeting via online	Same as left	**Tentative** Nontechnical meeting with **NAPTIN** 13:30～15:30 **AEDC** (with Persons in charge of Bill Collection and Customer Relations and Training staff for Raising Bill Collection Rate and Improvement of Customer Relations, on Additional Interviews or Data/Information Collectioon・Confirmation of result of interviews and discussions)	4th day of field survey	Abuja
15	9/21	Tue.	AM/ PM [AEDC] (1) AEDC's effort to reduce unplanned outage and shorten falut recovery time (responsible organization, work procedure, etc. (2) Organization and work procedure for maintenance, data management system for effective maintenance (3) Standards, manuals for maintenance	Same as left	10:00-12:00 **pwc Nigeria** (with Persons related to services to DisCos, on Status of services by pwc Nigeria for Performance Improvement of DisCo's performance, availability of experiences and know-how on Raising Bill Collection Rate and Improvement of Customer Relations of pwc of other countries in Nigeria) 13:30～15:30 **NERC** (with Persons interviewed so far, on Additional Interviews or Data/Information Collectioon・Confirmation of result of interviews and discussions)	5th day of field survey	Abuja
16	9/22	Wed.	AM/ PM [AEDC] (1) Site survey (Current situation of distribution network and substation, network configuration and autoreclosers) NAPTIN counterparts will join the site survey	Same as left	Same as left or Spare day	6th day of field survey	Abuja
17	9/23	Thu.	AM/ PM [AEDC] (1) Site survey (Current situation of maintenance works, fault recovery procedure, fault locating device) NAPTIN counterparts will join the site survey (2) Outline of distribution automation system (If any)	Same as left	Same as left or Spare day	7th day of field survey	Abuja
18	9/24	Fri.	Follow up discussion on ANED's training courses	Same as left	Same as left	8th day of field survey	Abuja
19	9/25	Sat.	Preparation of the Final Report	Same as left	Same as left	9th day of field survey	Abuja
20	9/26	Sun.	Preparation of the Final Report	Same as left	Same as left	10th day of field survey	Abuja
21	9/27	Mon.	Preparation of the Final Report	same as left	same as left	11th day of field survey	Abuja
22	9/28	Tue.	Preparation of the Final Report	same as left	same as left	12th day of field survey	Abuja
23	9/29	Wed.	10:00 Wrap up Meeting (NAPTIN) 13:00 Wrap up Meeting] (AEDC)	same as left	same as left	13th day of field survey	Abuja
24	9/30	Thu.	AM: COVID Test PM: Report to JICA Nigeria Office	same as left	same as left	14th day of field survey	Abuja
25	10/1	Fri.	Abuja (17:55)→	same as left	same as left	15th day of field survey	on board
26	10/2	Sat.	→Doha(05:15)	Same as left	Same as left		Doha
27	10/3	Sun.	Doha (0230)→Narita (18:55) QR806	Same as left	Same as left		

Appendix-3 List of Parties Concerned in the Recipient Country

Federal Ministry of Power (FMP)

Engr. Briskilla Sapke	Director of Distribution
Engr. Iyiola M. Olaniyi	Chief Electrical Engineer
Mr. Ogunfeyimi Gbadebo Jacob	Principal Technical Officer
Mr. David Joshua	Higher Technical Officer

Nigerian Electricity Regulatory Commission (NERC)

Engr. Sanusi Garba	Chairman
Mr. Oseni Musiliu	Commissioner
Mr. Bassey N. Ayambem	General Manager, Planning, Research and Strategy Division
Mr. Zubair Babatunde	Assistant General Manager

Association of Nigerian Electricity Distributors

Mr. Rotimi Adebari	Manager, Project Coordination
Mr. Akin Akinpelu	Technical Specialist
Mrs. Mayo Fadel	Project Coordinator

National Power Training Institute of Nigeria (NAPTIN)

Mr Ahmed Bolaji Nagode	Director General
Mr Olalekan Oregbesan	Head of IT
Mr Yusuf Khalil	Team Lead NAPTIN
Mr Muazu Aminu	Acting Director Training Prgrammes
Mr Okeke Chudulum	Technical Adviser To Director General
Mr Mabi Swomen	Assistant Director Public Affairs
Mr Kunle Oyenusi	Project Manager AFD Procurement
Mrs Felicia E. Uzuakpundu	Head Customer Service
Mr Akinyele Felix	Chief Executive Officer Accounts

Abuja Electricity Distribution Plc. (AEDC)

Dr. Ernest Mupwaya	Managing Director
Mr Bode Longe	General Manager Strategy And Corporate Planning
Engr Mike A. Ezugwu	Senior Manager Technical Services
Mr Andy Mba	Head of Control Center System
Mr Ugwoke Uchenna	Control System Engineer
Peter Ibeziako	Control System Engineer
Engr Yusuff Mudi	Control System Engineer
Engr Pomel	Regional Technical Service
Engr Razak Rahimi	Distribution System Operator

Ikeja Electric Plc. (IKEDC)

Mr. Abisola Oshinusi	Governance & Compliance
Mr. Jide Kumapayi	
Mr. Oladele daramola	
Mr. Olatayo Olalere	

Eko Electricity Distribution Plc. (EKEDC)

Mr Kamaldeen Saadu	Head of Department, Network Planning | Technical Services
Mr. Jonathan Lawani	Head of Department, Projects
Mr. Adewumi David	Executive Consultant (Projects)
Mr. Ukachi Agoha	

Port Harcourt Electricity Distribution Plc. (PHED)

Mr. Franklin Ajaegbu	Head, Special Projects
Mr. Canice Emeka	
Mr. Amon Galloway	
Mr. Joseph Titilope	
Ms. Noelle Okwedy	

French Development Agency (AFD)

Mr. Adesoji Ademola	Project manager Energy/Transport

The World Bank Group (WB)

Ms. Nataliya Kulichenko	Lead Energy Specialist
Mr. Muhammad Abba Wakil	Senior Energy Specialist

Confidential

Wrap Up Meeting
On
Data Collection Survey for Performance Improvement of Distribution Companies in the Federal Republic of Nigeria

September 2021

YACHIYO ENGINEERING CO., LTD., JAPAN

八千代エンジニヤリング株式会社

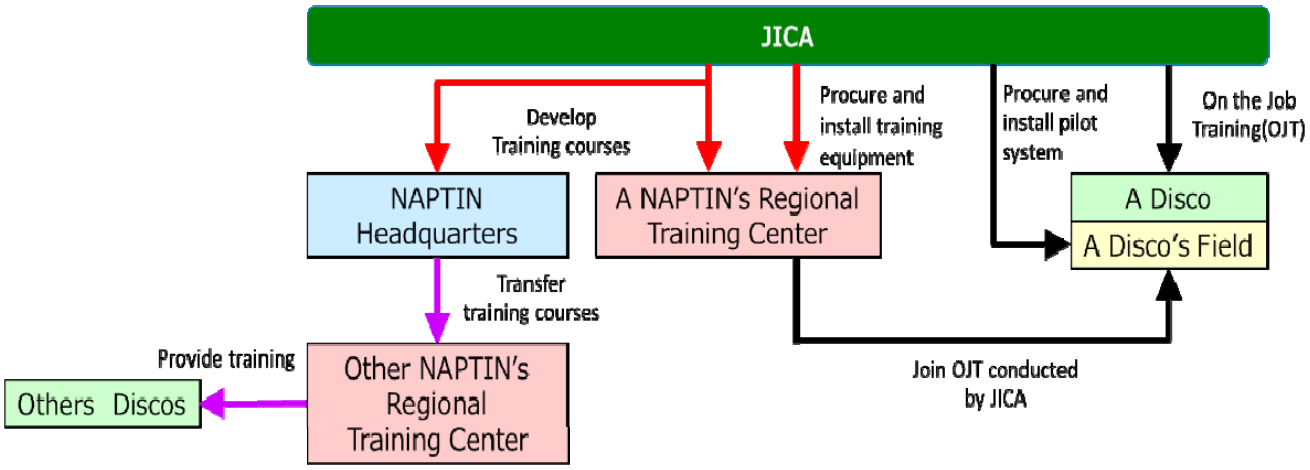
Contents

1. JICA's assistance for power sector in Nigeria

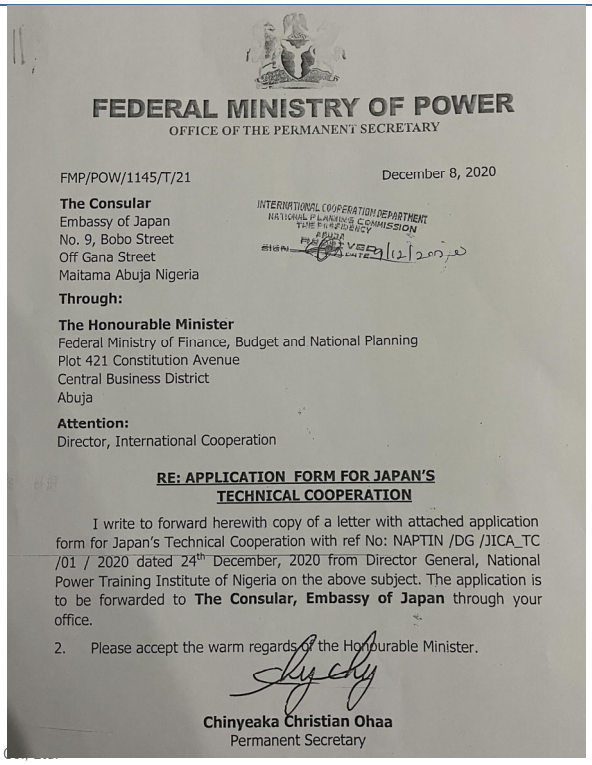
JICA (Japan International Cooperation Agency) is an executing agency of Japan's Official Development Assistance.

Year	Name of project	Type
2000~2002	The Project for Rural Electrification Phase 1-3 (In Borno, Bauchi, Gombe and Nasarawa states)	Grant aid
2006~2008	The project for Rural Electrification in Cross River and Akwa Ibom States Phase 1-3	Grant aid
2011	The Project for Emergency Repair and Overhaul Works for the Jebba Hydro Power Station	Grant aid
2012	The Project for Introduction of Clean Energy by Solar Electricity Generation System	Grant aid
2016	The Project for Emergency Improvement of Electricity Supply Facilities in Abuja (Apo and Keffi substation)	Grant aid
2018	The Project for Emergency Rehabilitation and Reinforcement of Lagos Transmission Substations	Grant aid
2019	The Project for Master Plan Study on National Power System Development	Technical cooperation

2. Structure of proposed technical cooperation



Application for Japan's technical cooperation



FEDERAL MINISTRY OF POWER
OFFICE OF THE PERMANENT SECRETARY

FMP/POW/1145/T/21 December 8, 2020

INTERNATIONAL COOPERATION DEPARTMENT
NATIONAL PLANNING COMMISSION
THE PRESIDENCY
ABUJA
SIGN
DATE 8/12/2020

The Consular
Embassy of Japan
No. 9, Bobo Street
Off Gana Street
Maitama Abuja Nigeria

Through:

The Honourable Minister
Federal Ministry of Finance, Budget and National Planning
Plot 421 Constitution Avenue
Central Business District
Abuja

Attention:
Director, International Cooperation

RE: APPLICATION FORM FOR JAPAN'S TECHNICAL COOPERATION

I write to forward herewith copy of a letter with attached application form for Japan's Technical Cooperation with ref No: NAPTIN /DG /JICA_TC /01 / 2020 dated 24th December, 2020 from Director General, National Power Training Institute of Nigeria on the above subject. The application is to be forwarded to **The Consular, Embassy of Japan** through your office.

2. Please accept the warm regards of the Honourable Minister.

Chinyeaka Christian Ohaa
Permanent Secretary

(Sheet 2-1.)

APPLICATION FORM FOR JAPAN'S TECHNICAL COOPERATION

1. **Date of Entry**: Day 08 Month 12 Year 2020
2. **Applicant**: The Government of Nigeria
3. **Technical Cooperation (T/C) Title**: The project for capacity development of power distribution companies in the Federal Republic of Nigeria
4. **Type of the T/C** ※**Select only one scheme.**

■ Technical Cooperation Project / Technical Cooperation for Development Planning
□Science and Technology Research Partnership for Sustainable Development (SATREPS)

□ Individual Expert □ Individual Training □ Equipment

5. **Contact Point (Implementing Agency):** National Power Training Institute of Nigeria (NAPTIN)
   Address: Plot 21, Cadastral Zone, Idu Industrial Area, Mbora District, FCT, Abuja, the Federal Republic of Nigeria
   Contact Person: Mr. A. B. Nagode, Director General
   Tel. No.: +234 803 394 7153 Fax No.
   E-Mail: abnagode@naptin.gov.ng
6. **Background of the T/C**

(1) Government policy

The Federal Government has been implementing the Economic Recovery and Growth Plan (ERGP 2017-2020) to restore macroeconomic stability and achieve sustained inclusive growth through a structural economic transformation, after the recession in 2016 which was led by the collapse of global oil prices.

The ERGP has five (5) Key Executive Priorities outlined below. Energy sufficiency is one of the priority areas which the ERGP aims to address.

- Stabilizing the macroeconomic environment
- Achieving agriculture and food security
- Ensuring energy sufficiency (power and petroleum products)
- Improving transportation infrastructure
- Driving industrialization on small and medium scale enterprises

3. Findings and countermeasures for challenges (Technical issues)

Current status and issues in the distribution sector

(Issues confirmed in this basic survey)

1

Major challenges of the sector	Current status of AEDC
1. High loss rate (loss reduction)	1-1. ATC&C Loss : 46% 1-2. Technical Loss : 11.72%
2. Low reliability	2-1. Frequent faults (times) : 4.2/Feeder/Year 2-2. Long recovery time: 88% (Rate of Faults cleared within 8 hours (2019)) 2-3. “8 hours” is much longer than in other countries
3. Low supply quality	3-1. Low supply voltage : 206V (Receiving Average) 3-2. Less effective voltage regulation methods 3-3. Long low voltage feeders *Allowable range:216.2～243.8 V)*
4. Lack of supply capacity / Low utilization rate	4-1. Utilization of a feeder: Around 50% loading (Bottlenecks anywhere except generation capacity ?)
5 . Network and grid operation issues	5-1. Less sectionalizing methods in a feeder except jumper connection 5-2. No fuse at distribution transformers (Example) 5-3. Lack of appropriate distribution planning and design
6 .Problems in the way of conducting O&M works	6-1. Many problematic facilities to be improved in maintenance work are left

Current status of AEDC	Countermeasures (Proposals of survey team)
1-1. ATC&C Loss : 46% 1-2. Technical Loss : 11.72%	1-1. Reconfiguration of LV system (Change to small trafo.) 1-2. Appropriate distribution substation placement 1-3. Upgrading of conductors 1-4. Improving quality of jointing overhead conductors
2-1. Frequent faults(times) : 4.2/Feeder/Year 2-2. Long recovery time: 88% (Rate of Faults cleared within 8 hours (2019)) 2-3 “8 hours” is much longer than in other countries	2-1. Change system configuration for quick sectionalizing 2-2. Improving pinpoint fault location using detecting instrument 2-3. Apply more efficient locating procedure with above device
3-1. Low supply voltage : 206V (Receiving Average) 3-2 Less effective voltage regulation methods 3-3 Long LV feeders	3-1. Same as item 1-1 ～ 1-4 （mentioned above） 3-2. Installing AVR on each transformer of injection substation
4-1. Utilization rate of a feeder: Around 50% loading (Bottlenecks anywhere except generation capacity ?)	4-1. Appropriate distribution planning 4-2. Standardization of network design
5-1. Less sectionalizing methods in a feeder except jumper connection 5-2. No fuse at distribution transformers (Example) 5-3. Lack of appropriate distribution planning	5-1. Same as item 4-1 and 4-2 5-2. Appropriate initial design (e.g., pole strength)
6-1. Many problematic facilities to be improved in O&M works are left	6-1. Creating an easy-to-understand maintenance work manual 6-2. Accumulation, analysis, and inheritance of maintenance data to contribute business improvement 6-3. Thorough correction discipline based on the above

2

3

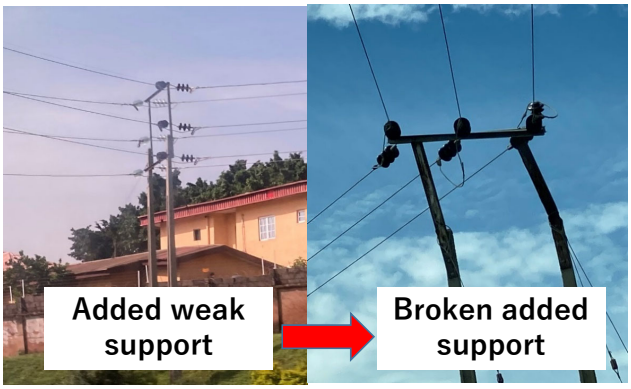
Current status of NAPTIN addressing issues in the distribution sector and enhancement proposals

Major challenges of the sector	Current status of NAPTIN (Training courses addressing the major issues)	Enhancement proposal for NAPTIN
1. High loss rate (loss reduction)	1-1. DISTRIBUTION NETWORK POWER LOSS MANAGEMENT COURSE 1-2. ENERGY AUDITING & LOAD MANAGEMENT C4	1. Improving the training contents to deal with technical issues in the actual work of DisCos (Specialized reducing technical losses)
2. Low reliability	2-1. POWER DISTRIBUTION NETWORK MAINTENANCE AND REPAIRS 2-2. DISTRIBUTION LINE CONSTRUCTION AND MAINTENANCE・MODULE I・MODULE 2 2-3. TRANSFORMER & SWITCHGEAR MAINTENANCE 2-4. DISTRIBUTION NETWORK DISPATCH AND EMERGENCY RESPONSE	2. Development of training courses aimed at improving skills for quick fault recovery (Practical training)
3. Low supply quality	3-1. POWER DISTRIBUTION NETWORK DESIGN & OPERATIONS 3-2. PLANNING & CONSTRUCTION OF DISTRIBUTION NETWORK	

4

Major challenges of the sector	Current status of NAPTIN (Training courses addressing the major issues)	Enhancement proposal for NAPTIN
4. Lack of supply capacity / Low utilization rate	4-1. Same as item 3-1 and 3-2	
5. Network and grid operation issues	5-1. DISTRIBUTION NETWORK OPERATIONS & MAINTENANCE 5-2. BASIC POWER SYSTEM PROTECTION - P1 5-3. DISTRIBUTION NETWORK PROTECTION COURSE 5-4. POWER SYSTEMS PROTECTION COURSE TECHNICAL	
6.Problems in the way of conducting distribution network planning, operation and maintenance	6-1. Lack of the course contents	6. Improving the training contents to deal with technical issues in the actual maintenance work of DisCos (aiming at high quality and ensured maintenance work)

Lack of correct discipline leads to following conditions



huge number of manual jointing conductor

YACHIYO Engineering

4. Findings and recommendations (Non-technical issues)

Recommendations to non-technical training for AEDC (1)

1. Development of Training on Bill Collection
   Recommendations: Develop and conduct of training of trainers (TOT) of OJT and Off-JT, using external resources such as NAPTIN
   Current Situation:
   * Current training on bill collection is limited to OJT (knowledge transfer)
   * Limited training resources of AEDC
2. Development of Training on Customer Relations based on the existing Proposal
   Recommendation: Developing AEDC's plan into practices, using external resources such as joint development with NAPTIN
   Current Situation:
   * AECD has a well considered proposal for Training on Customer Relations

Recommendations to non-technical training for AEDC (2)

3. Development of a System for Responding to Customer Complaints
   Recommendations: Develop a System for Responding to Customer Complaints by information exchange and interaction between Customer Service Team and Technical Team that is combating against the problems that cause the Complaints within a DisCo.
   For example: In case a complain in interruption arises, the Customer Service Team can know how the Technical Team is resolving the Interruption and easily explain to the Customer through the System.
   Current Situation:
   * Complaints from Customers are not resolved until the Customer understands how DisCos are combating against the problems.

Recommendations to non-technical training for NAPTIN (1)

1. Avoiding duplication with AFD Project and promoting synergy with the Project
2. Improvement in existing course on Bill Collection

   Recommendation: More Practical Training Course leading to better training (includ. OJT) of DisCos and higher bill collection rate, introducing Case Studies, inviting NERC and other external resources

   Current Situation:

   * Request for direct assistance to DisCos
   * Low willingness-to-pay for NAPTIN's tuitions
   * NAPTIN teaches principles (ex. "customers requirements") only.
   * NAPTIN does not have actual experiences of bill collection.
   * NAPTIN has less training resources for non-technical training compared to that for technical training

Recommendations to non-technical training for NAPTIN (2)

3. Improvement in existing Course on Customer Relations

   Recommendation: More Practical Training leading to better training of DisCos and better customer relations through co-development with DisCos, introducing Case Studies, inviting NERC and other eternal resources

   Current Situation:

   * DisCos have experiences and plans of training on Customer Relations
   * Low willingness-to-pay for NAPTIN's tuitions
   * NAPTIN teaches principles (ex. "customers requirements") only.
   * NAPTIN does not have actual experiences of customer relations.
   * NAPTIN has less training resources for non-technical courses compared to that for technical
4. Improvement in Training Management

   Recommendation:

   ✓ More close, effective and practical cooperation with DisCos
   ✓ Effective use of external resources
   ✓ More effective use of the training portal of NAPTIN

Appendix-5. List of the Acquired Reference Materials and Data

No.	Name	Form Book/Data/Map/Photograph etc.	Original･Copy	Issue Authority	Issue Year
1	NIGERIAN ELECTRICAL INSTALLATIONS AND CONSTRUCTION GUIDELINES MANUAL	Book	Original	NEMSA	2020
2	2021 TRAINING CALENDAR	Book	Original	NAPTIN	2021
3	ANNUAL REPORT 2020	Book	Original	NAPTIN	2020
4	NAPTIN 2019-2021 CAPITAL PLAN PROPOSAL ONGOING PROJECT	Data	Copy	NAPTIN	2021
5	TRAINING CALENDAR 2020	Data	Copy	NAPTIN	2020
6	CASH FLOW STATEMENT FOR THE YEAR ENDDED 31st DECEMBER, 2014 TO 2019	Data	Copy	NAPTIN	2020
7	TRAINERS OF DISTRIBUTION SECTOR	Data	Copy	NAPTIN	2014
8	NAPTIN DISCOs RELATED COURSES CONDUCTED 2009 – 2019	Data	Copy	NAPTIN	2020
9	Nos Trainees Total DisCos Non-technical Course 2014-2019	Data	Copy	NAPTIN	2020
10	Syllabus/Profile of the Training Courses	Data	Copy	NAPTIN	2021
11	TECHNICAL FOR NON-TECHNICAL COURSE: ELECTRICAL POWER SYSTEM NETWORK OVERVIEW	Book	Copy	NAPTIN	-
12	BASIC POWER RELAYING PROTECTION COURSE - P1 (MANUAL)	Book	Copy	NAPTIN	-
13	Text of Non-technical Course	Book	Copy	NAPTIN	-
14	Syllabus: Metering and Revenue Protection Course	Book	Copy	NAPTIN	-
15	NOS OF TRAININGS FOR TECHNICAL AND NON-TECHNICAL COURSES	Data	Copy	NAPTIN	2018

No.	Name	Form Book/Data/Map/Photograph etc.	Original･Copy	Issue Authority	Issue Year
16	SYSTEM DISTRIBUTION LINES MAINTENANCE COURSE, MODULE 1, MODULE 2	Book	Copy	NAPTIN	-
17	BRIEF PROFILES OF INSTRUCTORS	Data	Copy	NAPTIN	2021
18	Quarterly Report SECOND QUARTER 2017	Book	Copy	NERC	2017
19	Grid Code-Version 02	Book	Copy	NERC	-
20	Distribution Code-Version 02	Book	Copy	NERC	-
21	Metering Code-Version 02	Book	Copy	NERC	-
22	Electricity Health and Safety Code	Book	Copy	NERC	2014
23	Market Rules	Book	Copy	NERC	2014
24	NESIS-Regulations	Book	Copy	NERC	2015
25	Demography & Organization	Data	Copy	AEDC	-
26	Number of Trainings and participants between June 2019- June 2020	Data	Copy	AEDC	2020
27	TRAINING NEEDS	Data	Copy	AEDC	2020
28	AEDC’s ANED Certification Guidelines	Book	Copy	AEDC	2019
29	MAP Metering progress	Data	Copy	AEDC	2020
30	Integrated Commercial Management System (InCMS)	Book	Copy	AEDC	2019

No.	Name	Form Book/Data/Map/Photograph etc.	Original･Copy	Issue Authority	Issue Year
31	Metered Population Data Request 2016-2020	Data	Copy	AEDC	2021
32	AEDC's fixed asset register (Facility management system)	Data	Copy	AEDC	2020
33	GIS (Facility management system)	Data	Copy	AEDC	2020
34	Single Line Diagram	Data	Copy	AEDC	2017
35	ANNUAL PREVENTIVE MAINTENANCE PLAN/MANUAL	Book	Copy	AEDC	2020
36	Training of technical staff.	Data	Copy	AEDC	-
37	Energy (MWh) Delivered by Area Office 2016 - 2019	Data	Copy	AEDC	2019
38	Peak demand of each injection substation	Data	Copy	AEDC	-
39	Number of Injection points	Data	Copy	AEDC	-
40	Power Outage report	Data	Copy	AEDC	2019
41	Actual faults report	Data	Copy	AEDC	2019
42	Planned power outage implementation method	Book	Copy	AEDC	2018
43	SAIDI, SAIFI 2014-2018	Data	Copy	AEDC	2019
44	132kV Transformer Capacity	Data	Copy	AEDC	-
45	2020 – 2024 PERFORMANCE IMPROVEMENT PLAN	Book	Copy	AEDC	2019

No.	Name	Form Book/Data/Map/Photograph etc.	Original･Copy	Issue Authority	Issue Year
46	Technical services - organizational structure	Data	Copy	AEDC	-
47	ANED Training Courses Needs	Data	Copy	AEDC	-
48	AEDC Training Needs 2020	Data	Copy	AEDC	2020
49	Training Proposal for Building a Customer-Centric AEDC	Book	Copy	AEDC	-
50	TECHNICAL SERVICES PROCEDURE MANUALS	Book	Copy	AEDC	2020
51	Auto-recloser with Geographic Coordinates	Data	Copy	AEDC	-
52	SCHEMATIC DIAGRAM OF EKO DISTRIBUTION NETWORK	Data	Copy	EKEDC	2020
53	List of Distribution Transformer and Injection Substation	Data	Copy	EKEDC	2020
54	Design Manual	Data	Copy	EKEDC	-
55	Company Organogram	Data	Copy	EKEDC	-
56	11kV Power Consumption	Data	Copy	EKEDC	2020
57	EKEDC Training Calendar 2020	Data	Copy	EKEDC	2020
58	List of Executed Internal Training Program 2019	Data	Copy	EKEDC	2020
59	Number of Metered/Unmetered Customer	Data	Copy	EKEDC	2020
60	Average Time to clear fault	Data	Copy	EKEDC	2019

No.	Name	Form Book/Data/Map/Photograph etc.	Original・Copy	Issue Authority	Issue Year
61	PID-Nigeria-Distribution-Sector-Recovery-Program	Book	Copy	The World Bank	2020
62	CONTENTS OF ANED UPDATED COURSE	Data	Copy	ANED	2018
63	Identified Discos Training Needs ANED Data Collation & Analysis	Book	Copy	ANED, AFD	2018
64	COURSE HANDBOOK: ENERGY MANAGEMENT	Book	Copy	NAPTIN/GIZ	2016
65	REFERENCE MANUAL: Electrical Maintenance of High Voltage Transformers and Switchgear	Book	Copy	NAPTIN/GIZ	2016
66	TRAINING MARKET ASSESSMENT REPORT	Book	Copy	GIZ	2014