



**TRANSMISSION COMPANY OF NIGERIA
INDEPENDENT SYSTEM OPERATOR (ISO)**

Part 2

**Transmission Adequacy
Report**

Retrospective for year 2015

By

Market Operator

July 2017

Published by:

Transmission Company of Nigeria (TCN) – Independent System Operator (ISO)
Sector: Market Operator

Contact: Engr. Musa Musa Gumel
Ag. Managing Director Independent System Operator (ISO)
No. 14 Zambezi Crescent, Maitama, Abuja, Nigeria

Contact: Engr. Moshood Saleeman
Ag. Managing Director Market Operator (MO)
No. 14 Zambezi Crescent, Maitama, Abuja, Nigeria

Author:

Peter Lilje, Ph.D.
Dr.-Ing. Markus Pöller
Moeller & Poeller Engineering (M.P.E.) GmbH
Europaplatz 5, 72076 Tübingen, Germany
Tel.: +49 7071 13879-0
Email: info@moellerpoeller.de

Status: Final Report

Printed and distributed by: Transmission Company of Nigeria (TCN) – Independent System Operator (ISO) – Sector: Market Operator

Abuja, 19 July 2017

This report was prepared by the Market Operator with assistance from the **Nigerian Energy Support Programme (NESP)**.

No 2 Dr. Clement Isong street, Asokoro, Abuja/Nigeria
Contact: Ina Hommers (ina.hommers@giz.de)
T 00234 (0)8057601986

This project is funded by the European Union & the German Federal Ministry for Economic Cooperation and Development (BMZ).

Contents

Definitions of Terms and Acronyms	4
1. Introduction	5
2. Transmission Installed Capacity	6
3. Methodology.....	9
3.1. Transmission Capability.....	9
3.2. Transmission Constraints	9
3.3. Outages.....	9
3.4. Voltage Regulation	9
3.5. Losses	10
3.6. Load Management.....	10
4. Performance Indices.....	11
4.1. Transmission Capability.....	11
4.2. Transmission Constraints	11
4.2.1. <i>Constraints That Have Led to DISCO Re-dispatch</i>	<i>11</i>
4.2.2. <i>Constraints That Have Led to Generation Reduction During Operation</i>	<i>12</i>
4.3. Outages.....	16
4.3.1. <i>Transmission Lines.....</i>	<i>16</i>
4.3.2. <i>Transformers</i>	<i>21</i>
4.4. Voltage Regulation	24
4.5. Losses	26
4.6. Load Management.....	26
5. Summary of Performance Indices	28
6. Future Development of This Report	29
References	30
Annex 1 – Transmission Asset Register	31
Annex 1.1 – Transmission Lines.....	31
Annex 1.2 – Transmission Transformers (not supplying DISCOs)	39
Annex 1.3 – Transformers at Transmission Substation (supplying DISCOs)	42
Annex 1.4 – Effective Substation Capacities (sites supplying DISCOs)	50
Annex 1.5 – Shunt Reactors.....	53
Annex 1.6 – Shunt Capacitors	54

Annex 2 – Outages of Transmission Lines	55
Annex 3 – Outages of Transformers.....	63

Definitions of Terms and Acronyms

The acronyms, as well as terms that are used in the performance indices, are defined below.

Availability	$MTTF / (MTTF + MTTR)$
Available energy	Energy available from generation, taking into account the technical availability of generation, generation constraints as well as transmission constraints.
DISCO	Distribution company
Emergency Outage	Equipment being taken out of service immediately by operators to ensure the stability and security of the network, e.g. disconnection of radial transmission lines as a means of emergency frequency control.
Failure Rate	Number of failures per year
Forced Outage	Shutdown of equipment due to failure, normally initiated automatically by protection relay(s).
MTTF	Mean time to fail
MTTR	Mean time to repair
MV	Medium voltage
Potential energy demand	Energy demand based on the capacities of the DISCOs, plus transmission losses
Standard Deviation	A measure of variation or dispersion of data.
Substation Capacity	Sum of transformer ratings at the DISCO interfaces, considering (n-1)-security
Urgent Outage	Equipment being taken out of service by operators following short-term planning, normally within hours ahead of the outage

1. Introduction

The transmission adequacy during the year 2015 was analysed by assessing the ability of the transmission system to reliably transmit electrical power from the generation stations to the DISCOs and to the neighbouring countries.

Chapter 2 provides an overview of the transmission system, including its topology, the main assets and its installed capacity. In addition, it includes an assessment of the capacities of the distribution companies (DISCOs).

Chapter 3 explains how the various performance indices were calculated.

Chapter 4 presents the calculated performance indices and chapter 5 summarises these in a single table.

Chapter 6 lists some ideas for the future development of this report.

2. Transmission Installed Capacity

Figure 1 provides a graphical representation of the high voltage transmission lines, where the 330kV lines are shown in blue and 132kV lines are shown in green.

The transmission system supplies power to 11 DISCOs as well as two neighbouring countries (Benin and Niger). The geographical areas supplied by the DISCOs are shown in Figure 2.

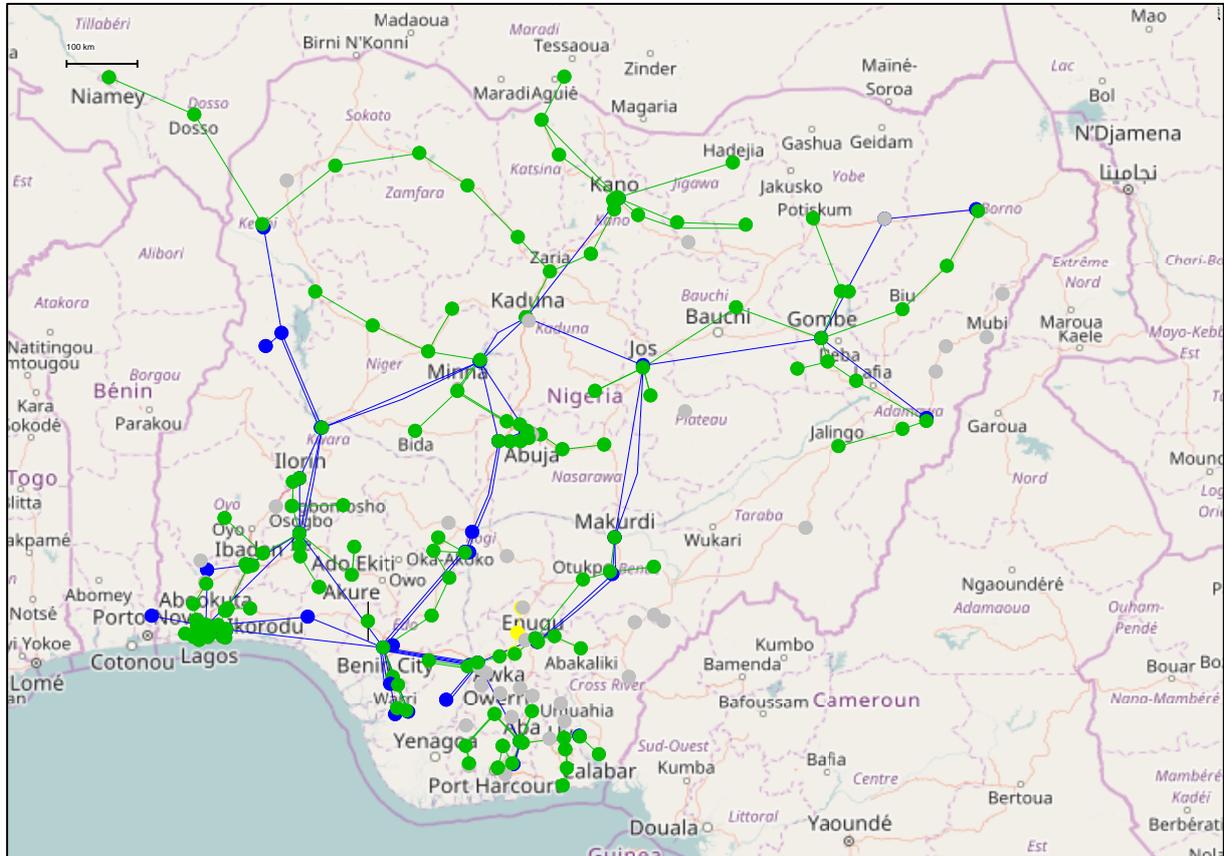


Figure 1: Map of transmission system at the end of 2015 showing voltage levels 330kV (blue), 132kV (green) and 66kV (yellow¹)

¹ The map shows lines that have been commissioned by the end of 2015.

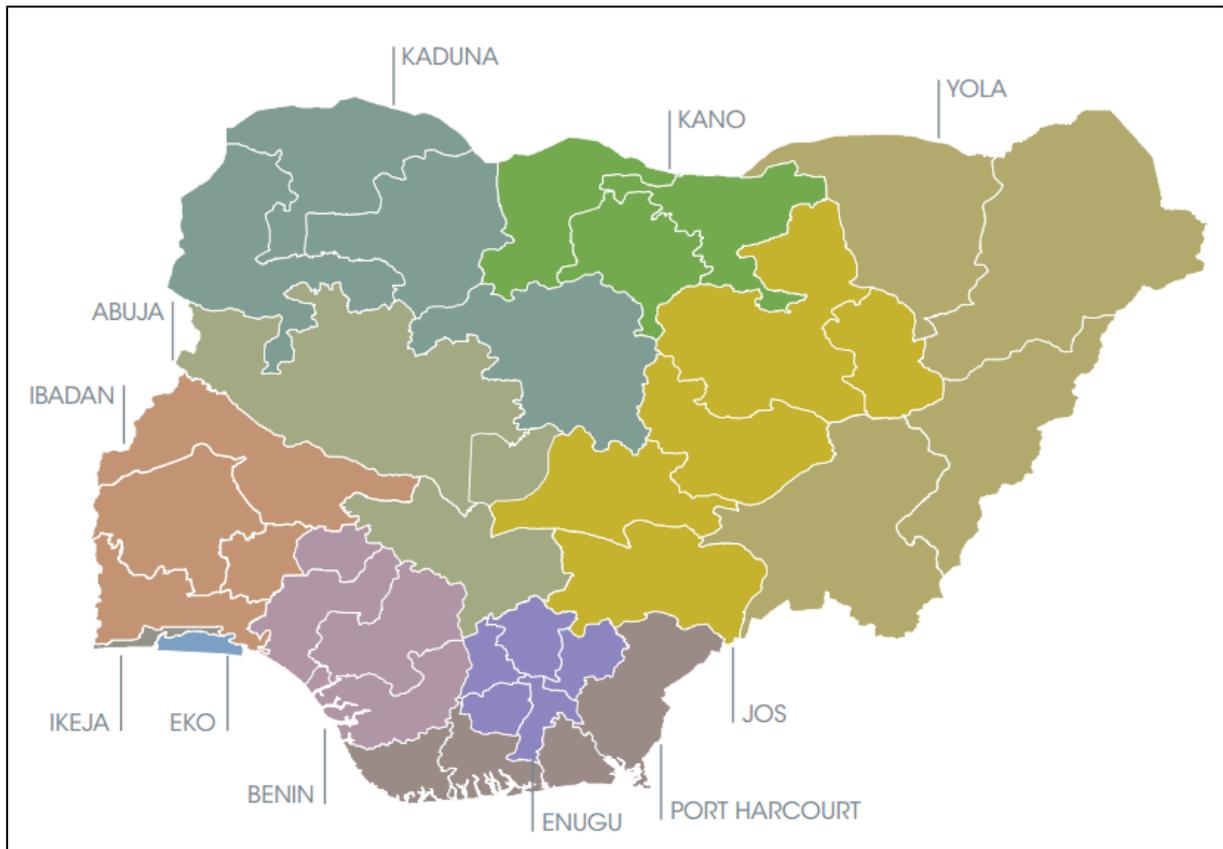


Figure 2: Allocation of geographical areas to DISCOs [1]

Table 1 provides a summary of the transmission assets. A summary of an asset register, consisting of lists of transmission lines, transformers and shunts, is included in Annex 1.

The capacities of the substations supplying the DISCOs were obtained from the ratings of the transformers that supply the DISCOs. The effective capacities exclude the redundant transformer capacities. Whether a transformer was redundant was based on engineering judgement², by looking at the ratings of the transformers. The total capacities and effective capacities are shown in Table 4. Additional information is included in Annex 1.4.

² A detailed analysis of each substation design could be executed in the future for increased accuracy.

Table 1: Summary of transmission assets (power components)

Type of asset, description	Number	Value
Number and total length of transmission lines (multiple-circuit / single-circuit)		
330kV	80	7958 km
132kV	202 ¹	8587 km
66kV	2	20 km
Number of substations	156	
Transformer capacity		
330/132kV	80	11736 MVA
132/66kV	1	30 MVA
132/MV	305	13522 MVA
66/33kV	2	15 MVA
Reactive compensation		
Inductive shunts	23	1470 Mvar
Capacitive shunts	33	720 Mvar
Dynamic compensation (e.g. SVC, STATCOM)	0	0 Mvar
<i>1: The transmission line Akangba – Itire, cct1 was permanently unavailable and was, therefore, assumed to have been scrapped. It was not considered in this report.</i>		

Table 2: Substation Capacity at transmission interface

DISCO	Total substation Capacity [MVA]	Effective Capacity [MVA]
Abuja	1592.5	1002.5
Benin	1165	785
Eko	1470	865
Enugu	1202.5	797.5
Ibadan	1495	985
Ikeja	1590	1025
Jos	555	425
Kaduna	975	635
Kano	827.5	550
Port Harcourt	1055	775
Yola	375	270
Total capacity (local)	12302.5	8115

3. Methodology

3.1. Transmission Capability

The true transmission system capability depends on the availability of the transmission equipment.

The capability of the transmission system can, in general, be deduced from operational data by considering the times when it was operating at its limit. Such times are characterised by the occurrence of transmission system constraints. However, it was found that the clear majority of transmission constraints only affected the south-eastern part of the network and that, at time when these constraints were active, the remainder of the network was operating below its maximum capability. Therefore, an overall figure for the transmission capability could not be deduced.

Considering the above, only a lower bound of the transmission capability could be calculated. This is given by the total of the power stations' sent-out powers. The generation output at 06:00am of each day was obtained from the Daily Operational Reports [2]. The sent-out generation values were calculated from these by subtracting an average percentage for the auxiliary power and losses, which, in turn, was obtained from the yearly "generated" and the yearly "sent-out energy".

3.2. Transmission Constraints

Transmission constraints, which are known prior to the allocation of DISCO loads, lead to an adaptation of the load allocation (security-constrained allocation). The number of days on which this occurred, and the average power that was reallocated, was derived from [3].

Transmission constraints may also develop during operation, requiring the system operators to adjust the level of generation of individual power stations. The number of days that each power plant was affected by such constraints was determined from [2]. The average required reduction in generation output power was calculated, assuming that the constraints that are reported at 06:00am on each day apply, approximately, for the whole day.

3.3. Outages

The outage rates and durations of both the transmission lines and the transformers were derived from [2] and [4]. The planned, urgent and Forced Outages were considered. Emergency Outages were not considered, since they do not affect the availability of the lines. These were categorised into short-term outages (up to one day) and for long-term outages (more than one day).

In addition, the average availabilities of numerous groups of equipment were calculated. The groups were defined according to voltage level. For example, the average availability of all 330kV transmission lines was calculated.

3.4. Voltage Regulation

The maximum and minimum voltages in the 330kV network that occurred on each day were obtained from [2]. Based on that, the number of days on which the minimum or maximum statutory voltage limits were exceeded, was calculated.

3.5. Losses

The electrical losses in the transmission system were calculated from the energy sent out by the generators and the energy delivered to both the DISCOs and neighbouring countries. The former was obtained from the Daily Operational Reports [2] and the latter from the DISCO nominations [5]. The losses were calculated as follows:

Energy sent out by generators
- Energy delivered to DISCOs
- Energy delivered to neighbouring countries
<hr/>
= Electrical losses in transmission system
<hr/>

The losses were expressed in % based on the energy sent out by the generators.

The above calculation could only be done for the period 25.11.2015 to 17.12.2015 due to the availability of the load data. The annual losses were calculated using the same percentage losses and the known sent-out energy from [2].

3.6. Load Management

The difference in the allocated DISCO loads and the actual DISCO loads provide an indication of the accuracy with which the load is projected, supplied and managed during operation. It is noted that such differences have various reasons, not all of which are within the control of the transmission system operators. The assessment therefore represents a performance measurement of the entire supply chain, not only the transmission system.

The above-mentioned differences were calculated for each hour of the year, subject to the availability of data in DISCO Nominations [6]. The mean difference between the total allocated load and the total actual load was calculated. In addition, the distribution of this difference was represented graphically and the variance from the mean value was assessed. The latter was done by calculating the Standard Deviation, which inherently implies that the probabilistic distribution was approximated by a normal distribution curve.

4. Performance Indices

4.1. Transmission Capability

Figure 3 shows the sent-out power values at 06:00am on each day. The red and green areas distinguish days on which there were or were no transmission constraints. The highest power transfer, during which a transmission constraint is known to have occurred, was 4156MW.

As stated in section 3.1, the above analysis is based on the sent-out generator power, which was calculated from the actual generated less a fixed average percentage for the auxiliary power and losses. The latter was calculated at 2.1% from the yearly energy values.

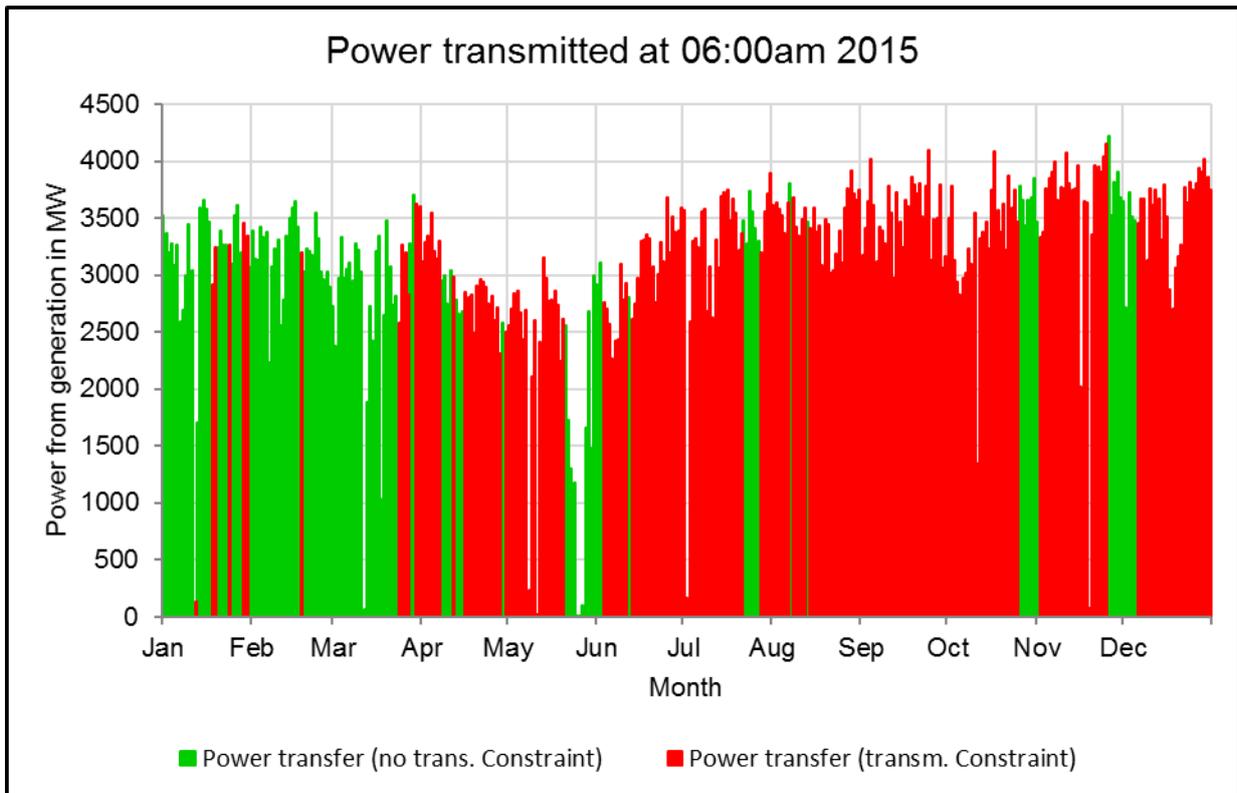


Figure 3: Peak power transfer (green represents days without, and red with transmission constraints)

4.2. Transmission Constraints

4.2.1. Constraints That Have Led to DISCO Re-dispatch

The day-ahead DISCO allocation was modified regularly from the predefined MYTO percentages during the months January to September due to transmission constraints in the southeastern part of the network. The total available generation was allocated every day, despite the occurrence of transmission constraints.

Table 3 shows the average reallocation over the 9-month period. Positive values imply an increase in the allocated load.

The reallocation was no longer required in October onwards following the strengthening of the 330kV network.

Table 3: Average reallocation due to transmission constraints, January to September 2015

DISCO	Average increase in allocated load [MW]
Abuja	-18.0
Benin	0.0
Eko	-21.5
Enugu	28.7
Ibadan	-25.1
Ikeja	-32.3
Jos	-18.0
Kaduna	-28.7
Kano	0.0
Port Harcourt	125.7
Yola	-10.8
Average total reallocation power	154
Minimum / maximum reallocation power	74 / 229
Number of days on which reallocation done	174

4.2.2. Constraints That Have Led to Generation Reduction During Operation

Figure 4 shows the reduction in generation output during system operation, due to transmission constraints. The average reduction in generation amounted to 146MW.

The most frequently-occurring constraints are described briefly below. Figure 5 shows the extent to which individual power stations were affected by transmission constraints. The southeast area was affected the most. In addition to generation reductions, some outages in the southeastern network often led to the formation of islands.

- Low ratings and poor condition of 132kV lines linking Odukpani and Ibom power stations to Itu and to Abu, requiring the power through these lines having to be limited, see Figure 6.
- Outages of transmission lines, especially in the southeast, where the power across the 330kV transmission link must be limited in line with the operating reserve policy [7], see Figure 7.
- Incorrect protection settings on 330kV lines westwards out of Benin, leading to their derating. See Figure 8.
- Prevention of risk of voltage collapse in an (n-1) operating condition, for example in the link from Shiroro to Kaduna, see Figure 9. Another example is when only one 330kV circuit between Lokoja and Gwagwalada was in service.

The constraints (a) to (c) above depend on the load in the southeastern part of the network.

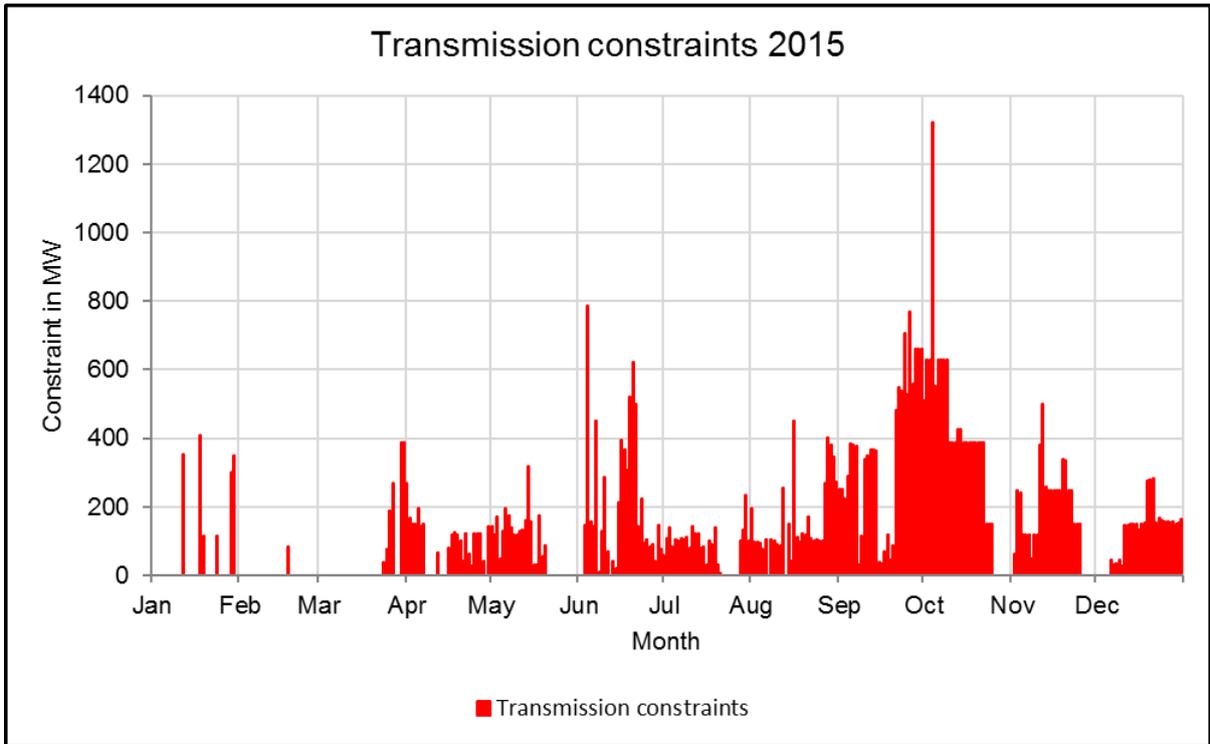


Figure 4: Generation reductions due to transmission constraints

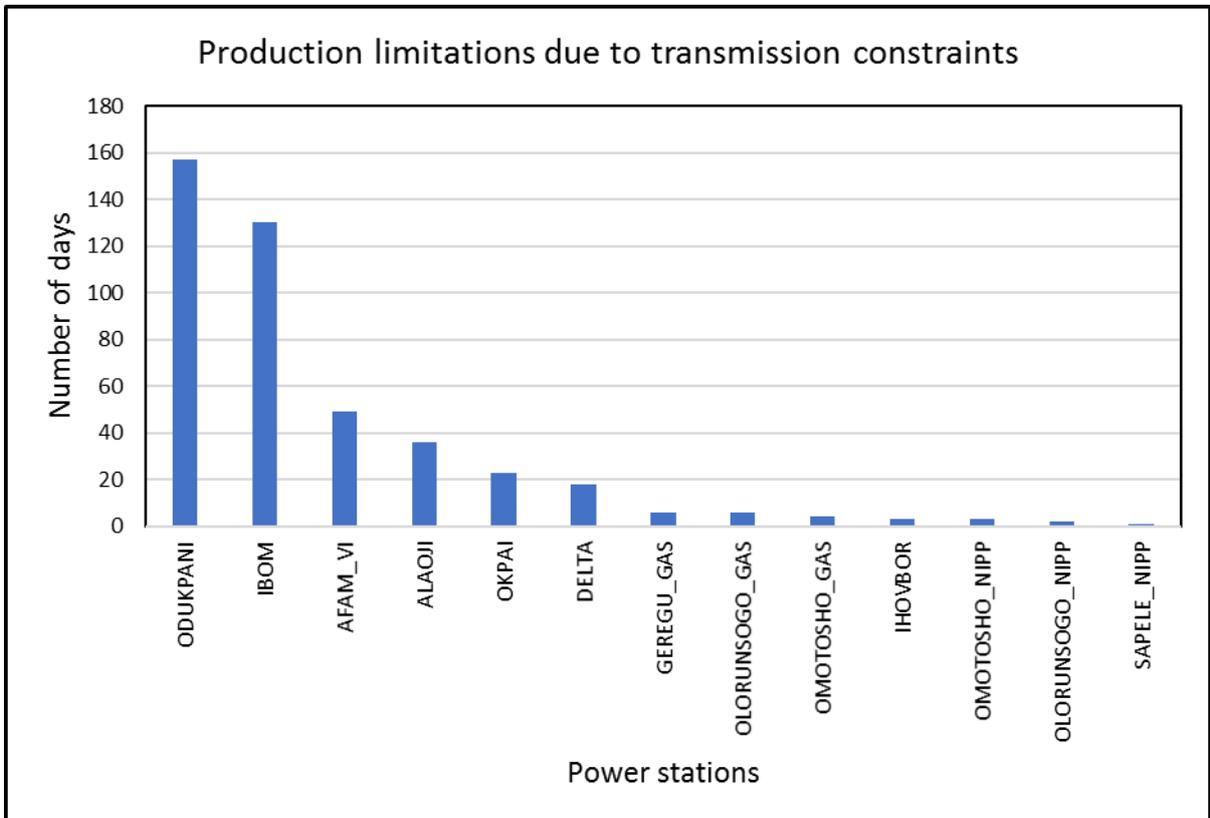


Figure 5: Number of days that generation was reduced due to transmission constraints

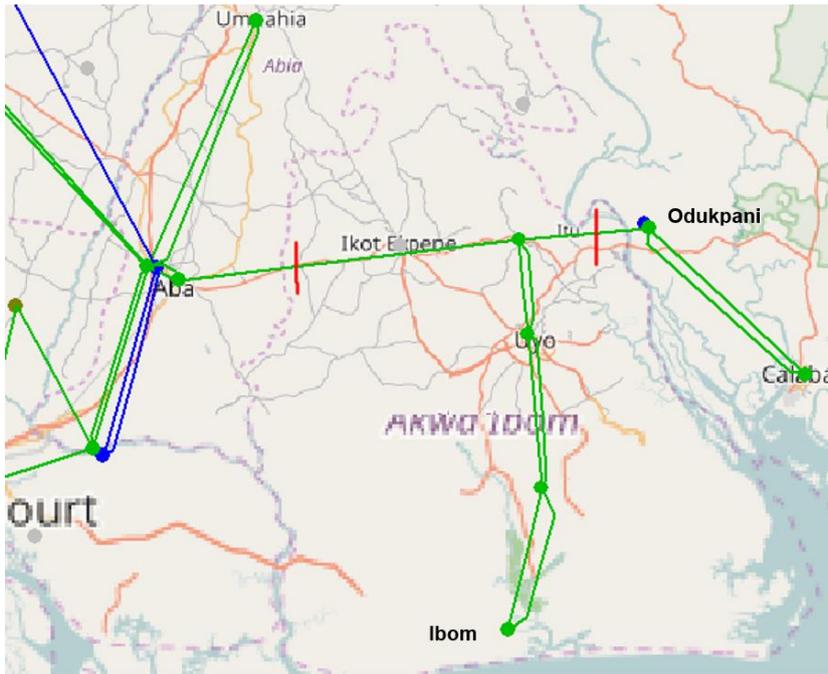


Figure 6: Transmission constraint due weak link to south-eastern part of network

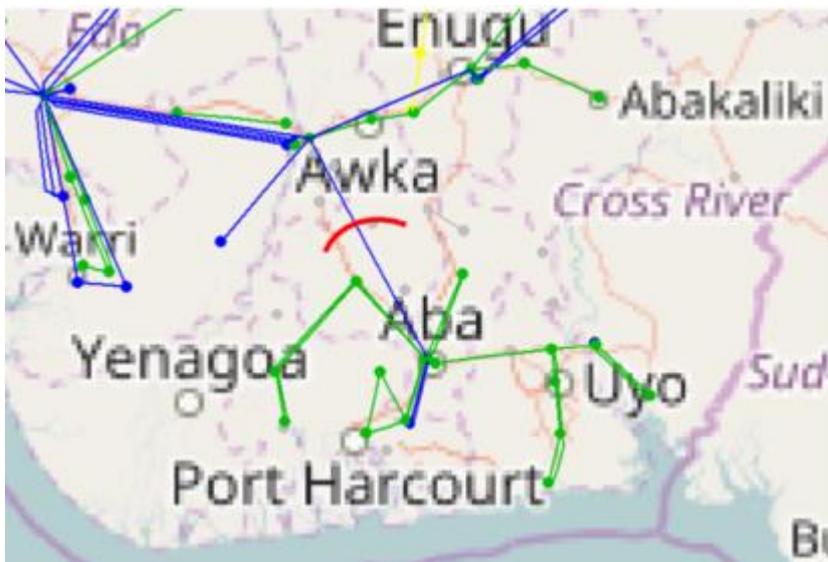


Figure 7: Transmission constraint due weak link to south-eastern part of network

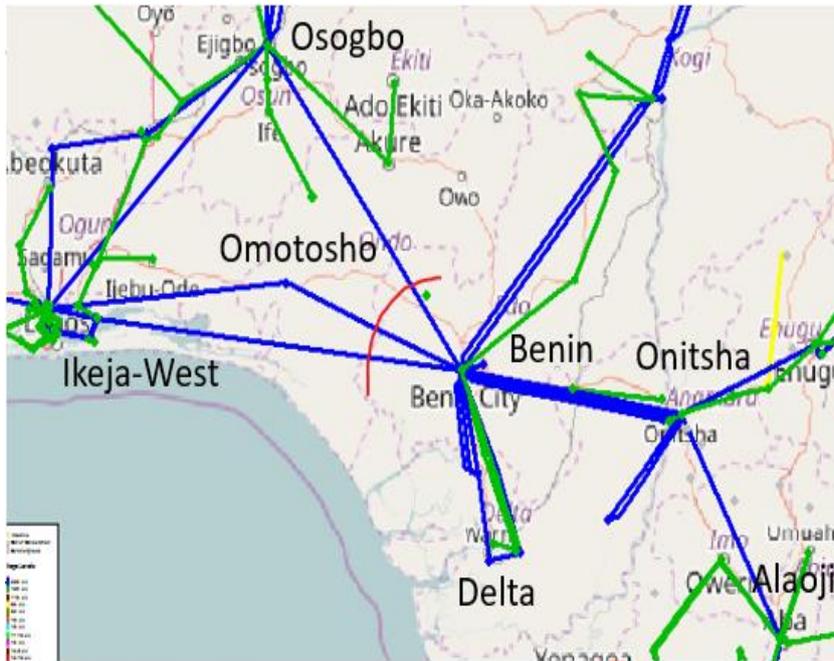


Figure 8: Transmission constraint due to incorrect protection settings on 330kV lines

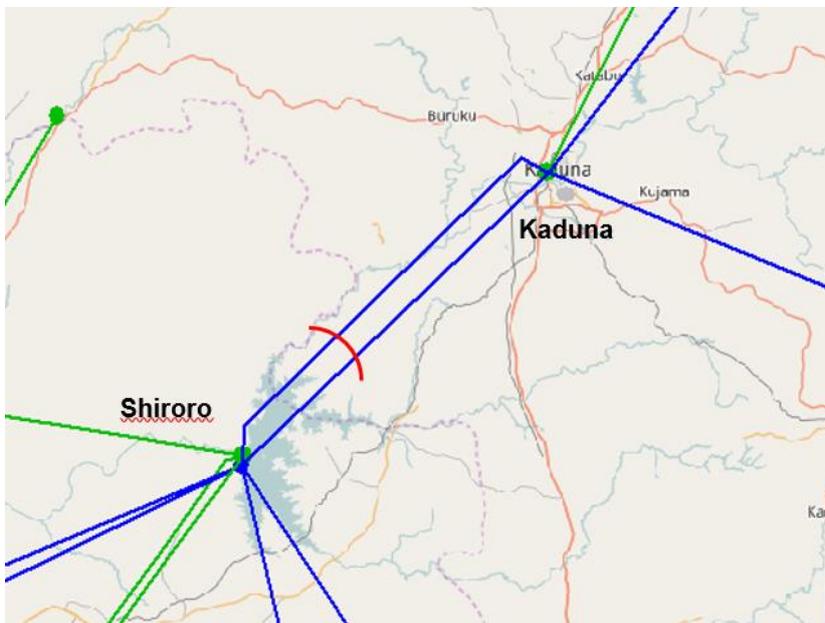


Figure 9: Transmission constraint to prevent risk of voltage collapse

4.3. Outages

4.3.1. Transmission Lines

Table 4 shows the number of outages (short-term and long-term) of transmission lines during 2015, as well as the overall outage rates for the three different voltage levels.

The proportions of short-term and long-term transmission line outages are shown diagrammatically in Figure 10. Table 5 provides more information about the lines that had long-term outages (more than one day).

Figure 11 shows the number of outages in each of the categories planned, forced and urgent, as well as the Failure Rates.

The Failure Rates of the individual transmission lines are given in Annex 2.

Table 4: Summary of transmission line outages

Quantity	Number of outages		
	330kV	132kV	66kV
Total number of outages	966	1686	7
<u>Outage by duration</u>			
Short-term outages	957	1672	7
Long-term outages	9	14	0
<u>Outage by type</u>			
Forced Outages	572	1004	1
Planned outages	210	252	0
Urgent Outages	184	430	6
<u>Frequency of outages</u>			
Frequency of outages [average / year per line]	12.1	8.3	3.5
Frequency of planned outages [average / year per line]	2.63	1.25	0
Frequency of Urgent Outages [average / year per line]	2.3	2.13	3.0
Failure Rate [average / year per line]	7.2	5.0	0.5
Failure Rate [per year per 100km]	7.2	11.7	5
<u>International experience</u>			
Failure Rate [average / year per 100km] [8]	<0.5	<0.5	-
Failure Rate [average / year per 100km] [9]	<1.0	<3.0	
Failure Rate [average / year per 100km] [10]	<2.6		

Table 5: Summary of long-term transmission line outages

Line	Duration [days]
<u>330kV</u>	
Aja – Egbin, cct2	196
Ganmo – Osogbo, cct1	80
Jos – Makurdi, cct1	42
Aladja – Sapele, cct1	17
Okpai – Onitsha, cct2	10
Benin – Egbin, cct1	3
Jebba-TS – Osogbo, cct1	2
Katampe – Shiroro, cct1	2
Benin – Onitsha, cct2	2
<u>132kV</u>	
Amukpe – Benin, cct1	351
Benin – Ogara, cct1	351
Agbara – Ojo, cct1	321
Ikeja-West – Illupeju, cct1	321
Ikeja-West – Illupeju, cct2	321
Afam – Alaoji-TS, cct1	317
Kwanar-Dangora – Tamburawa, cct1	306
Dakata – Kano, cct2	230
Egbin – Ikorodu, cct2	12
Aja – Alagbon, cct2	9
Afam – Alaoji-TS, cct2	4
Ayede – Shagamu, cct1	4
GCM – Onitsha, cct1	1

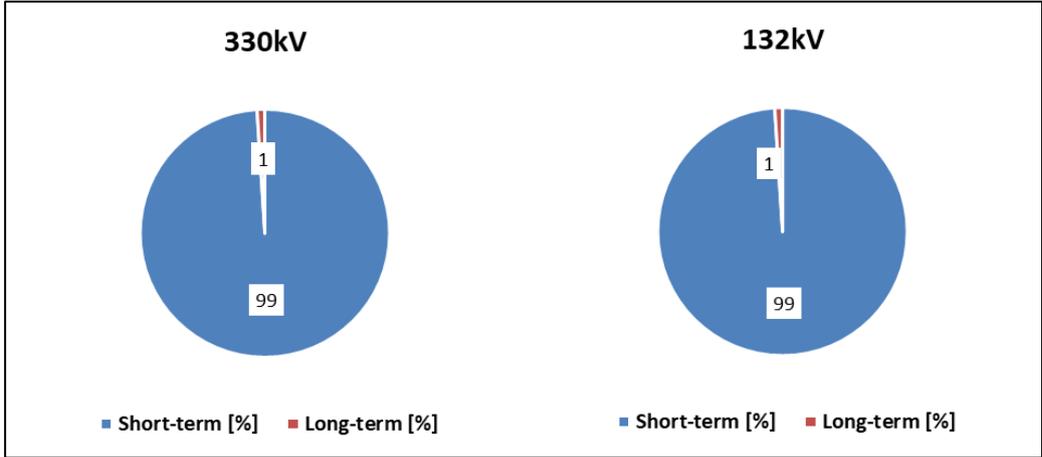


Figure 10: Proportions of long-term and short-term transmission line outages

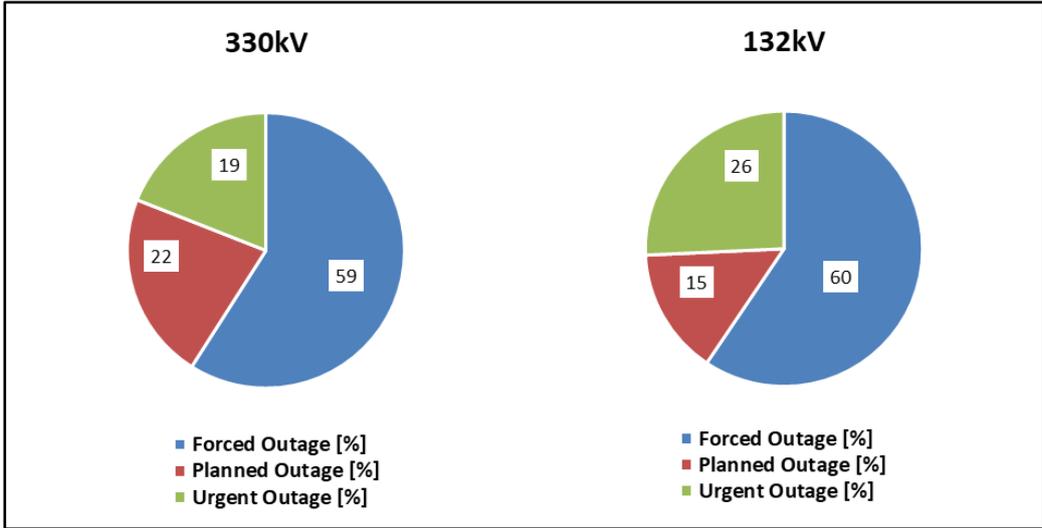


Figure 11: Proportions of different transmission line outage types

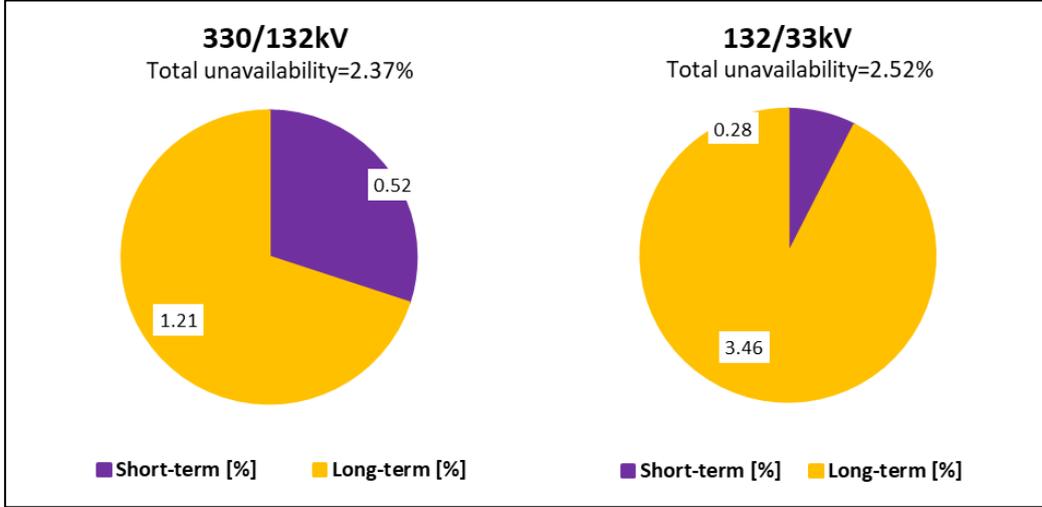


Figure 12: Proportions of unavailabilities, short- and long-term

Table 6 shows the average availability of all transmission lines at each of the three voltage levels during 2015. In addition, the proportion of unavailability due to Forced Outages and other outages is shown.

The availabilities of the individual transmission lines are shown in Annex 2.

Table 6: Transmission line availability

Quantity	Availability or unavailability		
	330kV	132kV	66kV
Availability	98.26%	96.26%	99.81%
Unavailability	1.74% (152h)	3.74% (327h)	0.19% (17h)
Unavailability due to Forced Outages	1.34% (117h)	3.10% (271h)	0.03% (3h)
Unavailability due to other outages	0.4% (35h)	0.64% (56h)	0.16% (14h)
International experience			
Availability as per [10]	>99.9% for 220kV	>99.5%	-
Unavailability [10]	<4.2h for 220kV	<12h	

Figure 13 and Figure 14 show that there is a poor correlation between the number of transmission line outages and their lengths, suggesting that many failures were due to factors not related to length (but rather, for example, maloperation of protection).

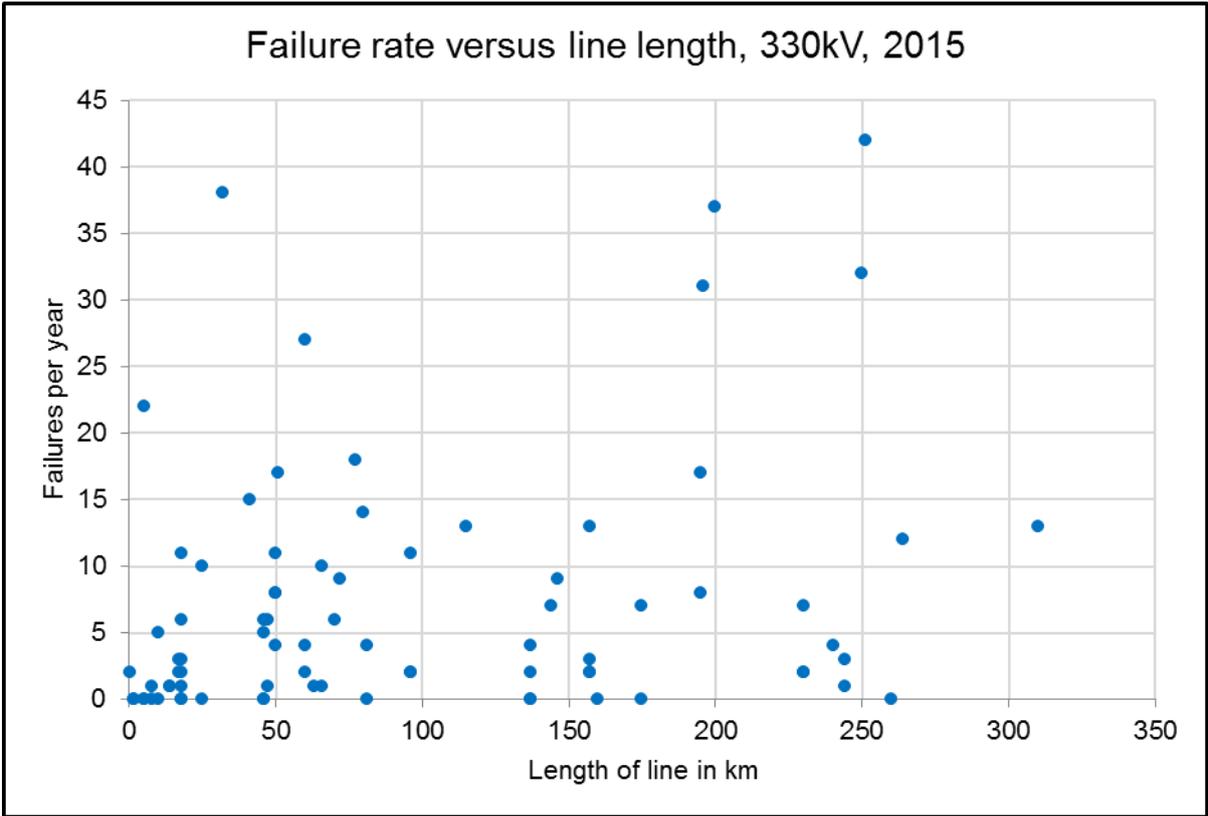


Figure 13: Forced Outage rates versus line lengths of 330kV transmission lines



Figure 14: Forced Outage rates versus line lengths of 132kV transmission lines

4.3.2. Transformers

Table 7 shows the number of number of outages (short-term and long-term) of transformers during 2015. The Failure Rates of the individual transformers are given in Annex 2.

Note: For some transformers the duration of the outages could not be deduced from the Daily Operational Reports. These outages were separated into short-term outages (up to one day) and long-term outages based on the comments provided. The short-term outages were assumed to be active until midnight and the long-term outages were assumed to have a duration of 2 months (see annex 3.2).

The proportions of short-term and long-term transformer outages are shown diagrammatically in Figure 15.

Table 7: Summary of transformer outages

Quantity	Number of outages			
	330 / 132kV	132 / 66kV	132kV / MV	66kV / MV
Total number of outages	345	3	859	0
<u>Outage by duration</u>				
Short-term outages	332	3	804	0
Long-term outages	13	0	55	0
<u>Outage by type</u>				
Forced Outages	132	0	353	0
Planned outages	72	1	177	0
Urgent Outages	141	2	329	0
<u>Frequency of outages</u>				
Frequency of outages [average / year per trans.]	4.31	3.0	2.82	0
Frequency of planned outages [average / year per trans.]	0.90	1.0	0.58	0
Frequency of Urgent Outages [average / year per trans.]	1.76	2.0	1.08	0
Failure Rate [average / year per trans.]	1.65	0.0	1.16	-
<u>International experience</u>				
Failure Rate as per [8]	0.05		0.015	
Failure Rate as per [9]	0.045		0.025	-
Failure Rate as per [11]	0.006		0.0043	0.0094

Figure 16 shows the proportions of the outages in each of the categories planned, forced and urgent.

Table 8 shows the average availability of 330 / 132kV and the 132kV/MV transformers. The proportions of short-term and long-term unavailabilities are shown diagrammatically in Figure 16.

The availabilities of the individual transformers are shown in Annex 3.

Table 8: Transformer availability

Quantity	Availability	
	330 / 132kV	132kV / MV
Availability	97.48%	97.53%
Unavailability	2.52% (220h)	2.47% (216h)
Unavailability due to Forced Outages	1.91% (168h)	2.34% (205h)
Unavailability due to other outages	0.6% (52h)	0.12% (11h)
<i>International experience</i>		
Availability [10]	>97.84% (considering major outages)	
Unavailability [10]	92.4h (considering major outages)	

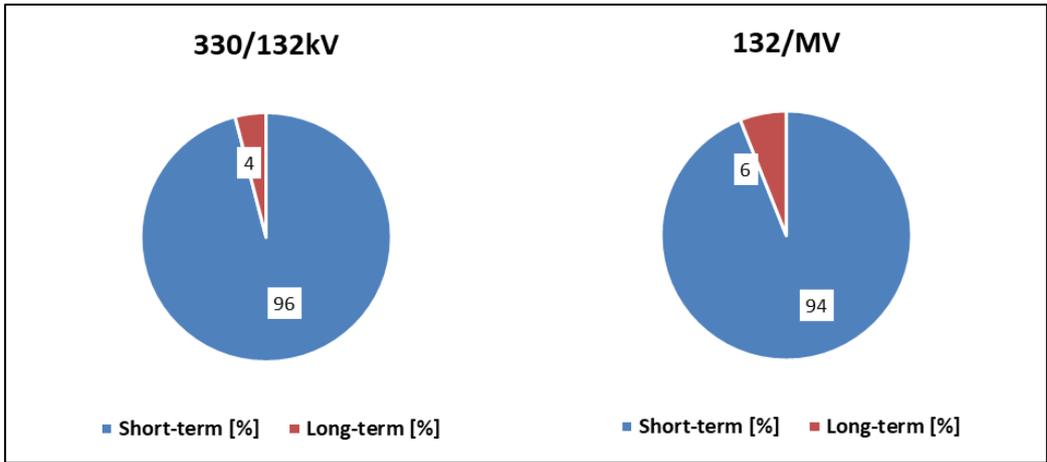


Figure 15: Proportions of number of long-term and short-term transformer outages

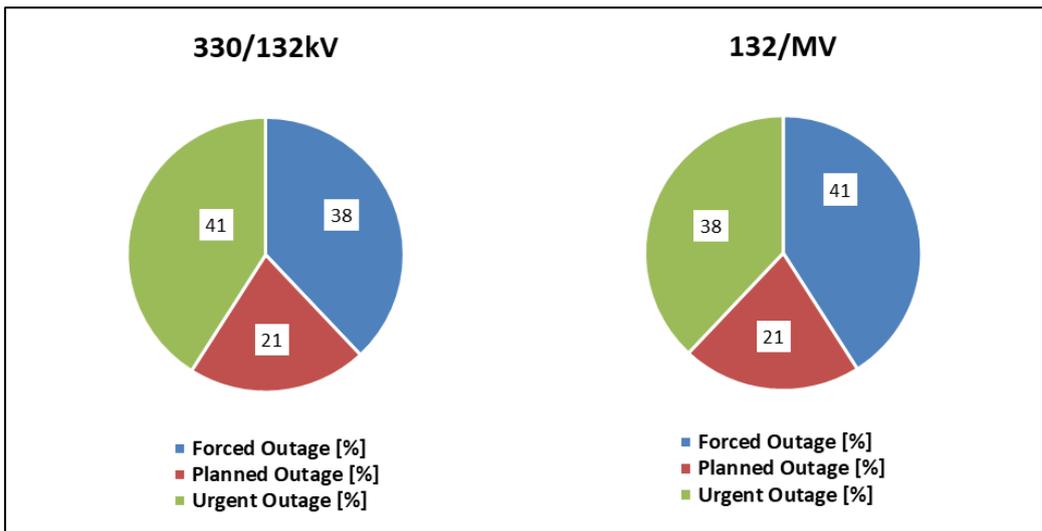


Figure 16: Proportions of different transformer outage types

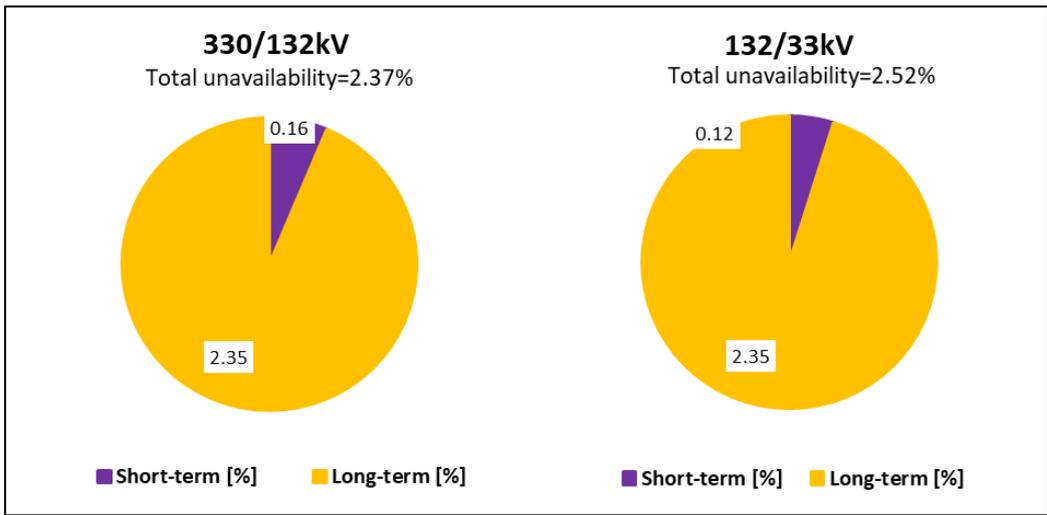


Figure 17: Proportions of unavailabilities, short- and long-term outages

4.4. Voltage Regulation

The following lines were disconnected from time to time as a means of voltage control:

- Jebba – Kainji
- Jos – Makurdi
- Lokoja – Ajaokuta
- Osogbo – Ikea-West
- Onitsha – Okpai

Figure 18 shows the maximum and minimum voltages that occurred in the 330kV network during 2015.

The number of days on which the statutory limits were not met can be deduced from the duration curves in Figure 19 and Figure 20. This information is summarised in Table 9.

Most incidents where the voltage exceeded the upper statutory limit occurred at Omotosho.

Most incidents where the voltage dropped below the lower statutory occurred at Kano, Gombe and Yola.

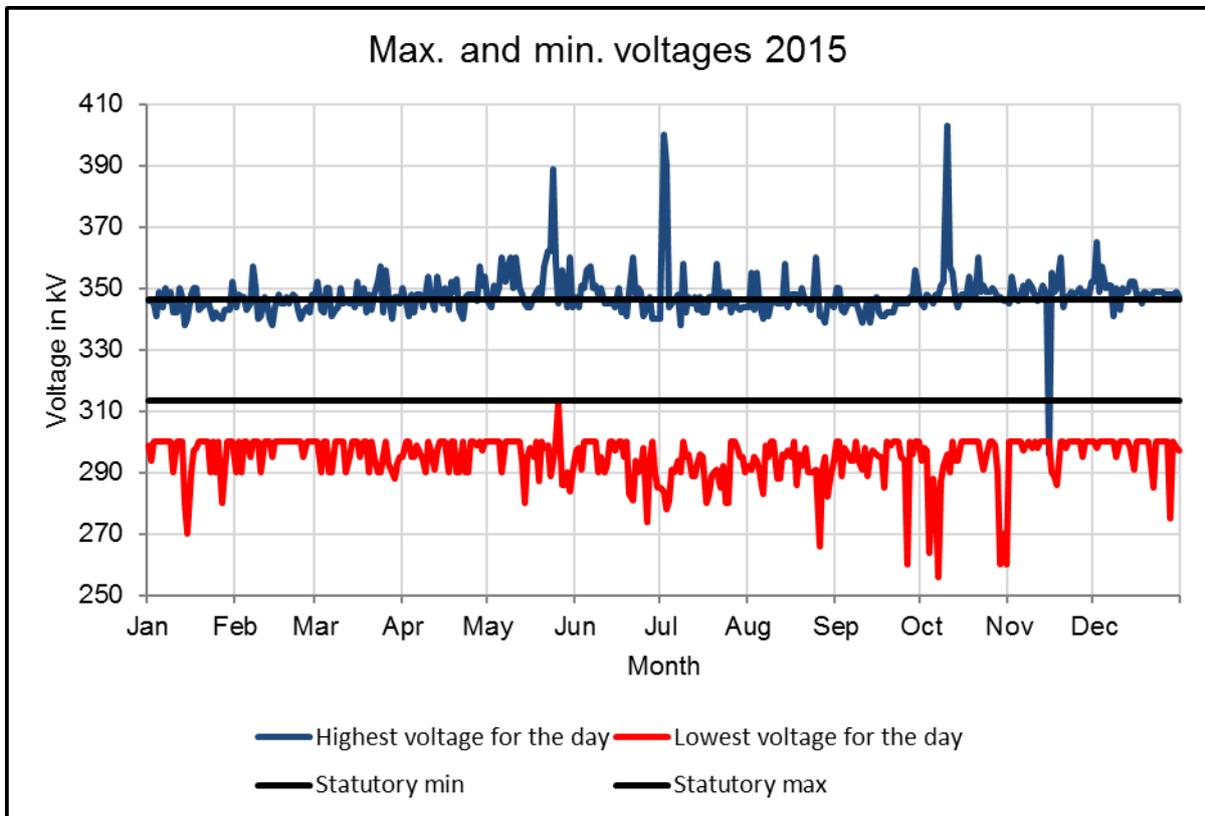


Figure 18: Minimum and maximum daily voltages (330kV level)

Table 9: Exceedances of statutory voltage limits

Quantity	Days
Number of days voltage above maximum limit	201
Number of days voltage below minimum limit	365

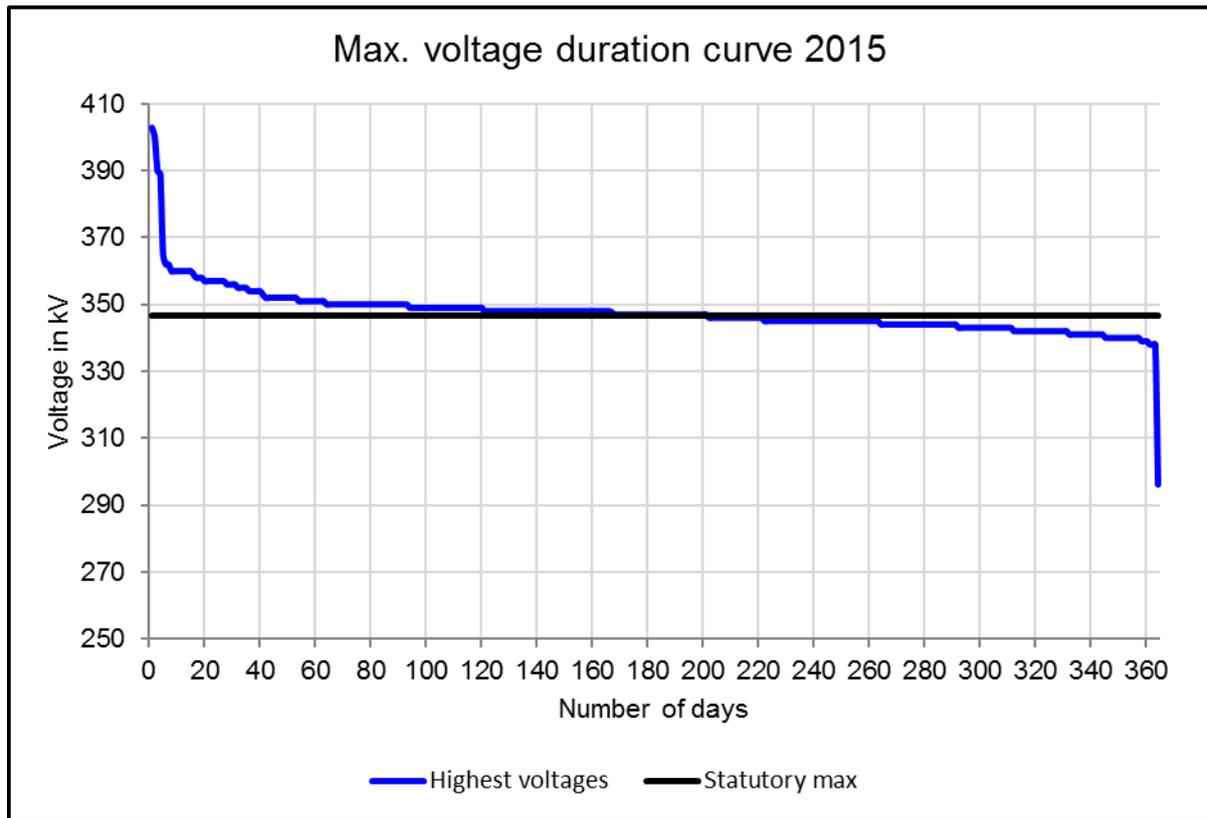


Figure 19: Maximum daily voltages, duration curve (330kV level)

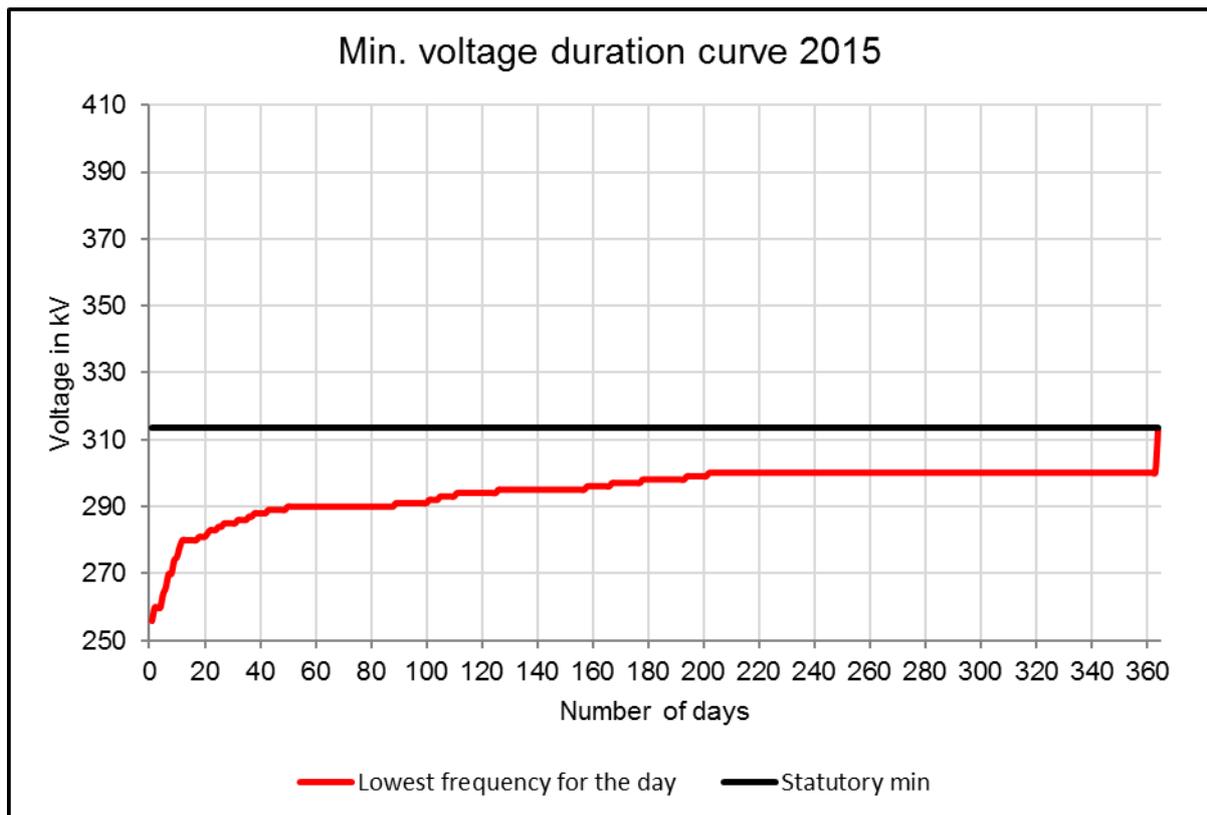


Figure 20: Minimum daily voltages, duration curve (330kV level)

4.5. Losses

Table 4 shows the calculation of the transmission losses as a percentage of the energy sent out by the generators. It is noted that these losses seem to be particularly high. This could be partly due many of the components being heavily loaded on a continuous basis.

Table 10: Summary of transmission system losses for stated period

Quantity during the period	25.11. – 17.12.2015	Projected annually
Energy sent out by generators	2100 GWh	30.9 TWh
Energy delivered to DISCOs	1800 GWh	26.5 TWh
Energy delivered to neighbouring countries	147 GWh	2.17 TWh
Transmission system electrical losses	153 GWh	2.26 TWh
Transmission system electrical losses as proportion of generated energy sent out	7.30%	7.30%
Yearly energy losses		2.26 TWh
Average year loss power		277.4 MWh/h

4.6. Load Management

Figure 21 shows the probabilistic distribution of the deviation between the total DISCO load and the total actual DISCO load. The x-axis represents the deviation as a percentage of the allocated load, and the y-axis represents the frequency of occurrence of such deviations.

On average, the total DISCO load is 26% less than allocated. As stated in section 3.6, the difference is due to many reasons, including problems in the generation, transmission and distribution systems.

The distribution of the difference could be approximated by a normal distribution curve. The Standard Deviation would then be 10%.

Table 11 shows the mean deviations of the individual DISCO loads from their respective allocated loads. The largest deviations occur in the DISCOs Kano, Yola and Ibadan. On average, the load of Port Harcourt approximately equals its allocation. However, large differences in both directions occur from time to time, as seen by corresponding high Standard Deviation.

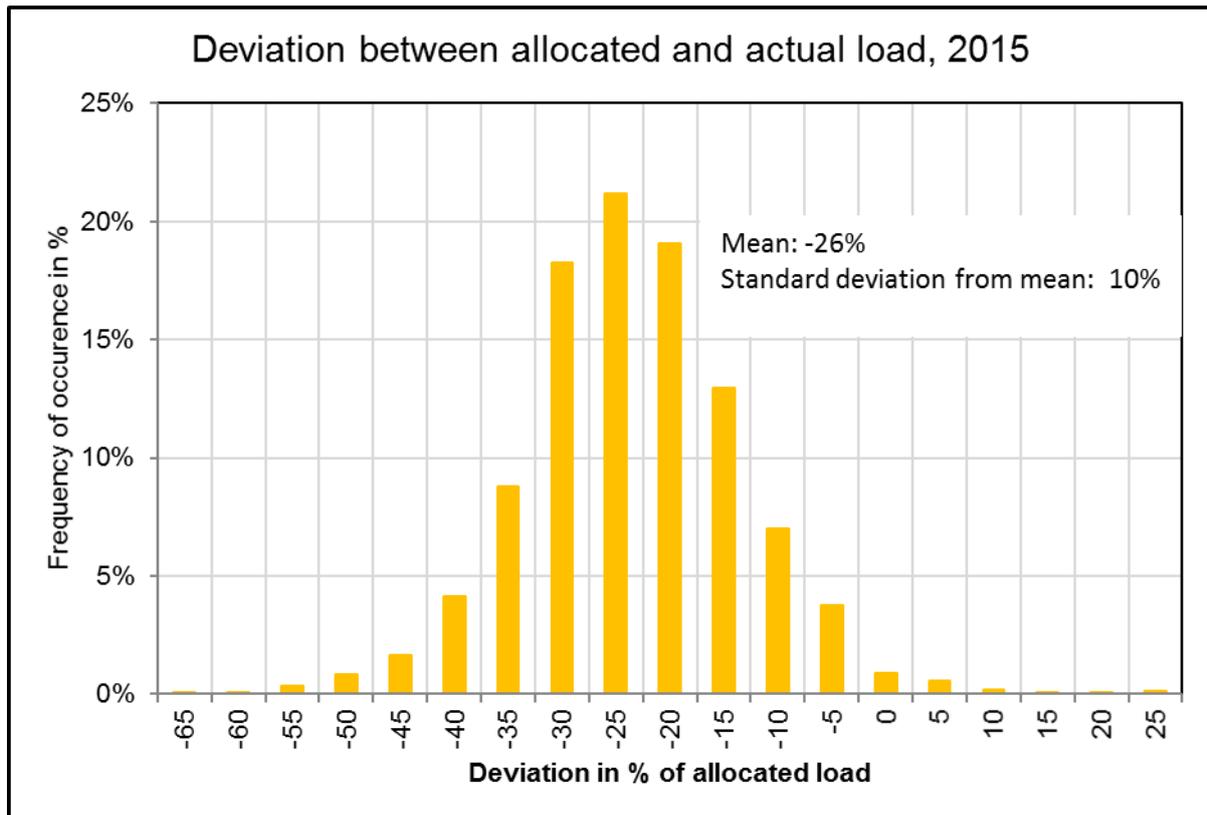


Figure 21: Probability distribution of deviation between total allocated and total actual load

Table 11: Deviation between allocated and actual load for the individual DISCOs

DISCO	Average allocated load [MWh/h]	Deviation (allocated – actual)	
		Mean	Standard Deviation
Abuja	533	-15%	17%
Benin	404	-30%	15%
Eko	497	-32%	14%
Enugu	407	-12%	19%
Ibadan	588	-37%	12%
Ikeja	694	-32%	12%
Jos	248	-18%	18%
Kaduna	361	-2%	20%
Kano	361	-42%	13%
Port Harcourt	293	-3%	32%
Yola	145	-36%	25%
Total	4531	-26%	10%

5. Summary of Performance Indices

Table 12: Summary of performance indices

Performance indicator		2014	2015
Transmission line reliability			
Failure Rate (average Forced Outages / year per line)	330kV		7.2
Failure Rate (average Forced Outages / year per line)	132kV		5.0
Failure Rate (average Forced Outages / year per 100km)	330kV		7.2
Failure Rate (average Forced Outages / year per 100km)	132kV		11.7
Frequency of outages (average outages / year per line)	330kV		12.1
Frequency of outages (average outages / year per line)	132kV		8.3
Availability (%)	330kV		98.3
Availability (%)	132kV		96.3
Average interruption duration (unavailability)	330kV		152 h
Average interruption duration (unavailability)	132kV		327 h
Transformer reliability			
Failure Rate (average failures / year per transformer)	330/132kV		1.7
Failure Rate (average failures / year per transformer)	132/MV		1.2
Availability (%)	330/132kV		97.5
Availability (%)	132/MV		97.5
Average interruption duration (unavailability)	330/132kV		220 h
Average interruption duration (unavailability)	132/MV		216 h
Transmission constraints			
Number of days where day-ahead DISCO allocation modified (days)			174
Average reallocation on these days (MW)			154
Average generation reduction during operation (MW)			146
Voltage regulation			
Number of days voltage above maximum limit			201
Number of days voltage below minimum limit			365
Losses of transmission system (estimate)			
Percentage losses (%)			7.3
Annual energy loss (TWh)			2.26
Average power loss (MWh/h)			277
Load management			
Consumption lower than allocation, on average (%)			26
Standard Deviation of this difference (%)			10

6. Future Development of This Report

Some ideas for the future improvement of this report are as follows:

1. The power transferred can be assessed against a calculated maximum power transfer limit, which will, in future, be obtained from the adequacy outlook report.
2. The voltage regulation in the 132kV network could be assessed, in addition to the voltage regulation at 330kV level.
3. The availability of on-load tap changers could be assessed.
4. In the future, long-term Failure Rates (e.g. over 5 years) could be calculated in addition to the Failure Rates during one year. The same applies to the availabilities. This would require a modification to the tool, which has been used to generate the results in this report.

References

- [1] Federal Government of Nigeria, "Nigeria Power Baseline Report," Nigeria, August 2015.
- [2] National Control Center, "Daily Operational Reports 2015," Osogbo, 2015.
- [3] National Control Center, "DISCO allocations (Excel spreadsheets)," Osogbo, 2015.
- [4] National Control Centre, "Reliability index (transmission line faults)," Osogbo, 2015.
- [5] Transmission Company of Nigeria, "DISCO Load Nominations," 2015.
- [6] National Control Center, "DISCO Nominations (Excel spreadsheets)," Osogbo, 2015.
- [7] Nigerian Electricity Regulatory Commission, "Grid Code," 24 12 2014. [Online]. Available: <http://www.nercng.org/index.php/nerc-documents/func-startdown/305/>. [Accessed 07 10 2016].
- [8] FNN, "Ermittlung von Eingangsdaten zur Zuverlässigkeitsberechnung aus der FNN Störungsstatistik," 2013.
- [9] entso-e, "Nordic and Baltic Grid Disturbance Statistics 2014," 2015.
- [10] Public Utilities Commission of Sri Lanka, "Transmission System Performance Report," 2012.
- [11] Cigre, "Transformer Reliability Survey, WG A2.37," 2011.
- [12] Transmission Company of Nigeria, "Grid System Operations; Annual Technical Report 2015," Osogbo, 2015.

Annex 1 – Transmission Asset Register

Annex 1.1 – Transmission Lines

Name	Region	Voltage level [kV]	Length [km]
Adiabo_Odukpani_330_cct1	8 PT HARCO	330	17.7
Adiabo_Odukpani_330_cct2	8 PT HARCO	330	17.7
Afam_Alaoji-TS_330_cct1	8 PT HARCO	330	25
Afam_Alaoji-TS_330_cct2	8 PT HARCO	330	25
Aja_Egbin_330_cct1	1 LAGOS	330	14
Aja_Egbin_330_cct2	1 LAGOS	330	14
Ajaokuta_Benin_330_cct1	4 BENIN	330	195
Ajaokuta_Benin_330_cct2	4 BENIN	330	195
Ajaokuta_Geregu_330_cct1	4 BENIN	330	1.5
Ajaokuta_Geregu_330_cct2	4 BENIN	330	1.5
Ajaokuta_Lokoja_330_cct1	4 BENIN	330	47.39
Ajaokuta_Lokoja_330_cct2	4 BENIN	330	47.39
Akangba_Ikeja-West_330_cct1	1 LAGOS	330	17
Akangba_Ikeja-West_330_cct2	1 LAGOS	330	17
Aladja_Delta_330_cct1	4 BENIN	330	32
Aladja_Sapele_330_cct1	4 BENIN	330	63
Alaoji_Onitsha_330_cct1	7 ENUGU	330	138
Alaoji-GS_Alaoji-TS_330_cct1	8 PT HARCO	330	10
Alaoji-GS_Alaoji-TS_330_cct2	8 PT HARCO	330	10
Aliade_Makurdi_330_cct1	7 ENUGU	330	46
Aliade_Makurdi_330_cct2	7 ENUGU	330	46
Aliade_Ugwuaji_330_cct1	7 ENUGU	330	157
Aliade_Ugwuaji_330_cct2	7 ENUGU	330	157
Asaba_Onitsha_330_cct1	7 ENUGU	330	0.2
Ayede_Olorunsogo_330_cct1	1 LAGOS	330	60
Ayede_Osogbo_330_cct1	2 OSOGBO	330	115
Benin_Delta_330_cct1	4 BENIN	330	41
Benin_Egbin_330_cct1	4 BENIN	330	280
Benin_Eyea_330_cct1	4 BENIN	330	25.1
Benin_Eyea_330_cct2	4 BENIN	330	25.1
Benin_Omotosho_330_cct1	4 BENIN	330	125
Benin_Onitsha_330_cct1	7 ENUGU	330	137
Benin_Onitsha_330_cct2	7 ENUGU	330	137
Benin_Onitsha_330_cct3	7 ENUGU	330	137
Benin_Onitsha_330_cct4	7 ENUGU	330	136.8
Benin_Osogbo_330_cct1	2 OSOGBO	330	251
Benin_Sapele_330_cct1	4 BENIN	330	50
Benin_Sapele_330_cct2	4 BENIN	330	50
Benin_Sapele_330_cct3	4 BENIN	330	50
Birnin-Kebbi_Kainji-GS_330_cct1	3 SHIRORO	330	310
Damaturu_Gombe_330_cct1	6 BAUCHI	330	160
Damaturu_Maiduguri_330_cct1	6 BAUCHI	330	260

Egbin_Ikeja-West_330_cct1	1 LAGOS	330	18
Egbin_Oke-Aro_330_cct1	1 LAGOS	330	18
Egbin_Oke-Aro_330_cct2	1 LAGOS	330	18
Ganmo_Jebba-TS_330_cct1	2 OSOGBO	330	110
Ganmo_Osogbo_330_cct1	2 OSOGBO	330	47
Gombe_Jos_330_cct1	6 BAUCHI	330	264
Gombe_Yola_330_cct1	6 BAUCHI	330	240
Gwagwalada_Katampe_330_cct1	3 SHIRORO	330	72.01
Gwagwalada_Lokoja_330_cct1	4 BENIN	330	174.6
Gwagwalada_Lokoja_330_cct2	6 BAUCHI	330	174.6
Gwagwalada_Shiroro_330_cct1	3 SHIRORO	330	145.99
Ikeja-West_Oke-Aro_330_cct1	1 LAGOS	330	18
Ikeja-West_Oke-Aro_330_cct2	1 LAGOS	330	18
Ikeja-West_Olorunsogo_330_cct1	1 LAGOS	330	77
Ikeja-West_Omosho_330_cct1	1 LAGOS	330	155
Ikeja-West_Osogbo_330_cct1	2 OSOGBO	330	250
Ikeja-West_Sakete_330_cct1	1 LAGOS	330	70
Jebba-GS_Jebba-TS_330_cct1	3 SHIRORO	330	8
Jebba-GS_Jebba-TS_330_cct2	3 SHIRORO	330	8
Jebba-TS_Kainji-GS_330_cct1	3 SHIRORO	330	81
Jebba-TS_Kainji-GS_330_cct2	3 SHIRORO	330	81
Jebba-TS_Osogbo_330_cct1	3 SHIRORO	330	157
Jebba-TS_Osogbo_330_cct2	3 SHIRORO	330	157
Jebba-TS_Shiroro_330_cct1	3 SHIRORO	330	244
Jebba-TS_Shiroro_330_cct2	3 SHIRORO	330	244
Jos_Kaduna_330_cct1	5 KADUNA	330	196
Jos_Makurdi_330_cct1	6 BAUCHI	330	230
Jos_Makurdi_330_cct2	6 BAUCHI	330	230
Kaduna_Kano_330_cct1	5 KADUNA	330	235
Kaduna_Shiroro_330_cct1	3 SHIRORO	330	96
Kaduna_Shiroro_330_cct2	5 KADUNA	330	96
Kainji_New-Bussa_330_cct1	3 SHIRORO	330	10
Katampe_Shiroro_330_cct1	3 SHIRORO	330	144
New-Haven_Onitsha_330_cct1	7 ENUGU	330	96
New-Haven_Ugwuaji_330_cct1	7 ENUGU	330	5
New-Haven_Ugwuaji_330_cct2	7 ENUGU	330	5
Okpai_Onitsha_330_cct1	7 ENUGU	330	60
Okpai_Onitsha_330_cct2	7 ENUGU	330	60
Aba_Alaoji-TS_132_cct1	8 PT HARCO	132	10
Aba_Alaoji-TS_132_cct2	8 PT HARCO	132	10
Aba_Itu_132_cct1	8 PT HARCO	132	85.4
Abakaliki_Nkalagu_132_cct1	7 ENUGU	132	54.25
Adiabo_Calabar_132_cct1	8 PT HARCO	132	13
Adiabo_Calabar_132_cct2	8 PT HARCO	132	13
Adiabo_Itu_132_cct1	8 PT HARCO	132	47.36

Ado-Ekiti_Akure_132_cct1	2 OSOGBO	132	47
Ado-Ekiti_Akure_132_cct2	2 OSOGBO	132	47
Afam_Alaoji-TS_132_cct1	8 PT HARCO	132	46
Afam_Alaoji-TS_132_cct2	8 PT HARCO	132	46
Afam_PHCT-Main_132_cct1	8 PT HARCO	132	37.8
Afam_Rivers_132_cct1	8 PT HARCO	132	18.9
Agbara_Ikeja-West_132_cct1	1 LAGOS	132	32.04
Agbara_Ikeja-West_132_cct2	1 LAGOS	132	32.04
Agbara_Ojo_132_cct1	1 LAGOS	132	16.37
Agbara_Ojo_132_cct2	1 LAGOS	132	16.37
Agbor_Asaba_132_cct1	7 ENUGU	132	52
Agbor_Asaba_132_cct2	7 ENUGU	132	52
Ahoda_Owerri_132_cct1	8 PT HARCO	132	73
Ahoda_Owerri_132_cct2	8 PT HARCO	132	73
Ahoda_Yenagoa_132_cct1	8 PT HARCO	132	46
Ahoda_Yenagoa_132_cct2	8 PT HARCO	132	46
Aja_Alagbon_132_cct1	1 LAGOS	132	26
Aja_Alagbon_132_cct2	1 LAGOS	132	26
Aja_Lekki_132_cct1	1 LAGOS	132	20
Aja_Lekki_132_cct2	1 LAGOS	132	20
Ajaokuta_Ajaokuta-Steel_132_cct1	4 BENIN	132	11
Ajaokuta_Ajaokuta-Steel_132_cct2	4 BENIN	132	11
Ajaokuta_Itakpe_132_cct1	4 BENIN	132	45
Ajaokuta_Okene_132_cct1	4 BENIN	132	60
Akangba_Amuwo-Odofin_132_cct1	1 LAGOS	132	10
Akangba_Amuwo-Odofin_132_cct2	1 LAGOS	132	10
Akangba_Apapa-Road_132_cct1	1 LAGOS	132	4.5
Akangba_Apapa-Road_132_cct2	1 LAGOS	132	4.5
Akangba_Ijora_132_cct1	1 LAGOS	132	8.3
Akangba_Ijora_132_cct2	1 LAGOS	132	8.3
Akangba_Isolo_132_cct1	1 LAGOS	132	4.5
Akangba_Isolo_132_cct2	1 LAGOS	132	4.5
Akangba_Itire_132_cct1	1 LAGOS	132	3
Akangba_Itire_132_cct2	1 LAGOS	132	3
Akoka_Alagbon_132_cct1	1 LAGOS	132	12
Akoka_Ijora_132_cct1	1 LAGOS	132	8
Akoka_Oworosoki_132_cct1	1 LAGOS	132	4.45
Akoka_Oworosoki_132_cct2	1 LAGOS	132	4.45
Akure_Osogbo_132_cct1	2 OSOGBO	132	92
Akwanga_Keffi_132_cct1	3 SHIRORO	132	62
Alagbon_Ijora_132_cct1	1 LAGOS	132	4
Alaoji_Owerri_132_cct1	8 PT HARCO	132	60
Alaoji_Owerri_132_cct2	8 PT HARCO	132	60
Alaoji_Umuahia_132_cct1	8 PT HARCO	132	66
Alaoji_Umuahia_132_cct2	8 PT HARCO	132	66

Alausa_Ogba_132_cct1	1 LAGOS	132	2
Alausa_Ogba_132_cct2	1 LAGOS	132	2
Aliade_Oturkpo_132_cct1	7 ENUGU	132	39.2
Aliade_Yandev_132_cct1	7 ENUGU	132	39.2
Alimosho_Ikeja-West_132_cct1	1 LAGOS	132	18.36
Alimosho_Ikeja-West_132_cct2	1 LAGOS	132	18.36
Alimosho_Ogba_132_cct1	1 LAGOS	132	19
Alimosho_Ogba_132_cct2	1 LAGOS	132	19
Amukpe_Benin_132_cct1	4 BENIN	132	12
Amukpe_Delta_132_cct1	4 BENIN	132	90
Amuwo-Odofin_Apapa-Road_132_cct1	1 LAGOS	132	2
Amuwo-Odofin_Apapa-Road_132_cct2	1 LAGOS	132	13.487
Amuwo-Odofin_Ojo_132_cct1	1 LAGOS	132	8.9
Amuwo-Odofin_Ojo_132_cct2	1 LAGOS	132	8.9
Apir_Aliade_132_cct1	7 ENUGU	132	50
Apir_Makurdi_132_cct1	7 ENUGU	132	3
Apo_Karu_132_cct1	3 SHIRORO	132	10
Apo_Katampe_132_cct1	3 SHIRORO	132	15
Apo_Katampe_132_cct2	3 SHIRORO	132	15
Apo_Kukwaba_132_cct1	3 SHIRORO	132	24
Apo_Kukwaba_132_cct2	3 SHIRORO	132	24
Ashaka_Ashaka-RNDAB_132_cct1	6 BAUCHI	132	10
Ashaka-RNDAB_Gombe_132_cct1	6 BAUCHI	132	76
Ashaka-RNDAB_Potiskum_132_cct1	6 BAUCHI	132	106
Awka_Oji-River_132_cct1	7 ENUGU	132	33.35
Awka_Onitsha_132_cct1	7 ENUGU	132	30
Ayede_Ibadan-North_132_cct1	2 OSOGBO	132	6
Ayede_Jericho_132_cct1	2 OSOGBO	132	2
Ayede_Shagamu_132_cct1	2 OSOGBO	132	92
Ayobo_Ikeja-West_132_cct1	1 LAGOS	132	10
Ayobo_Ikeja-West_132_cct2	1 LAGOS	132	10
Azare_Dutse_132_cct1	5 KADUNA	132	43
Azare_Wudil_132_cct1	5 KADUNA	132	100
Bauchi_Gombe_132_cct1	6 BAUCHI	132	146
Bauchi_Jos_132_cct1	6 BAUCHI	132	118
Benin_Irrua_132_cct1	4 BENIN	132	88.8
Benin_Ogara_132_cct1	4 BENIN	132	53
Bida_Minna_132_cct1	3 SHIRORO	132	90
Birnin-Gwari_Tegina_132_cct1	3 SHIRORO	132	70
Birnin-Kebbi_Dosso_132_cct1	3 SHIRORO	132	128
Birnin-Kebbi_Sokoto_132_cct1	3 SHIRORO	132	130
Biu_Damboia_132_cct1	6 BAUCHI	132	142
Biu_Gombe_132_cct1	6 BAUCHI	132	142
Central-Area_Katampe_132_cct1	3 SHIRORO	132	30
Central-Area_Katampe_132_cct2	3 SHIRORO	132	30

Dakata_Hadejia_132_cct1	5 KADUNA	132	150
Dakata_Kano_132_cct1	5 KADUNA	132	13
Dakata_Kano_132_cct2	5 KADUNA	132	13
Damboa_Maiduguri_132_cct1	6 BAUCHI	132	71
Dan-Agundi_Kano_132_cct1	5 KADUNA	132	9
Delta_Effurun_132_cct1	4 BENIN	132	32
Delta_Ogara_132_cct1	4 BENIN	132	54
Dosso_Niamey_132_cct1	3 SHIRORO	132	135
Dutse_Kano_132_cct1	5 KADUNA	132	108.5
East-Mains_Gwagwalada_132_cct1	3 SHIRORO	132	42
East-Mains_Gwagwalada_132_cct2	3 SHIRORO	132	42
East-Mains_Kukwaba_132_cct1	3 SHIRORO	132	24
East-Mains_Kukwaba_132_cct2	3 SHIRORO	132	24
Egbin_Ikorodu_132_cct1	1 LAGOS	132	20
Egbin_Ikorodu_132_cct2	1 LAGOS	132	20
Ejigbo_Ikeja-West_132_cct1	1 LAGOS	132	13.32
Ejigbo_Ikeja-West_132_cct2	1 LAGOS	132	13.32
Ejigbo_Itire_132_cct1	1 LAGOS	132	8
Ejigbo_Itire_132_cct2	1 LAGOS	132	8
Eket_Ibom_132_cct1	8 PT HARCO	132	45
Eket_Ibom_132_cct2	8 PT HARCO	132	45
Eket_Uyo_132_cct1	8 PT HARCO	132	46
Eket_Uyo_132_cct2	8 PT HARCO	132	46
Elelenwo_Rivers_132_cct1	8 PT HARCO	132	3.96
Elelenwo_Rivers_132_cct2	8 PT HARCO	132	3.96
Eyeon_Okada_132_cct1	4 BENIN	132	60
Eyeon_Okada_132_cct2	4 BENIN	132	60
Funtua_Gusau_132_cct1	5 KADUNA	132	110
Funtua_Zaria_132_cct1	5 KADUNA	132	70
Ganmo_Ilorin_132_cct1	2 OSOGBO	132	5
Ganmo_Ilorin_132_cct2	2 OSOGBO	132	5
Ganmo_Offra_132_cct1	2 OSOGBO	132	50
Ganmo_Offra_132_cct2	2 OSOGBO	132	50
Gazoua_Katsina_132_cct1	5 KADUNA	132	71.28
GCM_Onitsha_132_cct1	7 ENUGU	132	18.5
Gombe_T-Junction_132_cct1	6 BAUCHI	132	40
Gusau_Talata-Mafara_132_cct1	5 KADUNA	132	85
Ibadan-North_Iwo_132_cct1	2 OSOGBO	132	18
Ife_Ilesha_132_cct1	2 OSOGBO	132	19.5
Ife_Ondo_132_cct1	2 OSOGBO	132	58
Ijebu-Ode_Shagamu_132_cct1	1 LAGOS	132	41
Ikeja-West_Illupeju_132_cct1	1 LAGOS	132	20
Ikeja-West_Illupeju_132_cct2	1 LAGOS	132	20
Ikeja-West_Otta_132_cct1	1 LAGOS	132	12
Ikeja-West_Otta_132_cct2	1 LAGOS	132	12

Ikeja-West_Oworosoki_132_cct1	1 LAGOS	132	49
Ikeja-West_Oworosoki_132_cct2	1 LAGOS	132	49
Ikorodu_Maryland_132_cct1	1 LAGOS	132	13.715
Ikorodu_Shagamu-Tee_132_cct1	1 LAGOS	132	30.9
Ilesha_Osoybo_132_cct1	2 OSOYBO	132	17
Illupeju_Maryland_132_cct1	1 LAGOS	132	5.7
Illupeju_Maryland_132_cct2	1 LAGOS	132	5.7
Irrua_Ukpilla_132_cct1	4 BENIN	132	43
Iseyin_Iwo_132_cct1	2 OSOYBO	132	71
Itu_Uyo_132_cct1	8 PT HARCO	132	18
Itu_Uyo_132_cct2	8 PT HARCO	132	18
Iwo_Osoybo_132_cct1	2 OSOYBO	132	80
Jalingo_Mayo-Belwa_132_cct1	6 BAUCHI	132	140
Jos_Kafanchan_132_cct1	6 BAUCHI	132	77
Jos_Kafanchan_132_cct2	6 BAUCHI	132	77
Jos_Makeri_132_cct1	6 BAUCHI	132	50
Jos_Makeri_132_cct2	6 BAUCHI	132	50
Kaduna_Kaduna-Town_132_cct1	5 KADUNA	132	14
Kaduna_Zaria_132_cct1	5 KADUNA	132	62
Kankia_Kano_132_cct1	5 KADUNA	132	113
Kankia_Katsina_132_cct1	5 KADUNA	132	69
Kano_Katsina_132_cct1	5 KADUNA	132	145
Kano_Tamburawa_132_cct1	5 KADUNA	132	20
Kano_Wudil_132_cct1	5 KADUNA	132	50
Karu_Keffi_132_cct1	3 SHIRORO	132	41
Katampe_Kubwa_132_cct1	3 SHIRORO	132	7
Katampe_Kubwa_132_cct2	3 SHIRORO	132	7
Kontagora_Tegina_132_cct1	3 SHIRORO	132	90
Kontagora_Yelwa_132_cct1	3 SHIRORO	132	88
Kubwa_Suleja_132_cct1	3 SHIRORO	132	40
Kubwa_Suleja_132_cct2	3 SHIRORO	132	40
Kwanar-Dangora_Tamburawa_132_cct1	5 KADUNA	132	40
Kwanar-Dangora_Zaria_132_cct1	5 KADUNA	132	84.8
Maryland_Oke-Aro_132_cct1	1 LAGOS	132	8.168
Mayo-Belwa_Yola_132_cct1	6 BAUCHI	132	20
Minna_Shiroro_132_cct1	3 SHIRORO	132	68
Minna_Shiroro_132_cct2	3 SHIRORO	132	68
Minna_Suleja_132_cct1	3 SHIRORO	132	99
Minna_Suleja_132_cct2	3 SHIRORO	132	99
New-Haven_Nkalagu_132_cct1	7 ENUGU	132	39
New-Haven_Nkalagu_132_cct2	7 ENUGU	132	39
New-Haven_Oji-River_132_cct1	7 ENUGU	132	44.1
New-Haven_Oturkpo_132_cct1	7 ENUGU	132	156.1
Numan_Savannah-Tee_132_cct1	6 BAUCHI	132	85
Numan_Yola_132_cct1	6 BAUCHI	132	50

Offa_Omuaran_132_cct1	2 OSOGBO	132	47.53
Offa_Osogbo_132_cct1	2 OSOGBO	132	43.5
Ogba_Otta_132_cct1	1 LAGOS	132	44.3
Oke-Aro_Ikorodu_132_cct1	1 LAGOS	132	8.687
Okene_Ukpilla_132_cct1	4 BENIN	132	33
Okigwe_Mbalano_132_cct1	7 ENUGU	132	22
Old-Abeokuta_Papalanto_132_cct1	1 LAGOS	132	55
Otta_Papalanto_132_cct1	1 LAGOS	132	12
PHCT-Main_PHCT-Town_132_cct1	8 PT HARCO	132	3
PHCT-Main_PHCT-Town_132_cct2	8 PT HARCO	132	3
PHCT-Main_Rivers_132_cct1	8 PT HARCO	132	18.9
Savannah_T-Junction_132_cct1	6 BAUCHI	132	52
Shagamu_Shagamu-Tee_132_cct1	1 LAGOS	132	5
Shagamu-Cement_Shagamu-Tee_132_cct1	1 LAGOS	132	3
Shiroro_Tegina_132_cct1	3 SHIRORO	132	65
Sokoto_Talata-Mafara_132_cct1	3 SHIRORO	132	125
Kingsway_Nsukka_66_cct1	7 ENUGU	66	10

Annex 1.2 – Transmission Transformers (not supplying DISCOs)

Name	Region	Rating HV [MVA]	Rating MV [MVA]	Rating LV [MVA]	Voltage level HV side [kV]	Voltage level MV side [kV]	Voltage level LV side [kV]	2w/3w
Akangba_330_132_trf1	1 LAGOS	150	150	27.5	330	145.2	33	3w
Akangba_330_132_trf2	1 LAGOS	150	150	27.5	330	145.2	33	3w
Akangba_330_132_trf3	1 LAGOS	90	90	22.5	330	145.2	13.8	3w
Akangba_330_132_trf4	1 LAGOS	90	90	22.5	330	145.2	13.8	3w
Akangba_330_132_trf5	1 LAGOS	90	90	22.5	330	145.2	13.8	3w
Akangba_330_132_trf6	1 LAGOS	90	90	22.5	330	132	13.8	3w
Alangbon_330_132_trf1	1 LAGOS	90	90	22.5	330	132	13.8	3w
Egbin_330_132_trf1	1 LAGOS	150	150	27.5	330	138.6	33	3w
Egbin_330_132_trf2	1 LAGOS	150	150	150	330	138.6	33	3w
Ikeja-West_330_132_trf1	1 LAGOS	150	50	50	330	132	33	3w
Ikeja-West_330_132_trf2	1 LAGOS	150	150	75	330	143.88	33	3w
Ikeja-West_330_132_trf3	1 LAGOS	150	150	75	330	143.88	33	3w
Ikeja-West_330_132_trf4	1 LAGOS	150	150	75	330	143.88	33	3w
Ikeja-West_330_132_trf5	1 LAGOS	150	150	27.5	330	145.2	33	3w
Oke-Aro_330_132_trf1	1 LAGOS	300	225	75	330	138.6	33	3w
Oke-Aro_330_132_trf2	1 LAGOS	300	300	75	330	138.6	33	3w
Ayede_330_132_trf1	2 OSOGBO	150	150	75	330	143.88	33	3w
Ayede_330_132_trf2	2 OSOGBO	150	150	75	330	143.88	33	3w
Ayede_330_132_trf3	2 OSOGBO	150	150	37.5	330	132	33	3w
Ganmo_330_132_trf1	2 OSOGBO	150	150	37.5	330	137.28	33	3w
Ganmo_330_132_trf2	2 OSOGBO	150	112.5	37.5	330	137.28	33	3w
Omotosho_330_132_trf1	2 OSOGBO	150	150	37.5	330	145.2	33	3w
Osogbo_330_132_trf1	2 OSOGBO	150	150	37.5	330	132	33	3w
Osogbo_330_132_trf2	2 OSOGBO	150	150	37.5	330	141.24	33	3w
Osogbo_330_132_trf3	2 OSOGBO	90	90	22.5	330	141.24	18	3w
Osogbo_330_132_trf4	2 OSOGBO	150			330			3w
Bkebbi_330_132_trf1	3 SHIRORO	150	150	37.5	330	137.28	33	3w
Bkebbi_330_132_trf2	3 SHIRORO	90	90	90	330	137.28	13.8	3w
Bkebbi_330_132_trf3	3 SHIRORO	90	90	90	330	132	13.8	3w
Gwagwalada_330_132_trf1	3 SHIRORO	150	150	37.5	330	145.2	33	3w
Gwagwalada_330_132_trf2	3 SHIRORO	150	150	37.5	330	145.2	33	3w
Jebba-Ts_330_132_trf1	3 SHIRORO	90	90	20	330	132	13.8	3w
Katampe_330_132_trf1	3 SHIRORO	150	150	37.5	330	145.2	33	3w
Katampe_330_132_trf2	3 SHIRORO	150	150	37.5	330	145.2	33	3w
Katampe_330_132_trf3	3 SHIRORO	150	150	37.5	330	145.2	33	3w
Shiroro_330_132_trf1	3 SHIRORO	150	150	37.5	330	134.64	33	3w
Shiroro_330_132_trf2	3 SHIRORO	150	150	37.5	330	134.64	33	3w

Aja_330_132_trf1	4 BENIN	150	150	27.5	330	138.6	33	3w
Aja_330_132_trf2	4 BENIN	150	150	27.5	330	138.6	33	3w
Aja_330_132_trf3	4 BENIN	150	150	27.5	330	138.6	33	3w
Ajaokuta_330_132_trf1	4 BENIN	162	162	40.5	330	132	33	3w
Ajaokuta_330_132_trf2	4 BENIN	162	162	80	330	132	33	3w
Ajaokuta_330_132_trf3	4 BENIN	162	162	40.5	330	132	33	3w
Benin_330_132_trf1	4 BENIN	150	150	37.5	330	143.88	33	3w
Benin_330_132_trf2	4 BENIN	150	150	50	330	142.56	33	3w
Delta-lv_330_132_trf1	4 BENIN	150	150	27.5	330	133.32	33	3w
Eyean_330_132_Trf1	4 BENIN	300	225	75	330	138.6	33	3w
Lokoja_330_132_Trf1	4 BENIN	150	150	37.5	330	145.2	33	3w
Kaduna_330_132_trf1	5 KADUNA	90	90	22.5	330	132	33	3w
Kaduna_330_132_trf2	5 KADUNA	60	60	15	330	132	13.8	3w
Kaduna_330_132_trf3	5 KADUNA	150	150	37.5	330	132	33	3w
Kaduna_330_132_trf4	5 KADUNA	150	150	37.5	330	132	33	3w
Kaduna_330_132_trf5	5 KADUNA	150	150	37.5	330	132	33	3w
Kano_330_132_trf1	5 KADUNA	150	150	37.5	330	138.6	33	3w
Kano_330_132_trf2	5 KADUNA	150	150	50	330	138.6	33	3w
Kano_330_132_trf3	5 KADUNA	150	150	37.5	330	138.6	33	3w
Kano_330_132_trf4	5 KADUNA	150	150	37.5	330	138.6	33	3w
Gombe_330_132_trf1	6 BAUCHI	150	150	37.5	330	138.6	33	3w
Gombe_330_132_trf2	6 BAUCHI	150	150	37.5	330	138.6	33	3w
Jos_330_132_trf1	6 BAUCHI	150	150	37.5	330	138.6	33	3w
Jos_330_132_trf2	6 BAUCHI	150	150	37.5	330	138.6	33	3w
Yola_330_132_trf1	6 BAUCHI	150	150	37.5	330	145.2	33	3w
Yola_330_132_trf2	6 BAUCHI	150	150	37.5	330	132	33	3w
Asaba_330_132_trf1	7 ENUGU	150	150	37.5	330	145.2	33	3w
Asaba_330_132_trf2	7 ENUGU	150	150	37.5	330	145.2	33	3w
Makurdi_330_132_trf1	7 ENUGU	150	150	37.5	330	132	33	3w
New-Haven_330_132_trf1	7 ENUGU	150	150	37.5	330	138.6	33	3w
New-Haven_330_132_trf2	7 ENUGU	150	150	75	330	138.6	33	3w
Onitsha_330_132_trf1	7 ENUGU	150	150	37.5	330	142.56	33	3w
Onitsha_330_132_trf2	7 ENUGU	150	150	37.5	330	132	33	3w
Onitsha_330_132_trf3	7 ENUGU	90	90	22.5	330	142.56	13.8	3w
Onitsha_330_132_trf4	7 ENUGU	90	90	30	330	142.56	13.8	3w
Ugwuaji_330_132_trf1	7 ENUGU	150	150	27.5	330	132	33	3w
Oji-River_132_66_trf1	7 ENUGU	30		30	132		66	2w
Adiabo_330_132_trf1	8 PT HARCO	150	150	37.5	330	145.2	33	2w
Adiabo_330_132_trf2	8 PT HARCO	150	150	37.5	330	145.2	33	2w
Afam_330_132_trf1	8 PT HARCO	162	162	60	330	145.2	33	2w
Afam_330_132_trf2	8 PT HARCO	198	198	60	330	145.2	33	2w
Alaoji_330_132_trf1	8 PT HARCO	150	150	37.5	330	145.2	33	3w

Alaoji_330_132_trf2	8 PT HARCO	150	150	37.5	330	145.2	33	3w
Alaoji_330_132_trf3	8 PT HARCO	150	150	37.5	330	145.2	33	3w
Afam_132_33_trf1	8 PT HARCO	30			132		33	2w
Alaoji_132_33_trf1	8 PT HARCO	60			132		33	2w
Alaoji_132_33_trf2	8 PT HARCO	60			132		33	2w
Alaoji_132_33_trf3	8 PT HARCO	30			132		33	2w
Alaoji_132_33_trf4	8 PT HARCO	60			132		33	2w
Afam_132_11_trf1	8 PT HARCO	64			132		11	2w

Annex 1.3 – Transformers at Transmission Substation (supplying DISCOs)

Name	Region	DISCO	Rating HV [MVA]	Rating MV [MVA]	Rating LV [MVA]	Voltage level HV side [kV]	Voltage level MV side [kV]	Voltage level LV side [kV]	2w/3w
Agbara_132_33_trf1	1 LAGOS	Eko	60		60	132		33.99	2w
Agbara_132_33_trf2	1 LAGOS	Eko	60		60	132		33.99	2w
Agbara_132_33_trf3	1 LAGOS	Eko	60		60	132		33.99	2w
Akangba_132_33_trf1	1 LAGOS	Eko	60		60	132		33	2w
Akangba_132_33_trf2	1 LAGOS	Eko	60		60	132		33	2w
Akangba_132_33_trf3	1 LAGOS	Eko	60		60	132		33	2w
Akoka_132_33_trf1	1 LAGOS	Eko	40		40	132		34.65	2w
Akoka_132_33_trf2	1 LAGOS	Eko	45		45	132		34.65	2w
Alagbon_132_33_trf1	1 LAGOS	Eko	60		60	132		34.65	2w
Alagbon_132_33_trf2	1 LAGOS	Eko	60		60	132		34.65	2w
Alausa_132_33_trf1	1 LAGOS	Ikeja	30		30	132		34.65	2w
Alausa_132_33_trf2	1 LAGOS	Ikeja	30		30	132		34.65	2w
Alausa_132_33_trf3	1 LAGOS	Ikeja	60		60	132		34.65	2w
Alimosho_132_33_trf1	1 LAGOS	Ikeja	100		100	132		34.65	2w
Alimosho_132_33_trf2	1 LAGOS	Ikeja	30		30	132		34.65	2w
Alimosho_132_33_trf3	1 LAGOS	Ikeja	30		30	132		34.65	2w
Amuwo-Odofin_132_33_trf1	1 LAGOS	Eko	30		30	132		34.32	2w
Amuwo-Odofin_132_33_trf2	1 LAGOS	Eko	60		60	132		34.32	2w
Amuwo-Odofin_132_33_trf3	1 LAGOS	Eko	40		40	132		34.32	2w
Amuwo-Odofin_132_33_trf4	1 LAGOS	Eko	40		40	132		34.65	2w
Apapa-Road_132_33_trf1	1 LAGOS	Eko	45		45	132		34.65	2w
Apapa-Road_132_33_trf2	1 LAGOS	Eko	45		45	132		34.65	2w
Ayobo_132_33_trf1	1 LAGOS	Ikeja	60		60	132		34.65	2w
Ayobo_132_33_trf2	1 LAGOS	Ikeja	60		60	132		34.65	2w
Egbin_132_33_trf3	1 LAGOS	Eko	100			132		33	2w
Ejigbo_132_33_trf1	1 LAGOS	Ikeja	30		30	132		34.32	2w
Ejigbo_132_33_trf2	1 LAGOS	Ikeja	30		30	132		34.32	2w
Ejigbo_132_33_trf3	1 LAGOS	Ikeja	100		100	132		34.32	2w
Ijebu-Ode_132_33_trf1	1 LAGOS	Ibadan	30		30	132		33.66	2w
Ijebu-Ode_132_33_trf2	1 LAGOS	Ibadan	30		30	132		33.66	2w
Ijora_132_33_trf1	1 LAGOS	Eko	30		30	132		34.32	2w
Ijora_132_33_trf2	1 LAGOS	Eko	30		30	132		34.32	2w

Ijora_132_33_trf3	1 LAGOS	Eko	45		45	132		34.65	2w
Ijora_132_33_trf4	1 LAGOS	Eko	30		30	132		34.32	2w
Ikorodu_132_33_trf1	1 LAGOS	Ikeja	60		60	132		33.33	2w
Ikorodu_132_33_trf2	1 LAGOS	Ikeja	60		60	132		33.33	2w
Ikorodu_132_33_trf3	1 LAGOS	Ikeja	100		100	132		33.33	2w
Illupeju_132_33_trf1	1 LAGOS	Ikeja	30		30	132		32.34	2w
Illupeju_132_33_trf2	1 LAGOS	Ikeja	30		30	132		32.34	2w
Illupeju_132_33_trf4	1 LAGOS	Ikeja	30			132		33	2w
Isolo_132_33_trf1	1 LAGOS	Ikeja	30		30	132		34.32	2w
Isolo_132_33_trf2	1 LAGOS	Ikeja	60		60	132		34.32	2w
Isolo_132_33_trf3	1 LAGOS	Ikeja	60		60	132		34.32	2w
Itire_132_33_trf1	1 LAGOS	Eko	40		40	132		34.65	2w
Itire_132_33_trf2	1 LAGOS	Eko	30		30	132		34.65	2w
Itire_132_33_trf3	1 LAGOS	Eko	60		60	132		34.65	2w
Lekki_132_33_trf1	1 LAGOS	Eko	60		60	132		34.65	2w
Lekki_132_33_trf2	1 LAGOS	Eko	60		60	132		34.65	2w
Maryland_132_33_trf1	1 LAGOS	Ikeja	60		60	132		34.65	2w
Maryland_132_33_trf2	1 LAGOS	Ikeja	30		30	132		34.65	2w
Maryland_132_33_trf3	1 LAGOS	Ikeja	30		30	132		34.65	2w
Ogba_132_33_trf1	1 LAGOS	Ikeja	30		30	132		34.65	2w
Ogba_132_33_trf2	1 LAGOS	Ikeja	60		60	132		34.65	2w
Ogba_132_33_trf3	1 LAGOS	Ikeja	60		60	132		34.65	2w
Ogba_132_33_trf4	1 LAGOS	Ikeja	40		40	132		34.65	2w
Ojo_132_33_trf1	1 LAGOS	Eko	30		30	132		33	2w
Ojo_132_33_trf2	1 LAGOS	Eko	30		30	132		33	2w
Ojo_132_33_trf3	1 LAGOS	Eko	60		60	132		33.66	2w
Ojo_132_33_trf4	1 LAGOS	Eko	60		60	132		33.66	2w
Oke-Aro_132_33_trf1	1 LAGOS	Ikeja	60		60	132		34.65	2w
Oke-Aro_132_33_trf2	1 LAGOS	Ikeja	60		60	132		34.65	2w
Old-Abeokuta_132_33_trf1	1 LAGOS	Ibadan	30		30	132		31.35	2w
Old-Abeokuta_132_33_trf2	1 LAGOS	Ibadan	30		30	132		31.35	2w
Old-Abeokuta_132_33_trf3	1 LAGOS	Ibadan	30		30	132		31.35	2w
Otta_132_33_trf1	1 LAGOS	Ibadan	60		60	132		34.65	2w
Otta_132_33_trf2	1 LAGOS	Ibadan	40		40	132		34.65	2w
Otta_132_33_trf3	1 LAGOS	Ibadan	40		40	132		34.65	2w
Otta_132_33_trf4	1 LAGOS	Ibadan	60		60	132		34.65	2w
Oworosoki_132_33_trf1	1 LAGOS	Ikeja	60		60	132		34.65	2w
Oworosoki_132_33_trf2	1 LAGOS	Ikeja	60		60	132		34.65	2w
Papalanto_132_33_trf1	1 LAGOS	Ibadan	30		30	132		34.32	2w
Papalanto_132_33_trf2	1 LAGOS	Ibadan	15		15	132		33.99	2w
Papalanto_132_33_trf3	1 LAGOS	Ibadan	15		15	132		33.99	2w
Shagamu_132_33_trf1	1 LAGOS	Ibadan	30		30	132		33	2w
Shagamu_132_33_trf2	1 LAGOS	Ibadan	30		30	132		33	2w
Illupeju_132_11_trf1	1 LAGOS	Ikeja	15		15	132		10.78	2w
Illupeju_132_11_trf2	1 LAGOS	Ikeja	15		15	132		10.78	2w
Ogba_132_11_trf1	1 LAGOS	Ikeja	20		20	132		11.55	2w
Ado-Ekiti_132_33_trf1	2 OSOGBO	Benin	40		40	132		33	2w

Ado-Ekiti_132_33_trf2	2 OSOGBO	Benin	40		40	132		33	2w
Akure_132_33_trf1	2 OSOGBO	Benin	60		60	132		32.67	2w
Akure_132_33_trf2	2 OSOGBO	Benin	30		30	132		32.67	2w
Akure_132_33_trf3	2 OSOGBO	Benin	30		30	132		32.67	2w
Ayede_132_33_trf1	2 OSOGBO	Ibadan	100		100	132		33.66	2w
Ayede_132_33_trf2	2 OSOGBO	Ibadan	60		60	132		33.66	2w
Ayede_132_33_trf3	2 OSOGBO	Ibadan	60			132		33	2w
Ganmo_132_33_trf1	2 OSOGBO	Ibadan	60		60	132		32.34	2w
Ganmo_132_33_trf2	2 OSOGBO	Ibadan	60		60	132		32.34	2w
Ganmo_132_33_trf3	2 OSOGBO	Ibadan	45			132		33	2w
Ganmo_132_33_trf4	2 OSOGBO	Ibadan	60			132		33	2w
Ibadan-North_132_33_trf1	2 OSOGBO	Ibadan	60		60	132		33	2w
Ibadan-North_132_33_trf2	2 OSOGBO	Ibadan	60		60	132		33	2w
Ife_132_33_trf1	2 OSOGBO	Ibadan	30		30	132		33.66	2w
Ife_132_33_trf2	2 OSOGBO	Ibadan	30		30	132		33.66	2w
Ilesha_132_33_trf1	2 OSOGBO	Ibadan	40		40	132		33.66	2w
Ilesha_132_33_trf2	2 OSOGBO	Ibadan	40		40	132		33.66	2w
Ilorin_132_33_trf1	2 OSOGBO	Ibadan	45		45	132		32.34	2w
Ilorin_132_33_trf2	2 OSOGBO	Ibadan	60		60	132		32.34	2w
Iseyin_132_33_trf1	2 OSOGBO	Ibadan	45		45	132		32.01	2w
Iwo_132_33_trf1	2 OSOGBO	Ibadan	40		40	132		33	2w
Jericho_132_33_trf1	2 OSOGBO	Ibadan	45		45	132		33.33	2w
Jericho_132_33_trf2	2 OSOGBO	Ibadan	40		40	132		33.33	2w
Offa_132_33_trf1	2 OSOGBO	Ibadan	30		30	132		34.32	2w
Omuaran_132_33_trf1	2 OSOGBO	Ibadan	30		30	132		33.99	2w
Omuaran_132_33_trf2	2 OSOGBO	Ibadan	30		30	132		33.99	2w
Ondo_132_33_trf1	2 OSOGBO	Benin	30		30	132		34.32	2w
Ondo_132_33_trf2	2 OSOGBO	Benin	30		30	132		33	2w
Osogbo_132_33_trf1	2 OSOGBO	Ibadan	60		60	132		32.34	2w
Osogbo_132_33_trf2	2 OSOGBO	Ibadan	30		30	132		32.34	2w
Osogbo_132_33_trf3	2 OSOGBO	Ibadan	60		60	132		32.34	2w
Osogbo_132_33_trf4	2 OSOGBO	Ibadan	60			132		33	2w
Osogbo_132_33_trf5	2 OSOGBO	Ibadan	30			132		33	2w
Akwanga_132_33_trf1	3 SHIRORO	Abuja	40		40	132		34.155	2w
Akwanga_132_33_trf2	3 SHIRORO	Abuja	40		40	132		34.155	2w
Apo_132_33_trf1	3 SHIRORO	Abuja	45		45	132		34.65	2w
Apo_132_33_trf2	3 SHIRORO	Abuja	45		45	132		34.65	2w
Apo_132_33_trf3	3 SHIRORO	Abuja	60		60	132		34.65	2w
Apo_132_33_trf4	3 SHIRORO	Abuja	100		100	132		34.65	2w
Bida_132_33_trf1	3 SHIRORO	Abuja	30		30	132		34.65	2w
Bida_132_33_trf2	3 SHIRORO	Abuja	30		30	132		34.65	2w
Birnin-Kebbi_132_33_trf1	3 SHIRORO	Kaduna	60		60	132		33	2w
Birnin-Kebbi_132_33_trf2	3 SHIRORO	Yola	30		30	132		33.99	2w
Birnin-Kebbi_132_33_trf3	3 SHIRORO	Yola	15		15	132		33	2w
Central-Area_132_33_trf1	3 SHIRORO	Abuja	60		60	132		33.99	2w
Central-Area_132_33_trf2	3 SHIRORO	Abuja	60		60	132		33.99	2w
Central-Area_132_33_trf3	3 SHIRORO	Abuja	60		60	132		33.99	2w

Gwagwalada_132_33_trf1	3 SHIRORO	Abuja	60		60	132		34.65	2w
Gwagwalada_132_33_trf2	3 SHIRORO	Abuja	60			132		33	2w
Jebba_132_33_trf1	3 SHIRORO	Ibadan	30		30	132		33.33	2w
Karu_132_33_trf1	3 SHIRORO	Abuja	60		60	132		34.65	2w
Karu_132_33_trf2	3 SHIRORO	Abuja	60		60	132		34.65	2w
Katampe_132_33_trf1	3 SHIRORO	Abuja	60		60	132		34.65	2w
Katampe_132_33_trf2	3 SHIRORO	Abuja	60		60	132		34.65	2w
Keffi_132_33_trf1	3 SHIRORO	Abuja	30		30	132		34.65	2w
Kontagora_132_33_trf1	3 SHIRORO	Abuja	30		30	132		33	2w
Kubwa_132_33_trf1	3 SHIRORO	Abuja	60		60	132		33.66	2w
Kubwa_132_33_trf2	3 SHIRORO	Abuja	60		60	132		33.66	2w
Minna_132_33_trf1	3 SHIRORO	Abuja	60		60	132		34.65	2w
Minna_132_33_trf2	3 SHIRORO	Abuja	60		60	132		34.65	2w
Minna_132_33_trf3	3 SHIRORO	Abuja	30		30	132		34.65	2w
Shiroro_132_33_trf1	3 SHIRORO	Abuja	30		30	132		33.66	2w
Sokoto_132_33_trf1	3 SHIRORO	Kaduna	30		30	132		34.65	2w
Sokoto_132_33_trf2	3 SHIRORO	Kaduna	30		30	132		34.65	2w
Sokoto_132_33_trf3	3 SHIRORO	Kaduna	30		30	132		34.65	2w
Suleja_132_33_trf1	3 SHIRORO	Abuja	45		45	132		34.65	2w
Suleja_132_33_trf2	3 SHIRORO	Abuja	30		30	132		34.65	2w
Talata-Mafara_132_33_trf1	3 SHIRORO	Kaduna	30		30	132		34.65	2w
Tegina_132_33_trf1	3 SHIRORO	Abuja	30		30	132		33	2w
Bida_132_11_trf1	3 SHIRORO	Abuja	15		15	132		11.5	2w
Bida_132_11_trf2	3 SHIRORO	Abuja	15		15	132		11.5	2w
Minna_132_11_trf1	3 SHIRORO	Abuja	15		15	132		11.5	2w
Minna_132_11_trf2	3 SHIRORO	Abuja	15		15	132		11.5	2w
Suleja_132_11_trf1	3 SHIRORO	Abuja	7.5		7.5	132		11.55	2w
Aja_132_33_trf1	4 BENIN	Eko	60		60	132		33.66	2w
Aja_132_33_trf2	4 BENIN	Eko	60		60	132		33.66	2w
Aja_132_33_trf3	4 BENIN	Eko	100			132		33	2w
Ajaokuta_132_33_trf1	4 BENIN	Abuja	60		60	132		34.65	2w
Ajaokuta_132_33_trf2	4 BENIN	Abuja	60		60	132		34.65	2w
Amukpe_132_33_trf1	4 BENIN	Benin	30		30	132		34.65	2w
Amukpe_132_33_trf2	4 BENIN	Benin	60		60	132		32.67	2w
Benin_132_33_trf1	4 BENIN	Benin	60		60	132		33.66	2w
Benin_132_33_trf2	4 BENIN	Benin	60		60	132		33.66	2w
Benin_132_33_trf3	4 BENIN	Benin	60		60	132		33.66	2w
Benin_132_33_trf4	4 BENIN	Benin	60		60	132		33.66	2w
Delta_132_33_trf1	4 BENIN	Benin	60		60	132		34.65	2w
Delta_132_33_trf2	4 BENIN	Benin	30		30	132		34.65	2w
Effurun_132_33_trf1	4 BENIN	Benin	60		60	132		34.65	2w
Effurun_132_33_trf2	4 BENIN	Benin	60		60	132		34.65	2w
Effurun_132_33_trf3	4 BENIN	Benin	60		60	132		34.65	2w
Irrua_132_33_trf1	4 BENIN	Benin	60		60	132		34.32	2w
Irrua_132_33_trf2	4 BENIN	Benin	30		30	132		34.32	2w
Lokoja_132_33_Trf1	4 BENIN	Abuja	60		60	132		34.65	2w
Okada_132_33_Trf1	4 BENIN	Benin	40		40	132		34.65	2w

Okene_132_33_trf1	4 BENIN	Abuja	30		30	132		33.99	2w
Okene_132_33_trf2	4 BENIN	Abuja	40		40	132		33.99	2w
Ukpilla_132_33_trf1	4 BENIN	Benin	15		15	132		34.65	2w
Azare_132_33_trf1	5 KADUNA	Jos	30		30	132		33.99	2w
Azare_132_33_trf2	5 KADUNA	Jos	30		30	132		33.99	2w
Dakata_132_33_trf1	5 KADUNA	Kano	60		60	132		33.66	2w
Dakata_132_33_trf2	5 KADUNA	Kano	60		60	132		33.66	2w
Dakata_132_33_trf3	5 KADUNA	Kano	30		30	132		33.66	2w
Dan-Agundi_132_33_trf1	5 KADUNA	Kano	60		60	132		34.65	2w
Dan-Agundi_132_33_trf2	5 KADUNA	Kano	60		60	132		34.65	2w
Dutse_132_33_trf1	5 KADUNA	Kano	30		30	132		33.99	2w
Dutse_132_33_trf2	5 KADUNA	Kano	30		30	132		33.99	2w
Funtua_132_33_trf1	5 KADUNA	Kano	30		30	132		34.65	2w
Gusau_132_33_trf1	5 KADUNA	Kaduna	30		30	132		34.65	2w
Gusau_132_33_trf2	5 KADUNA	Kaduna	30		30	132		34.65	2w
Hadejia_132_33_trf1	5 KADUNA	Kano	7.5		7.5	132		31.35	2w
Hadejia_132_33_trf2	5 KADUNA	Kano	15		15	132		31.35	2w
Kaduna_132_33_trf1	5 KADUNA	Kaduna	60		60	132		33.66	2w
Kaduna_132_33_trf2	5 KADUNA	Kaduna	60		60	132		33.66	2w
Kaduna_132_33_trf3	5 KADUNA	Kaduna	60		60	132		33.66	2w
Kaduna_132_33_trf4	5 KADUNA	Kaduna	60		60	132		33	2w
Kaduna_132_33_trf5	5 KADUNA	Kaduna	30			132		33	2w
Kaduna-Town_132_33_trf2	5 KADUNA	Kaduna	60		60	132		34.65	2w
Kaduna-Town_132_33_trf3	5 KADUNA	Kaduna	30		30	132		34.65	2w
Kaduna-Town_132_33_trf4	5 KADUNA	Kaduna	60		60	132		34.65	2w
Kankia_132_33_trf1	5 KADUNA	Kano	30		30	132		34.65	2w
Kankia_132_33_trf2	5 KADUNA	Kano	30		30	132		33	2w
Kano_132_33_trf1	5 KADUNA	Kano	40		40	132		34.32	2w
Kano_132_33_trf2	5 KADUNA	Kano	30		30	132		33.99	2w
Kano_132_33_trf3	5 KADUNA	Kano	30		30	132		34.32	2w
Kano_132_33_trf4	5 KADUNA	Kano	60		60	132		34.32	2w
Katsina_132_33_trf1	5 KADUNA	Kano	60		60	132		33	2w
Katsina_132_33_trf2	5 KADUNA	Kano	30		30	132		33	2w
Katsina_132_33_trf3	5 KADUNA	Kano	30		30	132		33	2w
Kwanar-Dango_132_33_trf1	5 KADUNA	Kano	30		30	132		34.32	2w
Tamburawa_132_33_trf1	5 KADUNA	Kano	30		30	132		33	2w
Tamburawa_132_33_trf2	5 KADUNA	Kano	30		30	132		34.65	2w
Zaria_132_33_trf1	5 KADUNA	Kaduna	40		40	132		31.68	2w
Zaria_132_33_trf2	5 KADUNA	Kaduna	60		60	132		31.68	2w
Funtua_132_11_trf1	5 KADUNA	Kano	7.5		7.5	132		11.55	2w
Funtua_132_11_trf2	5 KADUNA	Kano	7.5		7.5	132		11.55	2w
Kaduna-Town_132_11_trf1	5 KADUNA	Kaduna	15		15	132		11.55	2w
Kano_132_11_trf1	5 KADUNA	Kano	15			132		11	2w
Bauchi_132_33_trf1	6 BAUCHI	Jos	40		40	132		34.65	2w
Bauchi_132_33_trf2	6 BAUCHI	Jos	40		40	132		34.65	2w
Biu_132_33_trf1	6 BAUCHI	Kaduna	60	33,75	60	132	34,65	33	2w

Biu_132_33_trf2	6 BAUCHI	Kaduna	30		30	132		33	2w
Gombe_132_33_trf1	6 BAUCHI	Jos	45			132		33	2w
Gombe_132_33_trf2	6 BAUCHI	Jos	60	11.25	132			11	3w
Jalingo_132_33_trf1	6 BAUCHI	Yola	30		30	132		34.65	2w
Jalingo_132_33_trf2	6 BAUCHI	Yola	30		30	132		34.65	2w
Jos_132_33_trf1	6 BAUCHI	Jos	60		60	132		34.65	2w
Jos_132_33_trf2	6 BAUCHI	Jos	60		60	132		34.65	2w
Kafanchan_132_33_trf1	6 BAUCHI	Kaduna	40		40	132		34.32	2w
Maiduguri_132_33_trf1	6 BAUCHI	Yola	15		15	132		33	2w
Maiduguri_132_33_trf2	6 BAUCHI	Yola	45		45	132		33	2w
Maiduguri_132_33_trf3	6 BAUCHI	Yola	45		45	132		33	2w
Makeri_132_33_trf1	6 BAUCHI	Jos	60		60	132		34.32	2w
Makeri_132_33_trf2	6 BAUCHI	Jos	60		60	132		34.32	2w
Potiskum_132_33_trf1	6 BAUCHI	Yola	30		30	132		34.32	2w
Potiskum_132_33_trf2	6 BAUCHI	Yola	30		30	132		34.32	2w
Savannah_132_33_trf1	6 BAUCHI	Yola	15		15	132		34.65	2w
Yola_132_33_trf1	6 BAUCHI	Yola	30		30	132		34.65	2w
Yola_132_33_trf2	6 BAUCHI	Yola	60		60	132		34.65	2w
Nsukka_66_33_trf1	7 ENUGU	Enugu	7.5		7.5	66		33.99	2w
Nsukka_66_33_trf2	7 ENUGU	Enugu	7.5		7.5	66		33.99	2w
Abakaliki_132_33_trf1	7 ENUGU	Enugu	30		30	132		33	2w
Abakaliki_132_33_trf2	7 ENUGU	Enugu	60		60	132		33	2w
Agu-Awka_132_33_trf1	7 ENUGU	Enugu	40		40	132		34.65	2w
Apir_132_33_trf1	7 ENUGU	Jos	40			132		33	2w
Asaba_132_33_trf1	7 ENUGU	Benin	60		60	132		34.65	2w
Asaba_132_33_trf2	7 ENUGU	Benin	60		60	132		34.65	2w
Awka_132_33_trf1	7 ENUGU	Enugu	30		30	132		32.34	2w
Awka_132_33_trf2	7 ENUGU	Enugu	30		30	132		32.34	2w
GCM_132_33_trf1	7 ENUGU	Enugu	60		60	132		34.65	2w
Makurdi_132_33_trf1	7 ENUGU	Jos	40		40	132		34.65	2w
New-Haven_132_33_trf1	7 ENUGU	Enugu	60		60	132		33.66	2w
New-Haven_132_33_trf2	7 ENUGU	Enugu	60		60	132		33.66	2w
New-Haven_132_33_trf3	7 ENUGU	Enugu	30		30	132		33.66	2w
New-Haven_132_33_trf4	7 ENUGU	Enugu	30		30	132		33.66	2w
Nkalagu_132_33_trf1	7 ENUGU	Enugu	30		30	132		33.99	2w
Nkalagu_132_33_trf2	7 ENUGU	Enugu	30		30	132		33.99	2w
Oji-River_132_33_trf1	7 ENUGU	Enugu	15		15	132		34.65	2w
Onitsha_132_33_trf1	7 ENUGU	Enugu	30		30	132		33	2w
Onitsha_132_33_trf2	7 ENUGU	Enugu	60		60	132		33	2w
Onitsha_132_33_trf4	7 ENUGU	Enugu	60		60	132		33	2w
Onitsha_132_33_trf5	7 ENUGU	Enugu	40		40	132		33	2w
Oturkpo_132_33_trf1	7 ENUGU	Jos	30		30	132		34.65	2w
Oturkpo_132_33_trf2	7 ENUGU	Jos	40		40	132		35	2w
Oturkpo_132_33_trf3	7 ENUGU	Jos	30		30	132		35	2w
Ugwuaji_132_33_trf1	7 ENUGU	Enugu	60		60	132		34.65	2w
Yandev_132_33_trf1	7 ENUGU	Jos	45		45	132		33	2w
Yandev_132_33_trf2	7 ENUGU	Jos	60		60	132		34.65	2w

Yandev_132_33_trf3	7 ENUGU	Jos	45		45	132		35	2w
Onitsha_132_11_trf1	7 ENUGU	Enugu	15		15	132		11.5	2w
Onitsha_132_11_trf2	7 ENUGU	Enugu	20		20	132		11.5	2w
Aba_132_6.6_trf1	8 PT HARCO	Enugu	7.5		7.5	132		6.6	2w
Aba_132_33_trf1	8 PT HARCO	Enugu	60		60	132		33.99	2w
Aba_132_33_trf2	8 PT HARCO	Enugu	60		60	132		33.99	2w
Aba_132_33_trf3	8 PT HARCO	Enugu	30		30	132		34.65	2w
Aba_132_33_trf4	8 PT HARCO	Enugu	45			132		33.9	2w
Ahoda_132_33_trf1	8 PT HARCO	PH	30		30	132		33	2w
Ahoda_132_33_trf2	8 PT HARCO	PH	30		30	132		33	2w
Calabar_132_33_trf1	8 PT HARCO	PH	60		60	132		34.65	2w
Calabar_132_33_trf2	8 PT HARCO	PH	60		60	132		34.65	2w
Calabar_132_33_trf3	8 PT HARCO	PH	60		60	132		34.65	2w
Eket_132_33_trf1	8 PT HARCO	PH	60		60	132		34.65	2w
Eket_132_33_trf2	8 PT HARCO	PH	45		45	132		34.65	2w
Elelenwo_132_33_trf1	8 PT HARCO	PH	60		60	132		34.65	2w
Elelenwo_132_33_trf2	8 PT HARCO	PH	60		60	132		34.65	2w
Itu_132_33_trf1	8 PT HARCO	PH	60		60	132		34.65	2w
Owerri_132_33_trf1	8 PT HARCO	Enugu	40		40	132		33.66	2w
Owerri_132_33_trf2	8 PT HARCO	Enugu	60		60	132		33.66	2w
Owerri_132_33_trf3	8 PT HARCO	Enugu	60		60	132		33.66	2w
Phct-Main_132_33_trf1	8 PT HARCO	PH	60		60	132		34.65	2w
Phct-Main_132_33_trf2	8 PT HARCO	PH	60		60	132		34.65	2w
PHCT-Main_132_33_trf3	8 PT HARCO	PH	60		60	132		34.65	2w
Phct-Town-1_132_33_trf1	8 PT HARCO	PH	60		60	132		33	2w
Phct-Town-1_132_33_trf2	8 PT HARCO	PH	30		30	132		33	2w
Phct-Town-1_132_33_trf3	8 PT HARCO	PH	30		30	132		33	2w

PHCT-Town-1_132_33_trf4	8 PT HARCO	PH	30		30	132		33	2w
Umuahia_132_33_trf1	8 PT HARCO	Enugu	40		40	132		33	2w
Umuahia_132_33_trf2	8 PT HARCO	Enugu	40		40	132		33.99	2w
Uyo_132_33_trf1	8 PT HARCO	PH	60		60	132		33	2w
Uyo_132_33_trf2	8 PT HARCO	PH	60		60	132		34.65	2w
Yenagoa_132_33_trf1	8 PT HARCO	PH	40		40	132		33	2w
Yenagoa_132_33_trf2	8 PT HARCO	PH	40		40	132		33	2w
Aba_132_11_trf1	8 PT HARCO	Enugu	15			132		11	2w

Annex 1.4 – Effective Substation Capacities (sites supplying DISCOs)

DISCO	Site	Effective capacity [MVA]
Abuja_DISCO	Ajaokuta	60
Abuja_DISCO	Akwanga	40
Abuja_DISCO	Apo	145
Abuja_DISCO	Bida	45
Abuja_DISCO	Central-Area	120
Abuja_DISCO	Gwagwalada	60
Abuja_DISCO	Karu	60
Abuja_DISCO	Katampe	60
Abuja_DISCO	Keffi	30
Abuja_DISCO	Kontagora	30
Abuja_DISCO	Kubwa	60
Abuja_DISCO	Lokoja	60
Abuja_DISCO	Minna	105
Abuja_DISCO	Okene	30
Abuja_DISCO	Shiroro	30
Abuja_DISCO	Suleja	37.5
Abuja_DISCO	Tegina	30
Benin_DISCO	Ado-Ekiti	40
Benin_DISCO	Akure	90
Benin_DISCO	Amukpe	90
Benin_DISCO	Asaba	60
Benin_DISCO	Benin	120
Benin_DISCO	Delta	90
Benin_DISCO	Effurun	120
Benin_DISCO	Irrua	90
Benin_DISCO	Okada	40
Benin_DISCO	Ondo	30
Benin_DISCO	Ukpilla	15
Eko_DISCO	Agbara	120
Eko_DISCO	Aja	60
Eko_DISCO	Akangba	120
Eko_DISCO	Akoka	40
Eko_DISCO	Alagbon	60
Eko_DISCO	Amuwo-Odofin	90
Eko_DISCO	Apapa-Road	45
Eko_DISCO	Ijora	90
Eko_DISCO	Itire	90
Eko_DISCO	Lekki	60
Eko_DISCO	Ojo	90
Enugu_DISCO	Aba	130

Enugu_DISCO	Abakaliki	90
Enugu_DISCO	Agu-Awka	40
Enugu_DISCO	Awka	30
Enugu_DISCO	GCM	60
Enugu_DISCO	New-Haven	90
Enugu_DISCO	Nkalagu	30
Enugu_DISCO	Nsukka	7.5
Enugu_DISCO	Oji-River	15
Enugu_DISCO	Onitsha	105
Enugu_DISCO	Owerri	100
Enugu_DISCO	Ugwuaji	100
Ibadan_DISCO	Ayede	160
Ibadan_DISCO	Ganmo	60
Ibadan_DISCO	Ibadan-North	60
Ibadan_DISCO	Ife	30
Ibadan_DISCO	Ijebu-Ode	30
Ibadan_DISCO	Ilesha	40
Ibadan_DISCO	Ilorin	105
Ibadan_DISCO	Iseyin	45
Ibadan_DISCO	Iwo	30
Ibadan_DISCO	Jericho	40
Ibadan_DISCO	Offa	30
Ibadan_DISCO	Old-Abeokuta	60
Ibadan_DISCO	Omuaran	30
Ibadan_DISCO	Osogbo	90
Ibadan_DISCO	Otta	100
Ibadan_DISCO	Papalanto	45
Ibadan_DISCO	Shagamu	30
Ikeja_DISCO	Alausa	90
Ikeja_DISCO	Alimosho	130
Ikeja_DISCO	Ayobo	60
Ikeja_DISCO	Ejigbo	130
Ikeja_DISCO	Ikorodu	160
Ikeja_DISCO	Illupeju	45
Ikeja_DISCO	Isolo	90
Ikeja_DISCO	Maryland	90
Ikeja_DISCO	Ogba	110
Ikeja_DISCO	Oke-Aro	60
Ikeja_DISCO	Oworosoki	60
Jos_DISCO	Azare	30
Jos_DISCO	Bauchi	40
Jos_DISCO	Gombe	60
Jos_DISCO	Jos	60
Jos_DISCO	Makeri	60
Jos_DISCO	Makurdi	40

Jos_DISCO	Oturkpo	30
Jos_DISCO	Yandev	105
Kaduna_DISCO	Birnin-Kebbi	90
Kaduna_DISCO	Gusau	30
Kaduna_DISCO	Kaduna-Town	105
Kaduna_DISCO	Kaduna-Town	180
Kaduna_DISCO	Kafaanchan	40
Kaduna_DISCO	Sokoto	60
Kaduna_DISCO	Talata-Mafara	30
Kaduna_DISCO	Zaria	100
Kano_DISCO	Dakata	90
Kano_DISCO	Dan-Agundi	60
Kano_DISCO	Dutse	30
Kano_DISCO	Funtua	37.5
Kano_DISCO	Hadejia	22.5
Kano_DISCO	Kankia	30
Kano_DISCO	Kano	130
Kano_DISCO	Katsina	90
Kano_DISCO	Kwanar	30
Kano_DISCO	Tamburawa	30
PH_DISCO	Ahoda	30
PH_DISCO	Calabar	120
PH_DISCO	Eket	105
PH_DISCO	Eleenwo	120
PH_DISCO	Itu	60
PH_DISCO	PHCT-Main	120
PH_DISCO	PHCT-Town	120
PH_DISCO	Uyo	60
PH_DISCO	Yenogoa	40
Yola_DISCO	Biu	45
Yola_DISCO	Jalingo	30
Yola_DISCO	Maiduguri	60
Yola_DISCO	Potiskum	30
Yola_DISCO	Savannah	15
Yola_DISCO	Yola	90

Annex 1.5 – Shunt Reactors

Name	Region	Type	Voltage level [kV]	Q [Mvar]
Alaoji_330_Reac_1	8 PT HARCO	Reactor	330	75
Benin_330_Reac_1	4 BENIN	Reactor	330	75
Benin_330_Reac_2	4 BENIN	Reactor	330	75
Gombe_330_Reac_1	6 BAUCHI	Reactor	330	50
Gombe_330_Reac_2	6 BAUCHI	Reactor	330	50
Ikeja-West_330_Reac_1	1 LAGOS	Reactor	330	75
Ikeja-West_330_Reac_2	1 LAGOS	Reactor	330	75
Jebba_330_Reac_1	3 SHIRORO	Reactor	330	75
Jebba_330_Reac_2	3 SHIRORO	Reactor	330	75
Jos_330_Reac_1	6 BAUCHI	Reactor	330	75
Kaduna_330_Reac_1	5 KADUNA	Reactor	330	75
Kano_330_Reac_1	5 KADUNA	Reactor	330	75
Katampe_330_Reac_1	3 SHIRORO	Reactor	330	75
Makurdi_330_Reac_1	7 ENUGU	Reactor	330	75
Maiduguri_330_Reac_1	6 BAUCHI	Reactor	330	50
Oke-Aro_330_Reac_1	1 LAGOS	Reactor	330	75
Onitsha_330_Reac_1	7 ENUGU	Reactor	330	75
Osogbo_330_Reac_1	2 OSOGBO	Reactor	330	75
Yola_330_Reac_1	6 BAUCHI	Reactor	330	75
Gombe_33_Reac_1	6 BAUCHI	Reactor	33	30
Gombe_33_Reac_2	6 BAUCHI	Reactor	33	30
Yola_33_Reac_1	6 BAUCHI	Reactor	33	30
Yola_33_Reac_2	6 BAUCHI	Reactor	33	30

Annex 1.6 – Shunt Capacitors

Name	Region	Type	Voltage level [kV]	Q [Mvar]
Kano_330_Cap_1	5 KADUNA	Capacitor	330	50
Kano_330_Cap_2	5 KADUNA	Capacitor	330	50
Agbara_33_Cap_1	1 LAGOS	Capacitor	33	20
Akure_33_Cap_1	2 OSOGBO	Capacitor	33	20
Akwanga_33_Cap_1	3 SHIRORO	Capacitor	33	20
Akwanga_33_Cap_2	3 SHIRORO	Capacitor	33	20
Amukpe_33_Cap_1	4 BENIN	Capacitor	33	20
Awka_33_Cap_1	7 ENUGU	Capacitor	33	20
Ayede_33_Cap_1	2 OSOGBO	Capacitor	33	20
Ayede_33_Cap_2	2 OSOGBO	Capacitor	33	20
Dakata_33_Cap_1	5 KADUNA	Capacitor	33	20
Dakata_33_Cap_2	5 KADUNA	Capacitor	33	20
Effurun_33_Cap_1	4 BENIN	Capacitor	33	20
Ijebu-Ode_33_Cap_1	1 LAGOS	Capacitor	33	20
Ikorodu_33_Cap_1	1 LAGOS	Capacitor	33	20
Ikorodu_33_Cap_2	1 LAGOS	Capacitor	33	20
Ilorin_33_Cap_1	2 OSOGBO	Capacitor	33	20
Irrua_33_Cap_1	4 BENIN	Capacitor	33	20
Iseyin_33_Cap_1	2 OSOGBO	Capacitor	33	20
Kaduna-Town_33_Cap_1	5 KADUNA	Capacitor	33	20
Kaduna-Town_33_Cap_2	5 KADUNA	Capacitor	33	20
Kontagora_33_Cap_1	3 SHIRORO	Capacitor	33	20
Kontagora_33_Cap_2	3 SHIRORO	Capacitor	33	20
Makurdi_33_Cap_1	7 ENUGU	Capacitor	33	20
Minna_33_Cap_1	3 SHIRORO	Capacitor	33	20
Minna_33_Cap_2	3 SHIRORO	Capacitor	33	20
Old-Abeokuta_33_Cap_1	1 LAGOS	Capacitor	33	20
Old-Abeokuta_33_Cap_2	1 LAGOS	Capacitor	33	20
Shagama_33_Cap_1	1 LAGOS	Capacitor	33	20
Uyo_33_Cap_1	8 PT HARCO	Capacitor	33	20
Zaria_33_Cap_1	5 KADUNA	Capacitor	33	20
Zaria_33_Cap_2	3 SHIRORO	Capacitor	33	20

Annex 2 – Outages of Transmission Lines

The following table shows the availability and the Failure Rates of the individual transmission lines. The cells highlighted in blue identify lines that had long-term outages.

Transmission line identifier	Voltage in kV	Availability in %	Failures/year
Adiabo_Odukpani_330_cct1	330	99.9	0
Adiabo_Odukpani_330_cct2	330	100.0	1
Afam_Alaoji-TS_330_cct1	330	99.7	5
Afam_Alaoji-TS_330_cct2	330	99.3	6
Aja_Egbin_330_cct1	330	100.0	1
Aja_Egbin_330_cct2	330	46.2	1
Ajaokuta_Benin_330_cct1	330	99.5	17
Ajaokuta_Benin_330_cct2	330	99.5	8
Ajaokuta_Geregu_330_cct1	330	100.0	0
Ajaokuta_Geregu_330_cct2	330	100.0	0
Ajaokuta_Lokoja_330_cct1	330	99.4	6
Ajaokuta_Lokoja_330_cct2	330	99.8	1
Akangba_Ikeja-West_330_cct1	330	99.5	3
Akangba_Ikeja-West_330_cct2	330	99.8	2
Aladja_Delta_330_cct1	330	98.2	38
Aladja_Sapele_330_cct1	330	94.7	1
Alaoji_Onitsha_330_cct1	330	99.8	5
Alaoji-GS_Alaoji-TS_330_cct1	330	99.9	10
Alaoji-GS_Alaoji-TS_330_cct2	330	100.0	1
Aliade_Makurdi_330_cct1	330	99.8	0
Aliade_Makurdi_330_cct2	330	99.2	0
Aliade_Ugwuaji_330_cct1	330	99.6	3
Aliade_Ugwuaji_330_cct2	330	99.3	2
Asaba_Onitsha_330_cct1	330	99.8	2
Ayede_Olorunsogo_330_cct1	330	98.7	27
Ayede_Osogbo_330_cct1	330	98.5	13
Benin_Delta_330_cct1	330	94.0	17
Benin_Egbin_330_cct1	330	97.5	37
Benin_Eyeon_330_cct1	330	99.7	10
Benin_Eyeon_330_cct2	330	100.0	0
Benin_Omotosho_330_cct1	330	99.2	17
Benin_Onitsha_330_cct1	330	99.8	2
Benin_Onitsha_330_cct2	330	99.2	4
Benin_Onitsha_330_cct3	330	99.9	0

Benin_Onitsha_330_cct4	330	100.0	0
Benin_Osogbo_330_cct1	330	98.6	42
Benin_Sapele_330_cct1	330	99.3	11
Benin_Sapele_330_cct2	330	99.6	4
Benin_Sapele_330_cct3	330	94.2	9
Birnin-Kebbi_Kainji-GS_330_cct1	330	99.6	13
Damaturu_Gombe_330_cct1	330	100.0	0
Damaturu_Maiduguri_330_cct1	330	100.0	0
Egbin_Ikeja-West_330_cct1	330	99.3	11
Egbin_Oke-Aro_330_cct1	330	99.6	6
Egbin_Oke-Aro_330_cct2	330	99.9	3
Ganmo_Jebba-TS_330_cct1	330	99.3	22
Ganmo_Osogbo_330_cct1	330	77.3	9
Gombe_Jos_330_cct1	330	99.5	12
Gombe_Yola_330_cct1	330	99.8	4
Gwagwalada_Katampe_330_cct1	330	99.9	9
Gwagwalada_Lokoja_330_cct1	330	99.4	7
Gwagwalada_Lokoja_330_cct2	330	100.0	0
Gwagwalada_Shiroro_330_cct1	330	99.6	9
Ikeja-West_Oke-Aro_330_cct1	330	99.9	2
Ikeja-West_Oke-Aro_330_cct2	330	99.8	0
Ikeja-West_Olorunsogo_330_cct1	330	99.1	18
Ikeja-West_Omosho_330_cct1	330	99.1	14
Ikeja-West_Osogbo_330_cct1	330	99.3	32
Ikeja-West_Sakete_330_cct1	330	99.7	6
Jebba-GS_Jebba-TS_330_cct1	330	99.9	1
Jebba-GS_Jebba-TS_330_cct2	330	99.7	0
Jebba-TS_Kainji-GS_330_cct1	330	99.5	4
Jebba-TS_Kainji-GS_330_cct2	330	100.0	0
Jebba-TS_Osogbo_330_cct1	330	99.0	13
Jebba-TS_Osogbo_330_cct2	330	99.8	2
Jebba-TS_Shiroro_330_cct1	330	100.0	0
Jebba-TS_Shiroro_330_cct2	330	100.0	0
Jos_Kaduna_330_cct1	330	98.7	31
Jos_Makurdi_330_cct1	330	88.4	7
Jos_Makurdi_330_cct2	330	99.8	2
Kaduna_Kano_330_cct1	330	99.8	2
Kaduna_Shiroro_330_cct1	330	99.9	2
Kaduna_Shiroro_330_cct2	330	99.7	2
Kainji_New-Bussa_330_cct1	330	100.0	0
Katampe_Shiroro_330_cct1	330	99.3	7

New-Haven_Onitsha_330_cct1	330	99.5	11
New-Haven_Ugwuaji_330_cct1	330	99.9	0
New-Haven_Ugwuaji_330_cct2	330	99.9	0
Okpai_Onitsha_330_cct1	330	99.7	2
Okpai_Onitsha_330_cct2	330	97.0	3
Aba_Alaoji-TS_132_cct1	132	99.2	17
Aba_Alaoji-TS_132_cct2	132	99.4	17
Aba_Itu_132_cct1	132	99.0	48
Abakaliki_Nkalagu_132_cct1	132	99.9	2
Adiabo_Calabar_132_cct1	132	99.6	12
Adiabo_Calabar_132_cct2	132	99.8	7
Adiabo_Itu_132_cct1	132	97.5	58
Ado-Ekiti_Akure_132_cct1	132	99.1	8
Ado-Ekiti_Akure_132_cct2	132	99.9	0
Afam_Alaoji-TS_132_cct1	132	13.1	1
Afam_Alaoji-TS_132_cct2	132	98.2	25
Afam_PHCT-Main_132_cct1	132	99.3	7
Afam_Rivers_132_cct1	132	98.6	14
Agbara_Ikeja-West_132_cct1	132	99.9	6
Agbara_Ikeja-West_132_cct2	132	99.9	2
Agbara_Ojo_132_cct1	132	12.1	0
Agbara_Ojo_132_cct2	132	100.0	0
Agbor_Asaba_132_cct1	132	100.0	0
Agbor_Asaba_132_cct2	132	100.0	0
Ahoda_Owerri_132_cct1	132	99.9	0
Ahoda_Owerri_132_cct2	132	99.9	0
Ahoda_Yenagoa_132_cct1	132	99.8	0
Ahoda_Yenagoa_132_cct2	132	99.8	0
Aja_Alagbon_132_cct1	132	99.4	7
Aja_Alagbon_132_cct2	132	96.9	15
Aja_Lekki_132_cct1	132	100.0	2
Aja_Lekki_132_cct2	132	100.0	0
Ajaokuta_Ajaokuta-Steel_132_cct1	132	100.0	2
Ajaokuta_Ajaokuta-Steel_132_cct2	132	99.9	2
Ajaokuta_Itakpe_132_cct1	132	99.9	2
Ajaokuta_Okene_132_cct1	132	99.7	3
Akangba_Amuwo-Odofin_132_cct1	132	99.8	4
Akangba_Amuwo-Odofin_132_cct2	132	99.3	3

Akangba_Apapa-Road_132_cct1	132	100.0	0
Akangba_Apapa-Road_132_cct2	132	99.9	0
Akangba_Ijora_132_cct1	132	100.0	1
Akangba_Ijora_132_cct2	132	100.0	0
Akangba_Isolo_132_cct1	132	100.0	2
Akangba_Isolo_132_cct2	132	99.9	1
Akangba_Itire_132_cct2	132	100.0	2
Akoka_Alagbon_132_cct1	132	100.0	0
Akoka_Ijora_132_cct1	132	100.0	0
Akoka_Oworosoki_132_cct1	132	99.9	0
Akoka_Oworosoki_132_cct2	132	99.9	0
Akure_Osogbo_132_cct1	132	98.9	25
Akwanga_Keffi_132_cct1	132	99.9	0
Alagbon_Ijora_132_cct1	132	100.0	0
Alaoji_Owerri_132_cct1	132	97.5	88
Alaoji_Owerri_132_cct2	132	96.9	106
Alaoji_Umuahia_132_cct1	132	99.0	7
Alaoji_Umuahia_132_cct2	132	99.1	4
Alausa_Ogba_132_cct1	132	100.0	1
Alausa_Ogba_132_cct2	132	99.9	1
Aliade_Oturkpo_132_cct1	132	99.9	0
Aliade_Yandev_132_cct1	132	99.7	0
Alimosho_Ikeja-West_132_cct1	132	99.7	7
Alimosho_Ikeja-West_132_cct2	132	99.5	0
Alimosho_Ogba_132_cct1	132	100.0	0
Alimosho_Ogba_132_cct2	132	100.0	0
Amukpe_Benin_132_cct1	132	2.8	8
Amukpe_Delta_132_cct1	132	99.2	1
Amuwo-Odofin_Apapa-Road_132_cct1	132	100.0	0
Amuwo-Odofin_Apapa-Road_132_cct2	132	100.0	0
Amuwo-Odofin_Ojo_132_cct1	132	99.8	1
Amuwo-Odofin_Ojo_132_cct2	132	99.5	0
Apir_Aliade_132_cct1	132	100.0	0
Apir_Makurdi_132_cct1	132	100.0	0
Apo_Karu_132_cct1	132	99.7	8
Apo_Katampe_132_cct1	132	100.0	3
Apo_Katampe_132_cct2	132	100.0	0
Apo_Kukwaba_132_cct1	132	99.9	0
Apo_Kukwaba_132_cct2	132	100.0	0

Ashaka_Ashaka-RNDAB_132_cct1	132	100.0	0
Ashaka-RNDAB_Gombe_132_cct1	132	99.9	0
Ashaka-RNDAB_Potiskum_132_cct1	132	100.0	0
Awka_Oji-River_132_cct1	132	99.4	0
Awka_Onitsha_132_cct1	132	99.3	8
Ayede_Ibadan-North_132_cct1	132	99.4	33
Ayede_Jericho_132_cct1	132	99.8	4
Ayede_Shagamu_132_cct1	132	97.4	39
Ayobo_Ikeja-West_132_cct1	132	99.6	2
Ayobo_Ikeja-West_132_cct2	132	99.8	0
Azare_Dutse_132_cct1	132	100.0	0
Azare_Wudil_132_cct1	132	100.0	0
Bauchi_Gombe_132_cct1	132	99.7	0
Bauchi_Jos_132_cct1	132	99.9	0
Benin_Irrua_132_cct1	132	99.1	14
Benin_Ogara_132_cct1	132	3.0	8
Bida_Minna_132_cct1	132	100.0	0
Birnin-Gwari_Tegina_132_cct1	132	100.0	0
Birnin-Kebbi_Dosso_132_cct1	132	99.9	1
Birnin-Kebbi_Sokoto_132_cct1	132	99.9	1
Biu_Damboa_132_cct1	132	99.5	3
Biu_Gombe_132_cct1	132	99.7	1
Central-Area_Katampe_132_cct1	132	100.0	2
Central-Area_Katampe_132_cct2	132	100.0	0
Dakata_Hadejia_132_cct1	132	100.0	0
Dakata_Kano_132_cct1	132	99.6	11
Dakata_Kano_132_cct2	132	37.0	1
Damboa_Maiduguri_132_cct1	132	99.7	0
Dan-Agundi_Kano_132_cct1	132	99.9	8
Delta_Effurun_132_cct1	132	99.5	8
Delta_Ogara_132_cct1	132	99.1	0
Dosso_Niamey_132_cct1	132	99.9	0
Dutse_Kano_132_cct1	132	99.7	1
East-Mains_Gwagwalada_132_cct1	132	99.8	3
East-Mains_Gwagwalada_132_cct2	132	100.0	1
East-Mains_Kukwaba_132_cct1	132	99.9	0
East-Mains_Kukwaba_132_cct2	132	100.0	0
Egbin_Ikorodu_132_cct1	132	99.6	9

Egbin_Ikorodu_132_cct2	132	96.0	3
Ejigbo_Ikeja-West_132_cct1	132	99.8	3
Ejigbo_Ikeja-West_132_cct2	132	99.9	0
Ejigbo_Itire_132_cct1	132	100.0	0
Ejigbo_Itire_132_cct2	132	100.0	0
Eket_Ibom_132_cct1	132	99.8	2
Eket_Ibom_132_cct2	132	100.0	0
Eket_Uyo_132_cct1	132	99.7	1
Eket_Uyo_132_cct2	132	100.0	0
Elelenwo_Rivers_132_cct1	132	100.0	0
Elelenwo_Rivers_132_cct2	132	100.0	0
Eyea_Okada_132_cct1	132	100.0	0
Eyea_Okada_132_cct2	132	100.0	0
Funtua_Gusau_132_cct1	132	99.7	4
Funtua_Zaria_132_cct1	132	99.5	4
Ganmo_Ilorin_132_cct1	132	99.9	1
Ganmo_Ilorin_132_cct2	132	100.0	0
Ganmo_Offra_132_cct1	132	99.6	4
Ganmo_Offra_132_cct2	132	100.0	0
Gazoua_Katsina_132_cct1	132	99.9	0
GCM_Onitsha_132_cct1	132	99.6	0
Gombe_T-Junction_132_cct1	132	99.9	4
Gusau_Talata-Mafara_132_cct1	132	99.9	0
Ibadan-North_Iwo_132_cct1	132	99.8	0
Ife_Ilesha_132_cct1	132	99.4	0
Ife_Ondo_132_cct1	132	99.0	5
Ijebu-Ode_Shagamu_132_cct1	132	99.7	5
Ikeja-West_Illupeju_132_cct1	132	12.1	1
Ikeja-West_Illupeju_132_cct2	132	12.1	1
Ikeja-West_Otta_132_cct1	132	100.0	3
Ikeja-West_Otta_132_cct2	132	100.0	1
Ikeja-West_Oworosoki_132_cct1	132	99.9	2
Ikeja-West_Oworosoki_132_cct2	132	99.9	0
Ikorodu_Maryland_132_cct1	132	99.3	2
Ikorodu_Shagamu-Tee_132_cct1	132	97.8	23
Ilesha_Osogbo_132_cct1	132	99.2	42
Illupeju_Maryland_132_cct1	132	99.7	2
Illupeju_Maryland_132_cct2	132	100.0	0
Irrua_Ukpilla_132_cct1	132	99.9	0
Iseyin_Iwo_132_cct1	132	99.7	0
Itu_Uyo_132_cct1	132	97.9	48

Itu_Uyo_132_cct2	132	100.0	0
Iwo_Osogbo_132_cct1	132	100.0	0
Jalingo_Mayo-Belwa_132_cct1	132	99.9	0
Jos_Kafanchan_132_cct1	132	100.0	0
Jos_Kafanchan_132_cct2	132	100.0	0
Jos_Makeri_132_cct1	132	99.9	0
Jos_Makeri_132_cct2	132	100.0	0
Kaduna_Kaduna-Town_132_cct1	132	99.2	5
Kaduna_Zaria_132_cct1	132	99.5	7
Kankia_Kano_132_cct1	132	99.9	7
Kankia_Katsina_132_cct1	132	99.9	4
Kano_Katsina_132_cct1	132	100.0	0
Kano_Tamburawa_132_cct1	132	100.0	2
Kano_Wudil_132_cct1	132	99.9	0
Karu_Keffi_132_cct1	132	99.8	0
Katampe_Kubwa_132_cct1	132	99.9	1
Katampe_Kubwa_132_cct2	132	100.0	0
Kontagora_Tegina_132_cct1	132	99.8	0
Kontagora_Yelwa_132_cct1	132	100.0	0
Kubwa_Suleja_132_cct1	132	100.0	0
Kubwa_Suleja_132_cct2	132	100.0	0
Kwanar-Dangora_Tamburawa_132_cct1	132	16.2	1
Kwanar-Dangora_Zaria_132_cct1	132	100.0	0
Maryland_Oke-Aro_132_cct1	132	100.0	0
Mayo-Belwa_Yola_132_cct1	132	99.9	0
Minna_Shiroro_132_cct1	132	99.9	6
Minna_Shiroro_132_cct2	132	100.0	2
Minna_Suleja_132_cct1	132	100.0	0
Minna_Suleja_132_cct2	132	100.0	0
New-Haven_Nkalagu_132_cct1	132	99.4	29
New-Haven_Nkalagu_132_cct2	132	99.3	20
New-Haven_Oji-River_132_cct1	132	99.8	2
New-Haven_Oturkpo_132_cct1	132	99.5	45
Numan_Savannah-Tee_132_cct1	132	99.9	0
Numan_Yola_132_cct1	132	99.9	0
Offa_Omuaran_132_cct1	132	99.8	0
Offa_Osogbo_132_cct1	132	99.6	6
Ogba_Otta_132_cct1	132	99.5	5
Oke-Aro_Ikorodu_132_cct1	132	100.0	0
Okene_Ukpilla_132_cct1	132	99.8	0

Okigwe_Mbalano_132_cct1	132	100.0	0
Old-Abeokuta_Papalanto_132_cct1	132	99.7	1
Otta_Papalanto_132_cct1	132	99.6	5
PHCT-Main_PHCT-Town_132_cct1	132	100.0	0
PHCT-Main_PHCT-Town_132_cct2	132	100.0	0
PHCT-Main_Rivers_132_cct1	132	99.3	4
Savannah_T-Junction_132_cct1	132	99.9	0
Shagamu_Shagamu-Tee_132_cct1	132	99.8	0
Shagamu-Cement_Shagamu-Tee_132_cct1	132	100.0	0
Shiroro_Tegina_132_cct1	132	99.7	3
Sokoto_Talata-Mafara_132_cct1	132	100.0	0
Kingsway_Nsukka_66_cct1	66	99.8	0
Kingsway_Oji-River_66_cct1	66	99.8	1

Annex 3 – Outages of Transformers

Annex 3.1 – Short-term and Long-term Outages

The following table shows the availability and the Failure Rates of the individual transmission transformers. The cells highlighted in blue identify lines that had long-term outages.

Transformer identifier	Linked voltage levels	Availability in %	Failures/year
Adiabo_330_132_trf1	330 / 132kV	80.5	3
Adiabo_330_132_trf2	330 / 132kV	82.7	1
Afam_330_132_trf1	330 / 132kV	99.9	0
Afam_330_132_trf2	330 / 132kV	100.0	0
Aja_330_132_trf1	330 / 132kV	99.0	0
Aja_330_132_trf2	330 / 132kV	99.9	1
Aja_330_132_trf3	330 / 132kV	83.0	4
Ajaokuta_330_132_trf1	330 / 132kV	100.0	0
Ajaokuta_330_132_trf2	330 / 132kV	99.9	1
Ajaokuta_330_132_trf3	330 / 132kV	100.0	0
Akangba_330_132_trf1	330 / 132kV	83.0	2
Akangba_330_132_trf2	330 / 132kV	99.6	0
Akangba_330_132_trf3	330 / 132kV	99.4	0
Akangba_330_132_trf4	330 / 132kV	99.4	0
Akangba_330_132_trf5	330 / 132kV	99.8	0
Akangba_330_132_trf6	330 / 132kV	100.0	0
Alangbon_330_132_trf1	330 / 132kV	100.0	0
Alaoji_330_132_trf1	330 / 132kV	99.8	4
Alaoji_330_132_trf2	330 / 132kV	99.2	5
Alaoji_330_132_trf3	330 / 132kV	99.5	5
Asaba_330_132_trf1	330 / 132kV	100.0	0
Asaba_330_132_trf2	330 / 132kV	100.0	0
Ayede_330_132_trf1	330 / 132kV	99.5	5
Ayede_330_132_trf2	330 / 132kV	99.7	3
Ayede_330_132_trf3	330 / 132kV	100.0	0
Benin_330_132_trf1	330 / 132kV	99.8	0
Benin_330_132_trf2	330 / 132kV	99.9	1
Bkebbi_330_132_trf1	330 / 132kV	99.9	0
Bkebbi_330_132_trf2	330 / 132kV	100.0	0
Bkebbi_330_132_trf3	330 / 132kV	100.0	3
Delta_330_132_trf1	330 / 132kV	100.0	0
Egbin_330_132_trf1	330 / 132kV	99.9	0
Egbin_330_132_trf2	330 / 132kV	99.7	1
Eyea_330_132_Trf1	330 / 132kV	100.0	0
Ganmo_330_132_trf1	330 / 132kV	100.0	1
Ganmo_330_132_trf2	330 / 132kV	100.0	1
Gombe_330_132_trf1	330 / 132kV	99.5	0
Gombe_330_132_trf2	330 / 132kV	99.6	0
Gwagwalada_330_132_trf1	330 / 132kV	100.0	1

Gwagwalada_330_132_trf2	330 / 132kV	100.0	1
Ikeja-West_330_132_trf1	330 / 132kV	99.7	2
Ikeja-West_330_132_trf2	330 / 132kV	99.2	5
Ikeja-West_330_132_trf3	330 / 132kV	99.9	2
Ikeja-West_330_132_trf4	330 / 132kV	99.8	1
Ikeja-West_330_132_trf5	330 / 132kV	99.8	3
Jebba-Ts_330_132_trf1	330 / 132kV	100.0	0
Jos_330_132_trf1	330 / 132kV	99.9	2
Jos_330_132_trf2	330 / 132kV	100.0	0
Kaduna_330_132_trf1	330 / 132kV	99.9	1
Kaduna_330_132_trf2	330 / 132kV	99.9	0
Kaduna_330_132_trf3	330 / 132kV	99.8	2
Kaduna_330_132_trf4	330 / 132kV	99.9	0
Kaduna_330_132_trf5	330 / 132kV	99.8	0
Kano_330_132_trf1	330 / 132kV	0.0	1
Kano_330_132_trf2	330 / 132kV	99.8	17
Kano_330_132_trf3	330 / 132kV	99.8	4
Kano_330_132_trf4	330 / 132kV	99.9	1
Katampe_330_132_trf1	330 / 132kV	99.9	0
Katampe_330_132_trf2	330 / 132kV	100.0	1
Katampe_330_132_trf3	330 / 132kV	99.9	0
Lokoja_330_132_Trf1	330 / 132kV	100.0	0
Makurdi_330_132_trf1	330 / 132kV	100.0	0
New-Haven_330_132_trf1	330 / 132kV	99.8	1
New-Haven_330_132_trf2	330 / 132kV	99.9	1
Oke-Aro_330_132_trf1	330 / 132kV	100.0	0
Oke-Aro_330_132_trf2	330 / 132kV	100.0	0
Omotosho_330_132_trf1	330 / 132kV	98.8	10
Onitsha_330_132_trf1	330 / 132kV	99.8	3
Onitsha_330_132_trf2	330 / 132kV	99.9	3
Onitsha_330_132_trf3	330 / 132kV	99.9	0
Onitsha_330_132_trf4	330 / 132kV	100.0	0
Osogbo_330_132_trf1	330 / 132kV	82.9	15
Osogbo_330_132_trf2	330 / 132kV	99.9	7
Osogbo_330_132_trf3	330 / 132kV	99.9	1
Osogbo_330_132_trf4	330 / 132kV	99.8	5
Shiroro_330_132_trf1	330 / 132kV	99.9	0
Shiroro_330_132_trf2	330 / 132kV	99.9	0
Ugwuaji_330_132_trf1	330 / 132kV	99.7	1
Yola_330_132_trf1	330 / 132kV	99.9	0
Yola_330_132_trf2	330 / 132kV	99.8	0
Oji-River_132_66_trf1	132 / 66kV	99.9	0
Aba_132_11_trf1	132kV / MV	100.0	0
Aba_132_33_trf1	132kV / MV	99.9	0
Aba_132_33_trf2	132kV / MV	99.8	1
Aba_132_33_trf3	132kV / MV	99.7	2
Aba_132_33_trf4	132kV / MV	100.0	0

Aba_132_6.6_trf1	132kV / MV	83.4	2
Abakaliki_132_33_trf1	132kV / MV	99.9	1
Abakaliki_132_33_trf2	132kV / MV	99.9	1
Ado-Ekiti_132_33_trf1	132kV / MV	100.0	0
Ado-Ekiti_132_33_trf2	132kV / MV	100.0	2
Afam_132_11_trf1	132kV / MV	99.8	0
Afam_132_33_trf1	132kV / MV	99.7	0
Agbara_132_33_trf1	132kV / MV	84.5	1
Agbara_132_33_trf2	132kV / MV	100.0	1
Agbara_132_33_trf3	132kV / MV	99.9	0
Agu-Awka_132_33_trf1	132kV / MV	100.0	0
Ahoada_132_33_trf1	132kV / MV	100.0	0
Ahoada_132_33_trf2	132kV / MV	100.0	0
Aja_132_33_trf1	132kV / MV	82.6	4
Aja_132_33_trf2	132kV / MV	82.3	5
Aja_132_33_trf3	132kV / MV	96.0	3
Ajaokuta_132_33_trf1	132kV / MV	100.0	0
Ajaokuta_132_33_trf2	132kV / MV	85.6	2
Akangba_132_33_trf1	132kV / MV	82.7	7
Akangba_132_33_trf2	132kV / MV	99.8	3
Akangba_132_33_trf3	132kV / MV	83.1	2
Akoka_132_33_trf1	132kV / MV	82.7	6
Akoka_132_33_trf2	132kV / MV	99.6	5
Akure_132_33_trf1	132kV / MV	99.9	0
Akure_132_33_trf2	132kV / MV	97.4	2
Akure_132_33_trf3	132kV / MV	100.0	0
Akwanga_132_33_trf1	132kV / MV	100.0	0
Akwanga_132_33_trf2	132kV / MV	100.0	0
Alagbon_132_33_trf1	132kV / MV	99.7	1
Alagbon_132_33_trf2	132kV / MV	100.0	0
Alaoji_132_33_trf1	132kV / MV	100.0	1
Alaoji_132_33_trf2	132kV / MV	100.0	0
Alaoji_132_33_trf3	132kV / MV	100.0	0
Alaoji_132_33_trf4	132kV / MV	100.0	0
Alausa_132_33_trf1	132kV / MV	100.0	0
Alausa_132_33_trf2	132kV / MV	99.8	0
Alausa_132_33_trf3	132kV / MV	99.9	0
Alimosho_132_33_trf1	132kV / MV	100.0	0
Alimosho_132_33_trf2	132kV / MV	100.0	0
Alimosho_132_33_trf3	132kV / MV	99.9	0
Amukpe_132_33_trf1	132kV / MV	100.0	0
Amukpe_132_33_trf2	132kV / MV	100.0	0
Amuwo-Odofin_132_33_trf1	132kV / MV	99.8	2
Amuwo-Odofin_132_33_trf2	132kV / MV	99.9	0
Amuwo-Odofin_132_33_trf3	132kV / MV	99.2	4
Amuwo-Odofin_132_33_trf4	132kV / MV	100.0	0
Apapa-Road_132_33_trf1	132kV / MV	82.8	2

Apapa-Road_132_33_trf2	132kV / MV	83.5	1
Apir_132_33_trf1	132kV / MV	99.9	2
Apo_132_33_trf1	132kV / MV	99.9	2
Apo_132_33_trf2	132kV / MV	83.5	3
Apo_132_33_trf3	132kV / MV	0.0	1
Apo_132_33_trf4	132kV / MV	100.0	0
Asaba_132_33_trf1	132kV / MV	100.0	0
Asaba_132_33_trf2	132kV / MV	100.0	0
Awka_132_33_trf1	132kV / MV	88.6	2
Awka_132_33_trf2	132kV / MV	100.0	0
Ayede_132_33_trf1	132kV / MV	81.9	15
Ayede_132_33_trf2	132kV / MV	100.0	1
Ayede_132_33_trf3	132kV / MV	99.1	0
Ayobo_132_33_trf1	132kV / MV	100.0	0
Ayobo_132_33_trf2	132kV / MV	99.9	0
Azare_132_33_trf1	132kV / MV	100.0	0
Azare_132_33_trf2	132kV / MV	99.9	0
Bauchi_132_33_trf1	132kV / MV	99.9	0
Bauchi_132_33_trf2	132kV / MV	99.9	0
Benin_132_33_trf1	132kV / MV	99.7	3
Benin_132_33_trf2	132kV / MV	99.7	0
Benin_132_33_trf3	132kV / MV	100.0	2
Benin_132_33_trf4	132kV / MV	7.0	4
Bida_132_11_trf1	132kV / MV	99.9	0
Bida_132_11_trf2	132kV / MV	100.0	0
Bida_132_33_trf1	132kV / MV	99.9	0
Bida_132_33_trf2	132kV / MV	99.9	0
Birnin-Kebbi_132_33_trf1	132kV / MV	99.8	0
Birnin-Kebbi_132_33_trf2	132kV / MV	100.0	0
Birnin-Kebbi_132_33_trf3	132kV / MV	100.0	0
Biu_132_33_trf1	132kV / MV	99.9	0
Biu_132_33_trf2	132kV / MV	100.0	0
Calabar_132_33_trf1	132kV / MV	82.6	7
Calabar_132_33_trf2	132kV / MV	82.7	4
Calabar_132_33_trf3	132kV / MV	82.8	8
Central-Area_132_33_trf1	132kV / MV	99.9	3
Central-Area_132_33_trf2	132kV / MV	100.0	2
Central-Area_132_33_trf3	132kV / MV	100.0	0
Dakata_132_33_trf1	132kV / MV	100.0	0
Dakata_132_33_trf2	132kV / MV	100.0	0
Dakata_132_33_trf3	132kV / MV	100.0	0
Dan-Agundi_132_33_trf1	132kV / MV	99.9	1
Dan-Agundi_132_33_trf2	132kV / MV	99.9	1
Delta_132_33_trf1	132kV / MV	99.9	1
Delta_132_33_trf2	132kV / MV	99.8	1
Dutse_132_33_trf1	132kV / MV	99.9	0
Dutse_132_33_trf2	132kV / MV	99.9	0

Effurun_132_33_trf1	132kV / MV	99.8	1
Effurun_132_33_trf2	132kV / MV	98.1	2
Effurun_132_33_trf3	132kV / MV	99.8	1
Egbin_132_33_trf3	132kV / MV	100.0	0
Ejigbo_132_33_trf1	132kV / MV	100.0	0
Ejigbo_132_33_trf2	132kV / MV	83.5	1
Ejigbo_132_33_trf3	132kV / MV	99.9	0
Eket_132_33_trf1	132kV / MV	99.9	0
Eket_132_33_trf2	132kV / MV	99.9	0
Elelenwo_132_33_trf1	132kV / MV	100.0	0
Elelenwo_132_33_trf2	132kV / MV	100.0	0
Funtua_132_11_trf1	132kV / MV	100.0	0
Funtua_132_11_trf2	132kV / MV	100.0	0
Funtua_132_33_trf1	132kV / MV	100.0	0
Ganmo_132_33_trf1	132kV / MV	83.5	2
Ganmo_132_33_trf2	132kV / MV	99.8	1
Ganmo_132_33_trf3	132kV / MV	100.0	1
Ganmo_132_33_trf4	132kV / MV	99.9	1
GCM_132_33_trf1	132kV / MV	100.0	2
Gombe_132_33_trf1	132kV / MV	99.6	1
Gombe_132_33_trf2	132kV / MV	99.6	1
Gusau_132_33_trf1	132kV / MV	99.9	0
Gusau_132_33_trf2	132kV / MV	100.0	0
Gwagwalada_132_33_trf1	132kV / MV	100.0	1
Gwagwalada_132_33_trf2	132kV / MV	100.0	1
Hadejia_132_33_trf1	132kV / MV	99.9	0
Hadejia_132_33_trf2	132kV / MV	83.5	1
Ibadan-North_132_33_trf1	132kV / MV	99.9	2
Ibadan-North_132_33_trf2	132kV / MV	100.0	0
Ife_132_33_trf1	132kV / MV	99.6	1
Ife_132_33_trf2	132kV / MV	99.9	0
Ijebu-Ode_132_33_trf1	132kV / MV	100.0	0
Ijebu-Ode_132_33_trf2	132kV / MV	100.0	0
Ijora_132_33_trf1	132kV / MV	100.0	2
Ijora_132_33_trf2	132kV / MV	83.1	5
Ijora_132_33_trf3	132kV / MV	100.0	0
Ijora_132_33_trf4	132kV / MV	100.0	0
Ikorodu_132_33_trf1	132kV / MV	99.8	1
Ikorodu_132_33_trf2	132kV / MV	99.8	0
Ikorodu_132_33_trf3	132kV / MV	83.1	2
Ilesha_132_33_trf1	132kV / MV	99.7	2
Ilesha_132_33_trf2	132kV / MV	99.8	2
Illupeju_132_11_trf1	132kV / MV	99.9	0
Illupeju_132_11_trf2	132kV / MV	100.0	0
Illupeju_132_33_trf1	132kV / MV	100.0	0
Illupeju_132_33_trf2	132kV / MV	100.0	0
Illupeju_132_33_trf4	132kV / MV	100.0	0

Ilorin_132_33_trf1	132kV / MV	94.9	3
Ilorin_132_33_trf2	132kV / MV	83.2	1
Irrua_132_33_trf1	132kV / MV	99.9	1
Irrua_132_33_trf2	132kV / MV	83.4	3
Iseyin_132_33_trf1	132kV / MV	99.7	1
Isolo_132_33_trf1	132kV / MV	99.9	0
Isolo_132_33_trf2	132kV / MV	83.5	1
Isolo_132_33_trf3	132kV / MV	99.9	1
Itire_132_33_trf1	132kV / MV	99.8	0
Itire_132_33_trf2	132kV / MV	99.9	1
Itire_132_33_trf3	132kV / MV	100.0	0
Itu_132_33_trf1	132kV / MV	99.6	7
Iwo_132_33_trf1	132kV / MV	99.8	18
Jalingo_132_33_trf1	132kV / MV	100.0	0
Jalingo_132_33_trf2	132kV / MV	100.0	0
Jebba_132_33_trf1	132kV / MV	100.0	0
Jericho_132_33_trf1	132kV / MV	99.8	3
Jericho_132_33_trf2	132kV / MV	99.6	4
Jos_132_33_trf1	132kV / MV	99.7	1
Jos_132_33_trf2	132kV / MV	99.7	0
Kaduna_132_33_trf1	132kV / MV	99.8	2
Kaduna_132_33_trf2	132kV / MV	99.8	1
Kaduna_132_33_trf3	132kV / MV	99.7	7
Kaduna_132_33_trf4	132kV / MV	99.8	0
Kaduna_132_33_trf5	132kV / MV	99.9	0
Kaduna-Town_132_11_trf1	132kV / MV	100.0	0
Kaduna-Town_132_33_trf2	132kV / MV	100.0	0
Kaduna-Town_132_33_trf3	132kV / MV	100.0	1
Kaduna-Town_132_33_trf4	132kV / MV	100.0	1
Kafanchan_132_33_trf1	132kV / MV	99.9	0
Kankia_132_33_trf1	132kV / MV	99.9	0
Kankia_132_33_trf2	132kV / MV	99.8	0
Kano_132_11_trf1	132kV / MV	100.0	0
Kano_132_33_trf1	132kV / MV	99.7	1
Kano_132_33_trf2	132kV / MV	99.9	1
Kano_132_33_trf3	132kV / MV	99.9	1
Kano_132_33_trf4	132kV / MV	100.0	0
Karu_132_33_trf1	132kV / MV	100.0	1
Karu_132_33_trf2	132kV / MV	100.0	0
Katampe_132_33_trf1	132kV / MV	99.9	3
Katampe_132_33_trf2	132kV / MV	99.9	2
Katsina_132_33_trf1	132kV / MV	99.8	2
Katsina_132_33_trf2	132kV / MV	100.0	0
Katsina_132_33_trf3	132kV / MV	99.7	1
Keffi_132_33_trf1	132kV / MV	100.0	0
Kontagora_132_33_trf1	132kV / MV	100.0	0
Kubwa_132_33_trf1	132kV / MV	99.9	0

Kubwa_132_33_trf2	132kV / MV	100.0	0
Kwanar-Dango_132_33_trf1	132kV / MV	99.7	2
Lekki_132_33_trf1	132kV / MV	83.1	7
Lekki_132_33_trf2	132kV / MV	99.8	4
Lokoja_132_33_Trf1	132kV / MV	100.0	0
Maiduguri_132_33_trf1	132kV / MV	100.0	0
Maiduguri_132_33_trf2	132kV / MV	99.8	0
Maiduguri_132_33_trf3	132kV / MV	100.0	0
Makeri_132_33_trf1	132kV / MV	100.0	0
Makeri_132_33_trf2	132kV / MV	99.9	0
Makurdi_132_33_trf1	132kV / MV	100.0	0
Maryland_132_33_trf1	132kV / MV	99.8	0
Maryland_132_33_trf2	132kV / MV	99.8	0
Maryland_132_33_trf3	132kV / MV	99.6	1
Minna_132_11_trf1	132kV / MV	99.9	0
Minna_132_11_trf2	132kV / MV	100.0	0
Minna_132_33_trf1	132kV / MV	99.6	3
Minna_132_33_trf2	132kV / MV	100.0	0
Minna_132_33_trf3	132kV / MV	99.9	0
New-Haven_132_33_trf1	132kV / MV	98.9	9
New-Haven_132_33_trf2	132kV / MV	99.4	12
New-Haven_132_33_trf3	132kV / MV	99.0	1
New-Haven_132_33_trf4	132kV / MV	99.2	2
Nkalagu_132_33_trf1	132kV / MV	99.6	2
Nkalagu_132_33_trf2	132kV / MV	99.9	2
Offa_132_33_trf1	132kV / MV	99.8	0
Ogba_132_11_trf1	132kV / MV	100.0	0
Ogba_132_33_trf1	132kV / MV	99.9	0
Ogba_132_33_trf2	132kV / MV	100.0	1
Ogba_132_33_trf3	132kV / MV	99.9	2
Ogba_132_33_trf4	132kV / MV	99.9	1
Oji-River_132_33_trf1	132kV / MV	99.9	0
Ojo_132_33_trf1	132kV / MV	100.0	0
Ojo_132_33_trf2	132kV / MV	100.0	0
Ojo_132_33_trf3	132kV / MV	99.9	0
Ojo_132_33_trf4	132kV / MV	99.9	1
Okada_132_33_Trf1	132kV / MV	100.0	0
Oke-Aro_132_33_trf1	132kV / MV	99.8	3
Oke-Aro_132_33_trf2	132kV / MV	99.9	2
Okene_132_33_trf1	132kV / MV	99.9	2
Okene_132_33_trf2	132kV / MV	85.5	2
Old-Abeokuta_132_33_trf1	132kV / MV	100.0	0
Old-Abeokuta_132_33_trf2	132kV / MV	99.8	0
Old-Abeokuta_132_33_trf3	132kV / MV	99.9	0
Omuaran_132_33_trf1	132kV / MV	96.6	0
Omuaran_132_33_trf2	132kV / MV	99.9	0
Ondo_132_33_trf1	132kV / MV	99.9	0

Ondo_132_33_trf2	132kV / MV	100.0	0
Onitsha_132_11_trf1	132kV / MV	100.0	0
Onitsha_132_11_trf2	132kV / MV	100.0	0
Onitsha_132_33_trf1	132kV / MV	91.3	1
Onitsha_132_33_trf2	132kV / MV	100.0	1
Onitsha_132_33_trf4	132kV / MV	99.8	0
Onitsha_132_33_trf5	132kV / MV	100.0	10
Osogbo_132_33_trf1	132kV / MV	99.9	1
Osogbo_132_33_trf2	132kV / MV	100.0	1
Osogbo_132_33_trf3	132kV / MV	99.9	2
Osogbo_132_33_trf4	132kV / MV	99.8	8
Osogbo_132_33_trf5	132kV / MV	99.9	4
Otta_132_33_trf1	132kV / MV	100.0	0
Otta_132_33_trf2	132kV / MV	99.8	1
Otta_132_33_trf3	132kV / MV	99.9	0
Otta_132_33_trf4	132kV / MV	100.0	0
Oturkpo_132_33_trf1	132kV / MV	100.0	0
Oturkpo_132_33_trf2	132kV / MV	100.0	0
Oturkpo_132_33_trf3	132kV / MV	100.0	0
Owerri_132_33_trf1	132kV / MV	99.7	3
Owerri_132_33_trf2	132kV / MV	74.3	4
Owerri_132_33_trf3	132kV / MV	99.9	1
Oworosoki_132_33_trf1	132kV / MV	100.0	0
Oworosoki_132_33_trf2	132kV / MV	99.9	0
Papalanto_132_33_trf1	132kV / MV	100.0	0
Papalanto_132_33_trf2	132kV / MV	99.8	1
Papalanto_132_33_trf3	132kV / MV	100.0	0
Phct-Main_132_33_trf1	132kV / MV	100.0	0
Phct-Main_132_33_trf2	132kV / MV	99.9	0
PHCT-Main_132_33_trf3	132kV / MV	100.0	0
Phct-Town-1_132_33_trf1	132kV / MV	99.9	1
Phct-Town-1_132_33_trf2	132kV / MV	100.0	0
Phct-Town-1_132_33_trf3	132kV / MV	100.0	0
PHCT-Town-1_132_33_trf4	132kV / MV	100.0	0
Potiskum_132_33_trf1	132kV / MV	99.7	1
Potiskum_132_33_trf2	132kV / MV	99.6	2
Savannah_132_33_trf1	132kV / MV	100.0	0
Shagamu_132_33_trf1	132kV / MV	82.6	12
Shagamu_132_33_trf2	132kV / MV	99.9	2
Shiroro_132_33_trf1	132kV / MV	83.5	1
Sokoto_132_33_trf1	132kV / MV	100.0	0
Sokoto_132_33_trf2	132kV / MV	100.0	0
Sokoto_132_33_trf3	132kV / MV	100.0	0
Suleja_132_11_trf1	132kV / MV	100.0	0
Suleja_132_33_trf1	132kV / MV	100.0	1
Suleja_132_33_trf2	132kV / MV	100.0	1
Talata-Mafara_132_33_trf1	132kV / MV	100.0	0

Tamburawa_132_33_trf1	132kV / MV	100.0	0
Tamburawa_132_33_trf2	132kV / MV	99.9	1
Tegina_132_33_trf1	132kV / MV	100.0	0
Ugwuaji_132_33_trf1	132kV / MV	100.0	0
Ukpilla_132_33_trf1	132kV / MV	99.9	0
Umuahia_132_33_trf1	132kV / MV	100.0	2
Umuahia_132_33_trf2	132kV / MV	99.9	1
Uyo_132_33_trf1	132kV / MV	99.7	0
Uyo_132_33_trf2	132kV / MV	100.0	0
Yandev_132_33_trf1	132kV / MV	100.0	0
Yandev_132_33_trf2	132kV / MV	100.0	0
Yandev_132_33_trf3	132kV / MV	100.0	0
Yenagoa_132_33_trf1	132kV / MV	100.0	0
Yenagoa_132_33_trf2	132kV / MV	100.0	0
Yola_132_33_trf1	132kV / MV	83.3	2
Yola_132_33_trf2	132kV / MV	99.9	0
Zaria_132_33_trf1	132kV / MV	99.9	1
Zaria_132_33_trf2	132kV / MV	99.9	1
Nsukka_66_33_trf1	66kV / MV	100	0
Nsukka_66_33_trf2	66kV / MV	100	0

Annex 3.2 – Details of Long-term Outages

The following table summarises the long-term transformer outages. The highlighted cells show the transformers for which the outage duration was assumed (due to lack of further information).

Transformer	Duration [days]	Date
330 / 132kV		
Kano_330_132_trf1	365	01.01.2015
Adiabo_330_132_trf1	62.5	09.04.2015
Adiabo_330_132_trf2	62.5	09.04.2015
Akangba_330_132_trf1	61.3	17.01.2015
Osogbo_330_132_trf1	60.8	17.01.2015
Aja_330_132_trf3	60.3	17.01.2015
Akangba_330_132_trf1	60	17.01.2015
Adiabo_330_132_trf1	8.2	27.02.2015
Akangba_330_132_trf1	1.3	16.01.2015
Akangba_330_132_trf2	1.2	17.01.2015
Akangba_330_132_trf3	1.2	17.01.2015
Akangba_330_132_trf4	1.2	17.01.2015
Gombe_330_132_trf2	1.2	09.04.2015
Ugwuaji_330_132_trf1	1	01.04.2015
132kV / MV		
Apo_132_33_trf4	365	01.01.2015
Benin_132_33_trf4	339	01.01.2015
Owerri_132_33_trf2	31.9	17.07.2015
Onitsha_132_33_trf3	31	01.12.2015
Ilorin_132_33_trf1	16.3	20.05.2015
Omuaran_132_33_trf1	12.1	10.09.2015
Aja_132_33_trf3	10.8	02.09.2015
Ayede_132_33_trf3	3	17.07.2015
New-Haven_132_33_trf3	3	14.01.2015
Akure_132_33_trf2	3	29.12.2015
New-Haven_132_33_trf1	2.8	10.06.2015
New-Haven_132_33_trf4	2.3	16.01.2015
Apapa-Road_132_33_trf1	1.3	11.06.2015
Kwanar-Dango_132_33_trf1	1.2	25.02.2015
Calabar_132_33_trf3	1.2	04.05.2015
Gombe_132_33_trf1	1.1	16.01.2015
Aja_132_33_trf3	1.1	02.09.2015
Aja_132_33_trf1	1.1	29.01.2015

Gombe_132_33_trf2	1.1	03.03.2015
Ayede_132_33_trf1	1	23.01.2015
Nkalagu_132_33_trf1	1	06.11.2015
Calabar_132_33_trf2	1	30.01.2015
Aja_132_33_trf3	1	02.09.2015
Aba_132_6.6_trf1	60	27.10.2015
Aja_132_33_trf1	60	29.01.2015
Aja_132_33_trf2	60	27.08.2015
Akangba_132_33_trf1	60	24.05.2015
Akangba_132_33_trf3	60	24.05.2015
Akoka_132_33_trf1	60	07.07.2015
Apapa-Road_132_33_trf1	60	11.06.2015
Apapa-Road_132_33_trf2	60	08.10.2015
Apo_132_33_trf2	60	17.07.2015
Ayede_132_33_trf1	60	23.01.2015
Calabar_132_33_trf1	60	05.04.2015
Calabar_132_33_trf2	60	30.01.2015
Calabar_132_33_trf3	60	04.05.2015
Ejigbo_132_33_trf2	60	25.04.2015
Ganmo_132_33_trf1	60	02.10.2015
Hadejia_132_33_trf2	60	09.08.2015
Ijora_132_33_trf2	60	23.03.2015
Ikorodu_132_33_trf3	60	27.06.2015
Ilorin_132_33_trf2	60	17.04.2015
Irrua_132_33_trf2	60	26.03.2015
Isolo_132_33_trf2	60	02.01.2015
Lekki_132_33_trf1	60	31.03.2015
Owerri_132_33_trf2	60	17.07.2015
Shagamu_132_33_trf1	60	13.09.2015
Shiroro_132_33_trf1	60	17.01.2015
Yola_132_33_trf1	60	08.04.2015
Agbara_132_33_trf1	56.4	05.11.2015
Ajaokuta_132_33_trf2	52.5	09.11.2015
Okene_132_33_trf2	52.5	09.11.2015
Awka_132_33_trf1	40.7	21.11.2015
Effurun_132_33_trf2	6.4	25.12.2015
Akure_132_33_trf2	5.9	29.12.2015

This report was prepared by the Market Operator with support from the Nigerian Energy Support Programme (NESP).