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NIGERIA ELECTRICITY MARKET INTELLIGENCE REPORT

Q1 2019

The killer app that got the world ready for appliances was the light bulb. So, the light bulb is what wired the world. And they weren't thinking about appliances when they wired the world. They were putting lighting into the home.

Jeff Bezos

Disclaimer

This publication presents information on the Nigerian Electricity Market. All reasonable precautions have been taken by Nextier Power to verify the reliability of the material in this publication. Its content reflects an analysis and trend of activities that characterise the market for the period under review. Although Nextier Power endeavours to ensure the accuracy of the information in this report, it cannot guarantee its 100 percent accuracy nor can it be held liable for errors that may be contained therein. Users are to note that use of any information herein is purely at their discretion.

Glossary of Terms

AEDC	Abuja Electricity Distribution Company
ANED	Association of Nigerian Electricity Distributors
ATC	Aggregate Technical and Commercial
ATC&C	Aggregate Technical, Commercial and Collection
BEDC	Benin Electricity Distribution Company
BPE	Bureau for Public Enterprise
DisCos	Distribution Companies
EEDC	Enugu Electricity Distribution Company
EKEDC	Eko Electricity Distribution Company Plc
FGN	Federal Government of Nigeria
FMPWH	Federal Ministry of Power, Works and Housing
GenCos	Generating Companies
GWh	Gigawatt-hour
IBEDC	Ibadan Electricity Distribution Company
IE	Ikeja Electric
JEDC	Jos Electricity Distribution Company
KED	Kaduna Electricity Distribution Plc
KEDCO	Kano Electricity Distribution Company
kW	Kilowatts
MHI	Manitoba Hydro International
MAP	Meter Asset Provider
MMSCFD	Million Standard Cubic Feet per Day
MW	Megawatts
MWh/h	Megawatt-hours per hour
NERC	Nigerian Electricity Regulatory Commission
NESI	Nigerian Electricity Supply Industry
NNPC	Nigerian National Petroleum Corporation
NSO	Nigeria System Operator
ONEM	Operator of the Nigeria Electricity Market
PHED	Port Harcourt Electricity Distribution Company
ROW	Right-of-Way
SCADA	Supervisory Control and Data Acquisition
TCN	Transmission Company of Nigeria
TLF	Transmission Loss Factor
TSP	Transmission Service Provider

Definition of Terms

ATC&C Losses	The difference between the amount of electricity received by a Distribution Company from the Transmission Company and the amount of electricity for which it invoices its customers plus the adjusted collections loss.
Evacuated Power	This is the amount of generated electricity that is dispatched from the power plant to the transmission grid for supply to the distribution companies.
Generation Constraints	The amount of electricity that cannot be generated and evacuated (or dispatched from the power plant to the transmission grid for supply to the distribution companies) due to challenges such as gas shortages, grid unreliability, distribution limitations and poor water management.
Grid Evacuation Efficiency	A measure of the efficiency concerning the evacuation of power at the generation-transmission interface.
Installed Generation Capacity	This is the maximum electricity generation capacity that a power plant is designed to operate at. It is also known as nameplate capacity, rated capacity, or nominal capacity of a power plant. It is the intended full-load sustained output of a facility.
Operational Performance	This is the recorded percentage of the installed generation capacity that is utilised for electricity evacuation, transmission and distribution. It is a measure of the performance of the generation, transmission and distribution assets.
Peak Demand	Peak (or maximum) demand refers to the times of day when electricity consumption is at its highest.
Peak Power Generation	The maximum amount of electricity generated within a short time in a definite period (typically 24 hours).
Peak Demand Forecast	The estimated maximum electricity demand over a specified period (hourly, daily, monthly, seasonal and yearly cycles).
Wheeling Capacity	The operational capacity of the grid (including lines, substations and transformers) in the process of transmitting electricity to the distribution companies.

Executive Summary

This publication presents an analysis of the quarterly performance of Nigeria's Electricity Market, highlighting the generation, transmission, and distribution segments. Data was open-sourced from the Advisory Power Team (APT) and National Control Centre[1] (NCC) and analysed by Nextier Power.

Improved market performance can be achieved through improved sector coordination and synchronised improvement of various factors. Some of these factors include adequate alignment of the gas suppliers and power generation; expanded, efficient and reliable transmission network; expanded distribution network capacities; proper water storage infrastructures; fair and bankable management of power dispatch; among many others. These proposed solutions are at a high level; therefore, it is important to present a proper in-depth analysis that investigates and identifies the root causes of these issues across several interfaces in the value chain.

An analysis approach, in subsequent reports, will be to categorise several performance parameters based on the performance issues, identified causes, and potential solutions. This exercise will enable the development of trends and provide reasons for any identified changes between successive months and/or quarters. For instance, a hike in the gas constraints could indicate unavailability of gas turbines, but the reasons why the turbines where not available would require more in-depth analysis of available performance data. The reasons could be low gas supply levels, vandalised pipelines, challenges with circulating water pumps, high turbine exhaust temperature, and many others.

For the period under review (Q1 2019), about 31 percent of the installed generation capacity was utilised and the generated electricity evacuated to the national grid. Factoring transmission and distribution losses, only about 20 percent of the electricity was supplied to the end-users.

These inefficiencies mean that only about 4,091 MW of the installed capacity was dispatched to the grid. Of this amount, only 3,218 MW of electricity was transmitted and 2,582 MW of electricity was distributed to the electricity consumers. The distributed electricity was about one-tenth of the peak demand.

The recorded Aggregate Technical, Commercial and Collection (ATC&C) losses were 48 percent and collection losses accounted for about 35 percent. The electricity market lost a combined revenue of about ₦197 billion during the period. These losses were mainly as a result of the generation constraints and uncollected revenue from electricity consumers.

[1] National Control Centre (NCC), "Daily Operational Report", Transmission Company of Nigeria (Performance Data Sourced: Peak Demand Forecast, Spinning Reserve, Wheeling Capacity and Grid Collapses).

Background

The expectation, with the privatisation of Nigeria's electricity supply industry in 2013, was that the industry will attract private investment, increase electricity generation and supply, improve efficiency, etc. This has not been the case mainly because the eventual owners lack the technical and financial capabilities required to transform the industry. Similarly, the government has failed to deliver on its promises of cost-reflective tariffs and other policy and regulatory requirements. As a result, Nigeria's electricity market has failed to deliver incremental, stable and uninterrupted power supply. The industry has also lacked coordination and communication among the market operators.

The current state of the market is not sustainable and manifests in accumulated market debt which, as at March 31, 2019, amounted to ₦520 billion (US$1.4 billion)[2]. This is driven mainly by the failure of the Distribution Companies (DisCos) to remit collections back up the value chain. In the period under review, DisCos, on average, remitted about 30 percent of their electricity invoices to the Nigeria Bulk Electricity Trader (NBET). This has created an adverse chain reaction where the Generation Companies (GenCos) are unable to pay their invoices to the gas suppliers and the Transmission Company of Nigeria (TCN) is unable to maintain or expand its network.

There are a myriad performance and operational issues with generation, transmission and distribution:

- Generation capacity issues where the operational capacity of the country's power plants is at less than one-third of the installed capacity
- Gas supply issues resulting from incessant vandalisation of oil and gas pipelines which, in turn, results in gas shortages at power plants
- Infrastructure issues resulting in frequent system collapses and restrictions within the transmission and distribution networks
- Financial issues resulting in high ATC&C losses impact the financial viability of the DisCOs.

An independent market analysis will point to the root causes of the challenges across the entire value chain and highlight the areas of intervention. The analysis will include the compilation, validation, interpretation and dissemination of comprehensive technical data on the performance and operations of the electricity market.

The intent is to create a single source of standardised market data to provide confidence between market stakeholders and provide pragmatic options for resolving performance and operational challenges. This Nextier Power Nigeria Electricity Market Intelligence Report aims to not only ensure improved and sustainable practices for the operators in the electricity market but also, build a robust stakeholder network in the electricity market.

[2] Source: Nigerian Electricity Regulatory Commission

Synopsis

The data presented below is for Q1 2019 with Q4 2018 as the baseline used in the comparison.

Average Power Evacuated

4,091 MW ⬆ 3 percent

Peak Demand Forecast

23,960 MW ⬆ 5 percent

Generation Constraints

3,133 MW ⬆ 2 percent

Operational Performance (Generation)

31 percent ⬆ 3 percent

Grid Collapses

Partial 0; Total 5

Grid Evacuation Efficiency

79 percent ⬆ 22 percent

Transmission Losses

21 percent ⬇ 13 percent

Operational Performance (Transmission)

24 percent ⬆ 9 percent

Distribution Losses (ATC&C)

48 percent ⬆ 7 percent

Collection Loss

35 percent ⬆ 9 percent

Revenue Collected

₦114.6 billion ⬆ 0.17 percent

Operational Performance (Distribution)

20 percent ⬆ 11 percent

1.0 Generation

In Nigeria, electricity generation supplied to the transmission grid comes predominately from two main sources of energy: water and gas. These energy sources are converted to electricity through turbines installed either in the hydro power plant or in a gas powered power plant.

Since 2015, Nigeria's installed generation capacity has increased by about 4 percent from about 12,522 megawatts[3] (MW) to over 13,000 MW[4]. However, the generation sub-sector is still challenged by a myriad of issues mainly gas supply, generation levels, dispatch operations, etc.

Other related challenges include pipeline vandalisation and its impact on gas availability for power generation, seasonal unavailability of water for hydropower generation plants, as well as inadequate transmission and distribution capacities. These combined challenges have resulted in a drop in expected generation capacity to about 7,000 MW.

In a wider context, most of the installed generation capacity is not supplied to the end-user due to grid and distribution constraints. The current operational generation capacity is about one-third of the installed capacity at about 4,000 MW.

The government, in an effort to improve electricity supply across the country, has implemented various electricity market policies and regulations in a bid to restructure the electricity market. The strategic plan is expected to engender fairness, encourage competition and promote market coordination and participation.

The Eligible Customer Regulation, which was issued on November 2017, is one of these regulations. The regulation provides an opportunity to resolve the irregular and unreliable supply to electricity consumers by enabling direct trade between GenCos and qualified customers under a willing buyer-willing seller transaction model.

Installed Capacity

13,208 MW ↔

Average Power Evacuated

4,091 MW ↑ 3 percent

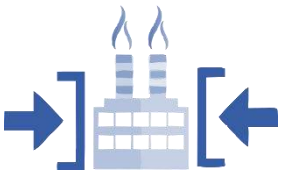
Peak Power Generation

5,375 MW ↑ 4 percent

Operational Performance

31% ↑ 3 percent

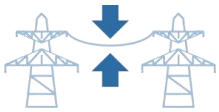
Average Gas Constraints



2,019 MW ↑ 19 percent

[3] The Advisory Power Team, Office of the Vice President, "Nigeria Power Baseline Report," Power Africa, 2015.
[4] For the period under review, the total installed capacity (including both the installed grid-connected and unconnected capacities) remains at about 13,208 MW. Thermal power plants (gas and steam) accounted for about 11,318 MW (86 percent) of the total installed capacity. Hydropower plants accounted for about 1,890 MW (14 percent) of the total installed capacity.

Average Grid Constraints



883 MW ⬇ 34 percent

Average Water Constraints

140 MW ⬆ 509 percent

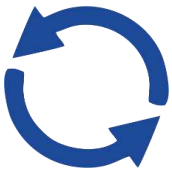
Constrained Revenue

₦135.1 billion ⬇ 0.4 percent

Average Gas Supply for Power Generation

729 mmscfd ⬆ 7 percent

MMSCFD to MW Conversion



3,455 MW ⬆ 31 percent

Peak Demand Forecast

23,960 MW ⬆ 5 percent

The Eligible Customer Regulation is currently being implemented by three GenCos under a bilateral agreement with eligible customers. The companies include Paras Energy/ Communauté Electrique du Bénin (CEB); Egbin/ Ikeja Distribution Company; and Mainstream Energy (Kainji and Jebba)/ Xing 1 and Xing 2, Asaka Cement, Olam Flour Mills, and Lordsmith[5]).

The intent is that, over the long run, unserved[6] and underserved[7] customers can purchase power directly from the GenCos. This will also lead to a fast-tracking of the transition from vesting contracts to bilateral contracts[8].

This chapter presents an analysis of several performance parameters related to electricity generation.

The parameters include Evacuated Power, Peak Power Generation, Peak Demand Forecast, Generation Constraints, Gas Supply for Power Generation and Operational Performance. The period under review is Q1 2019 while Q4 2018 is used as a baseline for comparison.

1.1. Gas Supply for Power Generation

Gas supply shortages have been one of the foremost challenges with electricity generation in Nigeria. The country has insufficient regulatory and policy frameworks and commitments to ensure an alignment of the gas and power generation sectors.

For the period under review, gas-fired power plants accounted for about 86 percent of the total

[5] Four of these Eligible Customers that applied in July 2018 are still operating without permits.
[6] An area within a distribution network without an existing distribution system.
[7] An area within a distribution network with an existing but poorly supplied or non-functional distribution system.
[8] Vesting contracts are regulatory instruments that mitigate the GenCos from exercising their market powers. It mandates a specified amount of electricity to be hedged at a specified price. Vesting contracts promote efficiency and competition in the electricity market for the benefit of consumers. Bilateral contracts are binding agreements between two licensed operators in the market. These contracts are signed to ensure that agreements are clear and legally enforceable. Currently, NBET is positioned to buy electricity in bulk from the generating companies (through Power Purchase Agreements) and sell (through vesting contracts) to the distribution companies. In advanced stages of the Nigerian Electricity Market, bilateral contracts will be signed between the GenCos and the DisCos. This will phase out NBET's position in the market.

installed generation capacity in the country. With such an overreliance on gas, there is a need to implement provisions that would enable well-timed and effective gas production and distribution to align with the demands of the power sector.

The average volume of gas supplied by the Nigerian National Petroleum Corporation (NNPC) to thermal power plants in Q1 2019 was about 729 million standard cubic feet per day (MMSCFD). This was a 7 percent increase from Q4 2018 (680 MMSCFD). Converting the quarterly average gas supply to electricity amounted to about 3,455 MW. This was a 31 percent increase from Q4 2018 (2,631 MW).

1.2. Peak Demand Forecast

Peak demand forecasts are needed for generation and network expansion planning, tariff evaluations, operations and dispatch management, etc. The peak demand forecast comprises of both the estimated connected loads[9] and the suppressed[10] loads. The monthly end-user approach estimates future trends from historical data and factors in indicators such as population growth, installed generation capacity, installed transmission substation and transformers, wheeling capacity, installed distribution feeders, daily electricity consumption, and others.

For the period under review, the average peak demand forecast was about 23,960 MW. This was a 5 percent increase from 22,893 MW in Q4 2018.

1.3. Peak Power Generation

Peak power generation is the maximum amount of electricity that is generated within a short time in a defined period of operation.

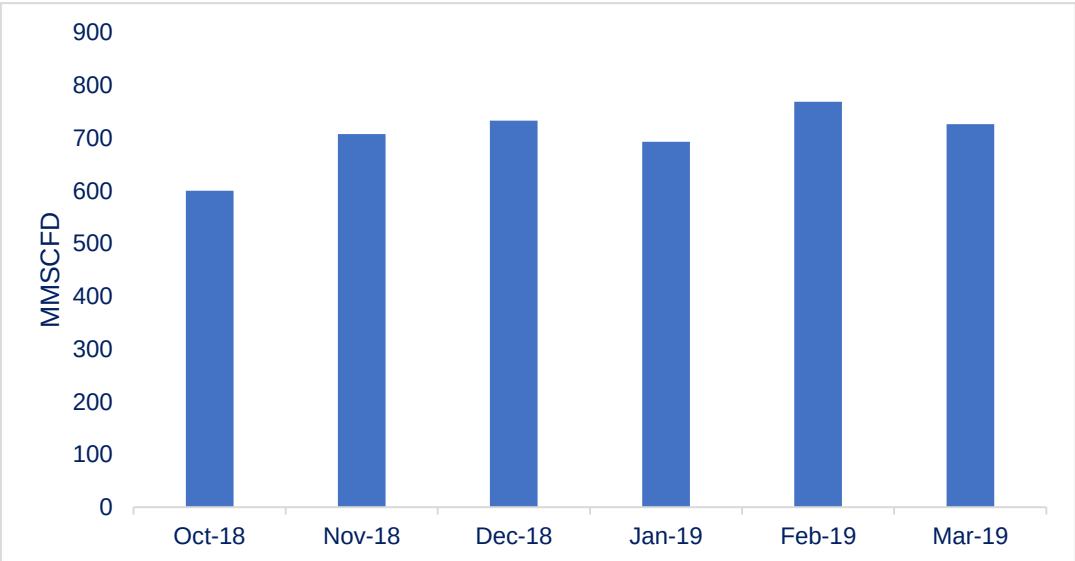


Figure 1: Average Gas Supply for Power Generation between October 2018 and March 2019.

[9] Connected load is the sum of ratings of all electrical equipment that are connected at the supply point (distribution feeders) regardless of their operational status. The calculation does not measure or test for their actual demand. The connected load, which is independent of time, is greater than the peak load demand.

[10] Suppressed load is the electricity that fails to get to the distribution companies due to unavailable infrastructures. The consumers' demands are also suppressed by this event.

Data from the Daily Operational Report provided by the National Control Centre (NCC) indicate that peak power generation is normally recorded over eight hours.

For the period under review (Q1 2019), Nigeria recorded the highest peak generation of 5,375 MW in February 2019. This was a 4 percent increase from Q4 2018 (5,191 MW in November 2018). The increase could have been as a result of the 7 percent increase in gas supply for power and a 5 percent increase in peak demand forecast. There was a 9 percent increase[10] in the average volume of gas supplied to thermal power plants in the month with the highest peak generations (February 2019).

1.4. Generation Constraints

Generation constraints are mainly caused by grid unreliability, distribution limitations, gas shortages and poor water management. For the period under review, total average constraints recorded was about 3,133 MW. This was a 2 percent increase from Q4 2018 (3,065 MW).

In Q1 2019, an average of 2,019 MW could not be generated due to unavailability of gas. Although gas supply increased by 7 percent during the period, gas was still largely unavailable to generate electricity to meet demands. Similarly, an average about 140 MW could not be generated by the hydro-power plants due to poor water management. This was a five-fold increase (509 percent) from the 23 MW constraint recorded in Q4 2018.

Grid constraints[11] result from unavailability of transmission and distribution network infrastructures. In Q1 2019, average grid constraints[12] was 883 MW; a 34 percent decline from 1,340 MW in Q4 2018. As a result of the constraints, grid evacuation efficiency[13] was about 79 percent in Q1 2019; a 22 percent improvement on the 65 percent recorded in Q4 2018.

Accordingly, generation constraints were driven mainly by gas constraints (64.3 percent), grid constraints (28.1 percent), and water constraints (4.5 percent). The remaining 3.1 percent of the generation constraints were due to generation plant outages (including forced, planned, emergency and urgent outages) and scheduled repairs and maintenances. These inefficiencies culminated in an estimated total revenue loss of about ₦135.1 billion; a 0.4 percent reduction from Q4 2018 (₦135.6 billion).

1.5. Evacuated Power

Evacuated power is the electricity that is generated and evacuated to the transmission grid and, then dispatched to the Distribution Companies (DisCos). It is typically tracked and recorded daily.

[11] Between November 2018 and February 2019, the average volume of gas supplied by the Nigerian National Petroleum Corporation (NNPC) to thermal power plants increased from 707 MMSCFD to 767 MMSCFD.

[12] [11]Due to frequency imbalance, caused by the load demand of the Distribution Companies (DisCos). Also, the transmission line constraints during electricity evacuation are caused by network outages, collapses, and other infrastructural limitations.

[13] The evacuation performance of the generation-transmission interface.

For the period under review, the average power evacuated to the grid was about 4,091 MW. This was a 3 percent increase from Q4 2018 (3,961 MW).

The increase could have been as a result of several performance parameters related to the generation-transmission interface, including the 4 percent increase in peak power generation, 7 percent increase in gas supply for power generation, 34 percent reduction in grid constraints, 22 percent increase in grid evacuation efficiency, and 8 percent increase in wheeling capacity.

Although the total grid collapses increased from two to five during the period, these incidents did not have a significant impact on the evacuated power. This is because the overall grid constraints also reduced significantly (about 34 percent) within the same period.

Similarly, the recorded increase in gas and water constraints did not have a significant impact on the power evacuated to the grid as there was also a significant reduction in grid constraints within the same period.

1.6. Operational Performance

Operational performance is recorded as a percentage of the installed generation capacity. For the period under review, average operational performance (or utilisation factor)[14] for the generation segment was about 31 percent. This was a 3 percent improvement from the 30 percent recorded in Q4 2018. The increase can be attributed to the 3 percent increase in power evacuated during the same period.

It also means that, on the average, only about 31 percent of the total installed generation capacity gets utilised and the electricity evacuated to the national grid. Without the constraints, the expected operational performance would be closer to 55 percent.

[14] The percentage of the nameplate capacity that is generated and dispatched daily to the national grid.

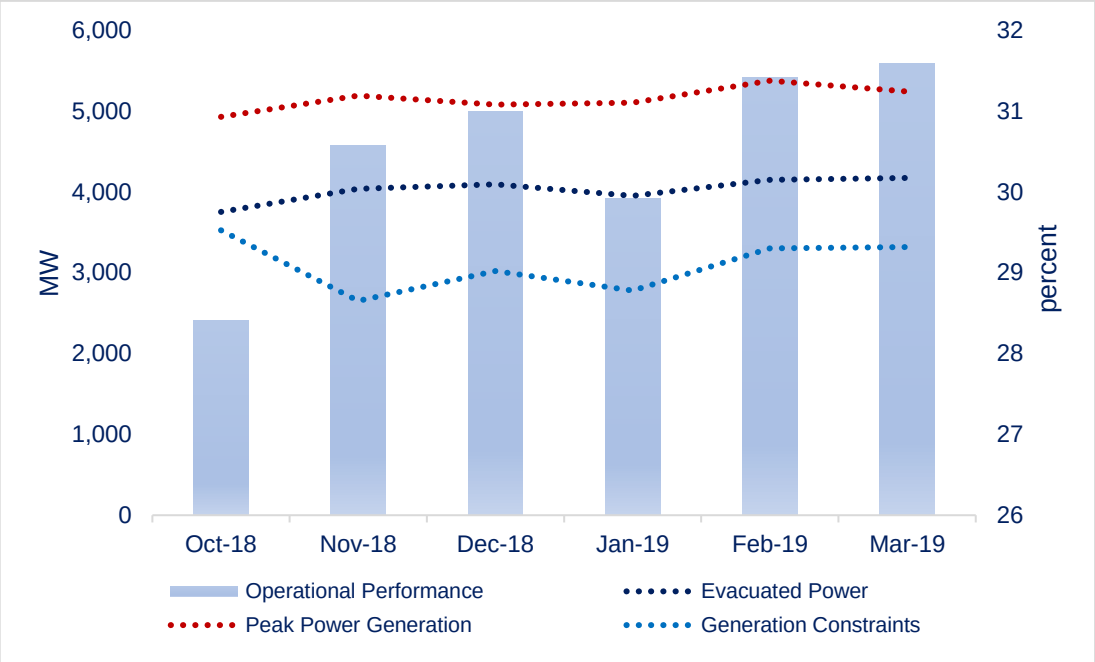


Figure 2: Operational Performance, Peak Power Generation, Evacuated Power and Generation Constraints between October 2018 and March 2019. The monthly average was recorded for the period under review.

Table 1: Generation Performance Data in Q4 2018 and Q1 2019. The monthly average was recorded for the period under review.

Period	Q4 2018			Q1 2019		
	October	November	December	January	February	March
Evacuated Power (MW)	3,752.24	4,037.89	4,092.62	3,951.73	4,148.05	4,172.02
Peak Power Generation (MW)	4,928	5,191	5,078	5,104	5,375	5.243
Peak Demand Forecast (MW)	22,780	22,900	23,000	23,020	23,960	24,900
Generation Constraints (MW)	3,524.78	2,651.23	3,019.66	2,780.31	3,302.29	3,316.79
Gas Supply for Power Generation (MMSCFD)	599.64	707.11	732.67	692.66	768.63	725.96
Operational Performance (percent)	28.41	30.57	30.99	29.92	31.41	31.59

2.0 Transmission

The transmission segment of Nigeria's electricity industry is responsible for supplying electricity, through the national transmission grid to the distribution companies (DisCos). The segment is often regarded as the "middleman" between generation and distribution in the electricity value chain.

Nigeria's national transmission grid is owned and managed by the Transmission Company of Nigeria (TCN). Despite TCN being fully government-owned, it is also a licensed operator in Nigeria's electricity market. TCN consists of the Operator of the Nigeria Electricity Market (ONEM)[15], Nigeria System Operator (NSO)[16] and the Transmission Service Provider (TSP)[17].

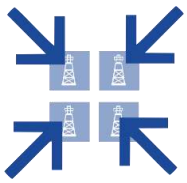
Here's some context. The Government of Nigeria retained ownership of the Transmission Company of Nigeria during the unbundling and subsequent privatisation of electricity supply industry. The reasons adduced for this structure was the need to protect national security and also to avoid creating a natural monopoly. This strategic decision was also informed by the significant financial requirements for maintaining and expanding the grid infrastructure, Right-of-Way (ROW) settlements, among others.

As part of the reform process, TCN was to be managed under concession. Manitoba Hydro International (MHI) was selected as concessionaires to improve the operational efficiencies and overall performance of the company between 2012 and 2016[18]. In February 2017, a new leadership was installed at TCN following the failure of MHI to achieve any significant improvements. The new leadership has established a Transmission Rehabilitation and Expansion Programme (TREP).

Wheeling Capacity

8,100 MW ⬆ 8 percent

Grid Collapses

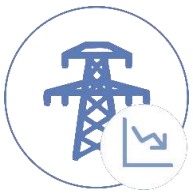


Partial 0, Total 5

Grid Evacuation Efficiency

82% ⬆ 8 percent

Transmission Losses



21% ⬇ 13 percent

Operational Performance

24% ⬆ 9 percent

[15] The administrator of the electricity market. The ONEM is licensed to function as the Market Operator of the electricity market. ONEM is responsible for the operation and settlement arrangements in the market. It is also responsible for the administration of the metering and settlement system among GenCos, TCN, and DisCos.
[16] The administrator of the national grid. The NSO is responsible for the planning, dispatch and operation of the transmission system, in addition to ensuring the security and reliability of the electricity network grid. It operates out of TCN but will become an independent organisation under the "Long-Term Stage" of the market.
[17] The operators of the national grid. The TSP is responsible for developing network infrastructure through grid construction, operation and maintenance of the grid system, international connections, load forecasting, system expansion planning, among others.
[18] A four-year management contract was initialed between the Federal Government of Nigeria (FGN) and Manitoba Hydro International (MHI). The objective of the contract was to provide technical and managerial expertise that will improve the operational efficiencies and overall performance of TCN. However, the contract ended on August 31, 2016, without achieving its objective. The FGN did not extend the contract any further.

The plan is to stabilise the grid for optimum performance, in line with international best practices. TREP is expected to expand the capacity of the grid to 20,000MW by 2021. The four TREP milestones include system frequency control, adequate spinning reserve, functional Supervisory Control and Data Acquisition (SCADA), and a critical investment in lines and substations. The programme also includes plans to develop an effective and well-motivated workforce.

Expanding the infrastructure and improving reliability of the grid is in line with the government's policy roadmap to achieve stable power supply. An improvement in the available generation capacity (over 7,500 MW) nationwide has further equipped the government to deliver on this objective.

As such, several projects have been scheduled to be completed in the transmission sub-sector, including accomplishing the required frequency control and expanding transmission networks.

This chapter presents an analysis of several performance parameters related to the transmission segment. The parameters include Wheeling Capacity, Grid Collapses, Transmission Losses and Operational Performance. The period under review is Q1 2019 with Q4 2018 as baseline used for comparative analysis.

2.1. Wheeling Capacity

Wheeling capacity is the rated ability of a transmission network to supply energy to an electrical load outside its boundaries. It is a measure of how much energy can be supplied for distribution to the end-user. This measure is based on the capacity of transmission equipment, such as lines, substations, transformers, among others.

The capacity of Nigeria's transmission network including installed substations and transformers is about 16,000 MW. The simulation for the wheeling capacity is, however, theoretic. The simulation also includes the constraints of the transmission network. The wheeling capacity, at the end of Q1 2019, is estimated to be 8,100 MW. This was an 8 percent increase from Q1 2018 (7,500 MW).

In practice, Nigeria's national grid operates at a wheeling capacity close to 5,500 MW. The grid has been unable to supply electricity to match its wheeling capacity. Regardless of the true estimate, inadequate infrastructural and network capacities of the DisCos may be the leading reason why the grid has been unable to wheel electricity close to its capacity.

There are about 738 transmission interfaces with the electricity distribution companies (DisCos). Of this number, 421 of these interfaces are completely protected. The remaining 317 interfaces are not protected. This means that any fault or incidence will affect the substations or transformers owned by TCN.

Hence, there is a need for more injection substations at these interfaces to protect transmission equipment, and also, optimise the wheeling capacity and electricity supply.

2.2. Grid Collapses

The national grid recorded 13 grid system collapses (12 total, and 1 partial collapse) in 2018. The total collapses occurred in January (five), February (one), June (one), July (one), September (two) and December (two). One partial collapse was recorded in April.

In an effort to resolve these collapses, TCN has completed a competitive procurement of Spinning Reserve.

The Spinning Reserve provides auxiliary electricity needed to stabilise the grid in the event of frequency imbalances that may lead to a system collapse. This procurement was in response to the directive from the Federal Ministry of Power, Works and Housing (FMPWH) to improve industry performance and coordination.

Usually, the Spinning Reserve of TCN (as recorded on the NCC daily operational report) is either 40, or zero MW. As at March 31, 2019, the recorded spinning reserve was zero MW. The spinning reserve should be at least 400MW (10% of the evacuated power – 4,091 MW).

The proposed amount of procured electricity is 260 MW, which falls short of the required 400 MW. It is, however, an improvement in achieving grid stability.

For the period under review, the total number of grid collapses recorded was five (5 collapses). This was a 150 percent increase from Q4 2018 (2 collapses).

2.3. Transmission Losses

Transmission of electricity over long distances results in energy losses. Majority of these losses are from transmission lines, as well as substations that are situated at interfaces with the DisCos.

According to Nigerian Electricity Regulatory Commission (NERC), the Transmission Loss Factor (TLF) is "measured by the proportion of the difference between the total energy sent out by power stations and energy delivered to all DisCos by TCN relative to the total energy sent out".

TCN continues to implement several loss-reduction measures that will expand and stabilise the grid. These proactive measures include line maintenance, completion of the line and substation projects, administration of grid code and market rules, among others.

The average energy evacuated through the national grid to the Distribution Companies (DisCos) was 4,091 MW (see section 1.1). For the period under review, the average energy received at the DisCos was 6,951 GWh (3,218 MW). This was an 8 percent increase from Q4 2018 (6,469 GWh, about 2,995 MW).

Consequently, the recorded transmission losses were about 21 percent. This was a 13 percent reduction from Q4 2018 (24 percent).

2.4. Operational Performance

The operational performance is recorded as a percentage of the installed generation capacity (about 13,208 MW).
For the period under review, the average operational performance of the transmission segment was about

24 percent. This was a 9 percent increase from Q4 2018 (22 percent) and it can be logically attributed to the 8 percent increase in the electricity transmitted to the distribution companies, during the same period.

It also means that only about 24 percent of the total installed capacity gets transmitted to the distribution companies for consumption. Concerning the estimated wheeling capacity of 8,100 MW, the operational performance will be closer to 40 percent.

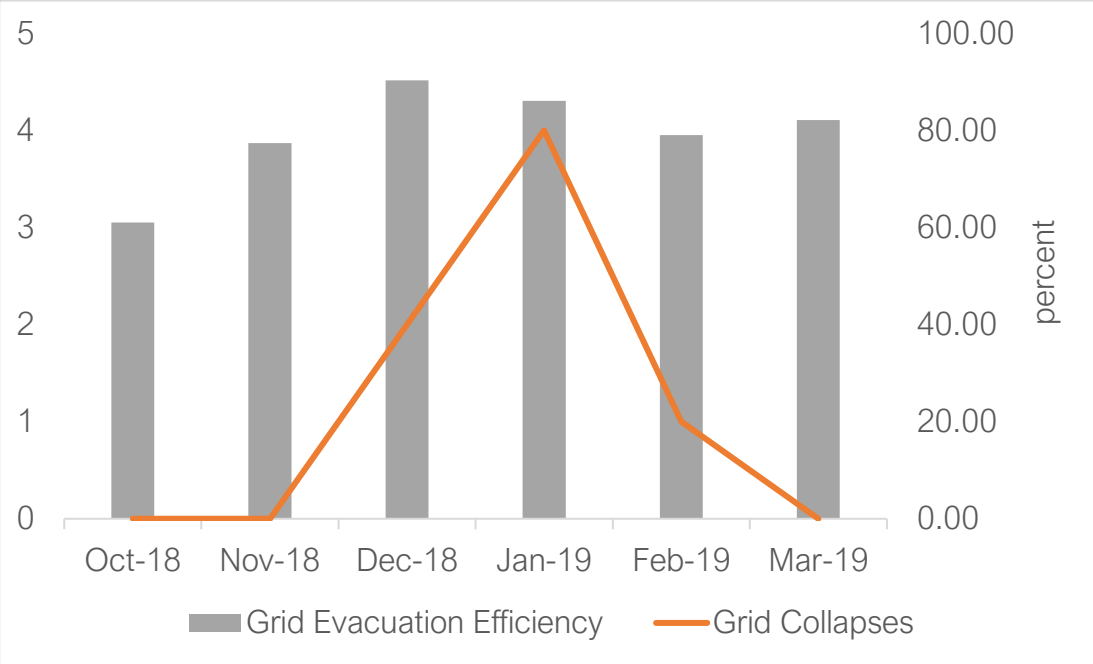


Figure 3: Average Grid Evacuation Efficiency and Total Number of Grid Collapses between October 2018 and March 2019.

Table 2: Transmission Performance Data in Q4 2018 and Q1 2019.

Period	Q4 2018			Q1 2019		
	October	November	December	January	February	March
Wheeling Capacity (MW)	7,500	7,500	7,500	8,100	8,100	8,100
Grid Collapses	0	0	2	4	1	0
Grid Evacuation Efficiency (percent)	61.00	77.39	90.28	86.09	79.01	82.10

Period	Q4 2018	Q1 2019

Losses (percent)	26.03	21.33
Transmitted Electricity (MW)	2,929.94	3,217.96
Operational Performance (percent)	22.18	24.36

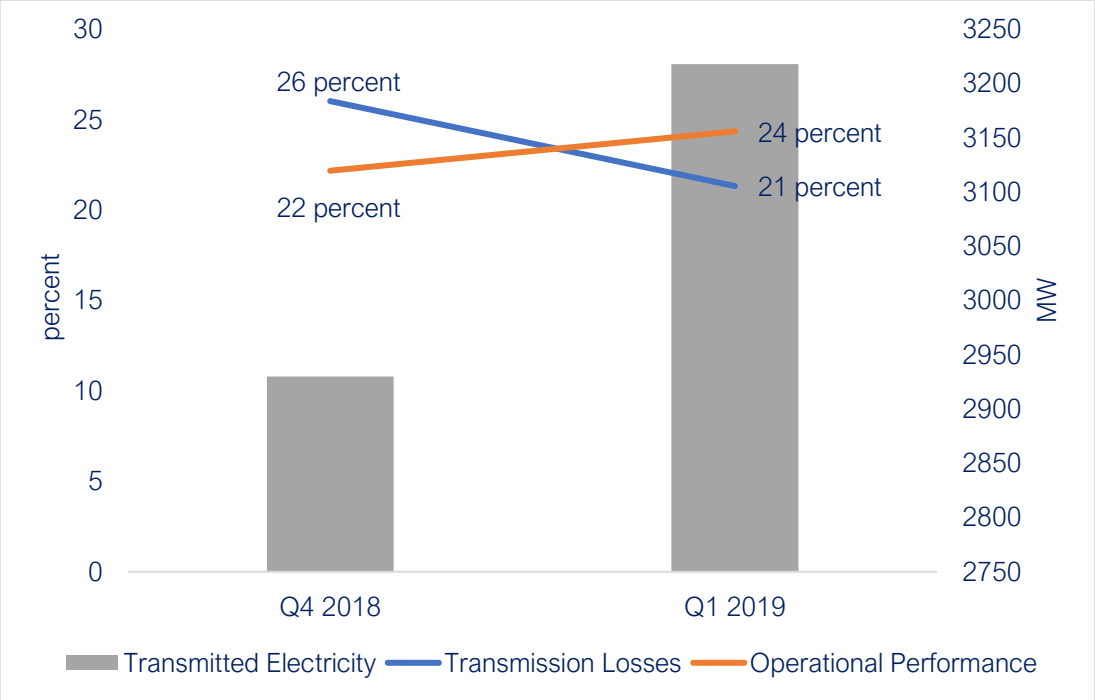


Figure 4: Transmitted Electricity, Transmission Losses and Operational Performance between October 2018 and March 2019. The monthly average was recorded for the period under review.

3.0 Distribution

The distribution sub-sector is tasked with the responsibility of providing last-mile delivery of electricity to the consumer.

In the unbundling and subsequent privatisation of the electricity value-chain, the national distribution network was regionalised to eleven franchise areas. These areas are managed and operated by licensed distribution companies.

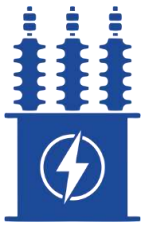
The privatised sub-sector is still faced with significant challenges related to distribution losses. Thus, there is a requirement for the DisCos to invest in the network system to meet performance and efficiency targets.

Recall that the privatisation of the distribution system assets was centred on the capability of prospective investors to reduce Aggregate Technical and Commercial Collection (ATC&C) losses in the distribution network. With Bureau for Public Enterprise (BPE) extending the performance agreement end date to December 2019 (December 2020 for Kaduna DisCo), the DisCos are on borrowed time to invest in network infrastructures and improve efficiency to specified targets.

Accordingly, a plan to expand the distribution network capacity will require loss reduction investments, engagement of Meter Asset Providers (MAP), completion of customer and asset enumeration, improved metering infrastructure and carrying out energy demand studies.

This chapter presents an evidence-based analysis of several performance parameters related to the distribution sub-sector. The parameters include Energy Received, Distribution (Technical, Commercial and Collection) Losses and Operational Performance. The period under review is Q1 2019 with Q4 2018 as baseline used for comparative analysis.

Energy Received



6,951 GWh ⬆8 percent

Energy Billed

5,577 GWh ⬆7 percent

₦ 176.5 billion ⬆5 percent

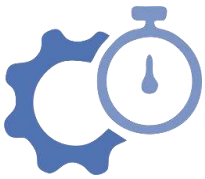
Distribution Losses (ATC&C)

48 percent ⬆7 percent

Revenue Collected

₦114.6 billion ⬆0.17 percent

Collection Loss



35 percent ⬆9 percent

Operational Performance

20 percent ⬆11 percent

3.1. Energy Received

The amount of energy received at the distribution interface is a function of the energy evacuated, transmission losses and the wheeling capacity.

The grid currently operates at a wheeling capacity close to 5,500 MW, although the simulated wheeling capacity is estimated at 8,100 MW. However, there are also grid constraints and transmission losses that further reduce the operational wheeling capability to lower levels.

Several upgrades and expansions in the transmission and distribution network interfaces (132kV and 33 kV), including the lines and injection substations, can improve the amount of energy received.

For the period under review, the average energy received at the Distribution Companies (DisCos)[19] was about 6,951 GWh (3,218 MW). This was an 8 percent increase from Q4 2018 (6,469 GWh, about 2,930 MW).

The increase could have been as a result of several performance parameters related to the generation and transmission sub-sectors, including the 3 percent increase in evacuated power, 4 percent increase in peak power generation, 7 percent increase in gas supply for power generation, 13 percent and 34 percent reductions in transmission losses and grid constraints respectively, 8 percent increase in grid evacuation efficiency, and 8 percent increase in wheeling capacity.

3.2. Distribution Losses

Distribution losses in the Nigerian Electricity Supply Industry (NESI) can be categorised into Technical, Commercial and Collection losses.

Technical losses are losses from the transmission and distribution of electricity through conductors, substations and transformers. Ideally, there should be no technical losses, but this is impossible. However, it can be minimised with proper equipment sizing and selection.

Commercial Losses results from the energy that is consumed but not accounted for. This occurrence can be related to illicit activities, such as meter bypass, meter tampering and energy theft. An erroneous estimate on the electricity consumption from unmetered customers could also be a reason for a commercial loss.

The non-payment of electricity utility bills by customers results in collection losses. This is the billed, but not collected energy.

The ATC&C losses total the above-mentioned three. It is also the difference between the allocated energy to a distribution system network and the collected energy (equivalent to payments from the electricity consumer) within a definite period.

Consumer malpractices that attribute to these ATC&C losses are widespread across the eleven electricity distribution companies. Urgent measures are being taken to reduce these malpractices. In 2018, the management of Kano Electricity Distribution Company (KEDCO) revealed that it loses about ₦180 million every month due to activities of vandals.

Similarly, Jos Electricity Distribution Company (JEDC) attributed the

[19] Data does not include Yola Distribution Company.

inability to collect up to 50 percent of its revenue to theft and vandalism. The company collected about ₦1 billion out of the ₦4.5 billion worth of electricity it distributed in February.

Eko Electricity Distribution Company Plc (EKEDC) has also lost over ₦1 billion to various forms of energy theft and vandalism in its franchise areas.

For the period under review, the ATC&C losses recorded were about 48 percent. This was a 7 percent increase from Q4 2018 (45 percent). The main reason for the increase was that the changes (0.17 percent) in the revenue collected during the period did not match the 8 percent and 7 percent increments in the energy received and energy billed respectively.

3.2.1. Technical and Commercial Losses

Energy theft accounts for a major part of the Aggregate Technical and Commercial (ATC) losses. The annual global losses from energy theft are about $89.3 billion; $58.7 billion of these losses come from emerging markets in developing countries[20]. Many of these countries are also facing high rates of electricity demand growth, straining infrastructure, and unreliable grids.

In the Nigerian Electricity Market, energy theft has led to poor collection efficiency for the DisCos, low remittance up the value-chain, and high billings to unmetered customers due to stolen and unaccounted energy.

To ensure sustainable electricity utility, the reduction of overall losses within the electricity distribution system is imperative. For this reason, a Performance Agreement was implemented between successful DisCo bidders and BPE. There was also an exigency for DisCos to formulate strategies to reduce losses and improve billing efficiency[21], as well as revenue collection.

For the period under review, the recorded ATC losses during electricity distribution were about 20 percent. This was a 5 percent increase from Q4 2018 (19 percent).

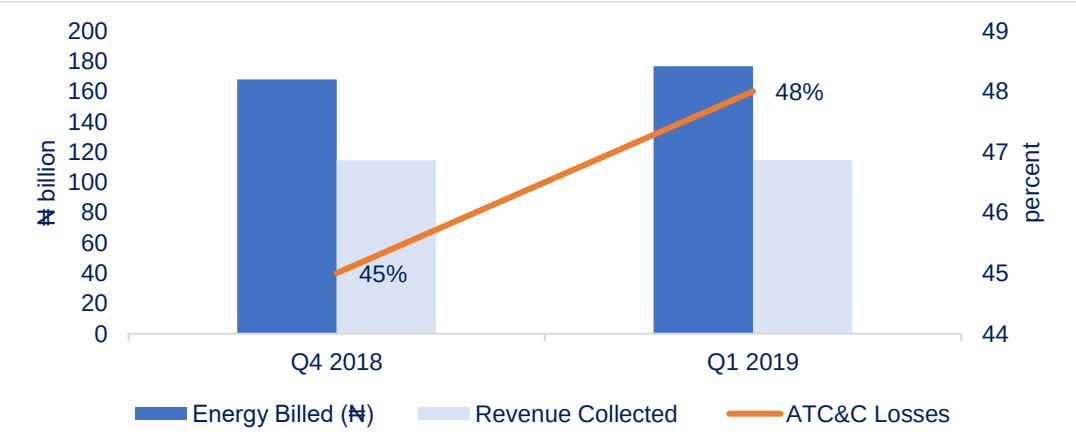


Figure 3: Energy Billed (Naira), Revenue Collected and ATC&C Losses in Q4 2018 and Q1 2019. The quarterly average was recorded for the period under review.

[20] Northeast Group, LLC, "Emerging Markets Smart Grid: Outlook 2015," Northeast Group LLC, Washington, 2014.

[21] The proportion of the energy received that is billed to the end-user.

Consequently, the total energy billed[22] from the Distribution Companies (DisCos) was about 5,577 GWh. This was a 7 percent increase from Q4 2018 (5,227 GWh).

3.2.2. Collection Losses

Collection losses account for a major part of the ATC&C losses. This is mainly because of the huge metering gap, which is currently over five million. Other malpractices, such as estimated billing and unwillingness to pay electricity bills also contribute to these losses.

Here is some context. In 2018, the eleven DisCos supplied 79,850 prepaid meters to cover the 4.6 million metering gap in the country. The total number of consumers with prepaid meters increased by a meagre 1 percent from Q3 2018 (1.65 million) to Q4 2018 (1.67 million).

Fittingly, the DisCos will need to close the metering gap by providing meters to registered consumers that are under the weight of estimated billing. This is also logical, as consumers will now pay for only the electricity they consume.

Concerning estimated billing, the general perception is that the situation translates to several outcomes. These outcomes include consumer complaints about exorbitant bills; avenues for illegal activities from DisCos' marketing staff to defraud and extort consumers; consumer apathy in paying for electricity; and hostility, assault and physical harm on DisCo staffs. This ultimately leads to a lack of transparency and accountability between the DisCos and consumers.

To resolve, consumer enumeration exercises can ensure that all existing and potential customers are registered, identified and categorised. Their details should be taken, and load assessment/energy requirements determined. This will allow for effective planning and future infrastructural development. It will also enable the Meter Asset Providers (MAPs) to roll-out pre-paid meters to registered customers.

Consumers also need to be better sensitised and protected. This can improve on their willingness to pay for electricity consumed.

For the period under review, the collected revenue recorded was ₦ 114.6 billion. This was a 0.17 percent increase from Q4 2018 (₦ 114.4 billion). This resulted in a collection loss of 35 percent – a 9 percent increase from Q4 2018 (32 percent). The reason for the increase, despite the slight increase in the collected revenue, was as a result of the 7 percent increment in the energy billed during the period.

3.3. Operational Performance

The operational performance is recorded as a percentage of the installed generation capacity (about 13,208 MW).

For the period under review, the average operational performance of the distribution sub-sector was 20 percent. This was an 11 percent increase from Q4 2018 (18 percent) and it can be logically attributed to

[22] The energy billed amounted to about ₦ 176.5 billion – a 5 percent increase from Q4 2018 (₦ 168 billion).

the 9 percent increase in the electricity distributed to consumers.

It also means that only about 20 percent of the total installed capacity gets distributed to the end-user for consumption.

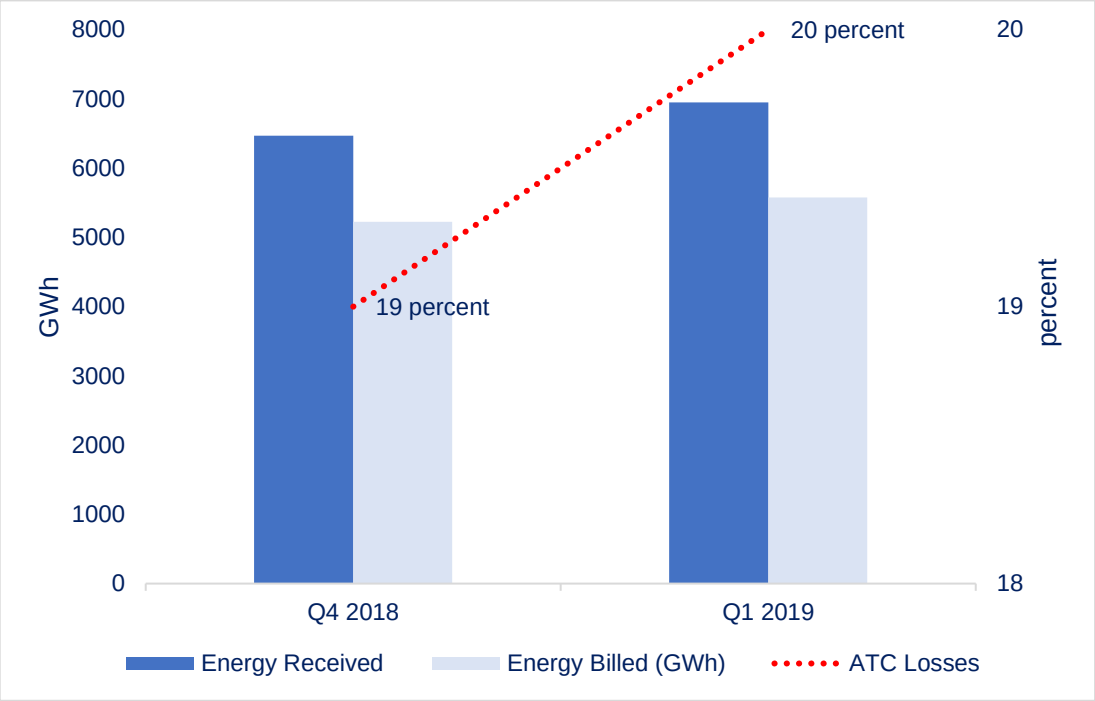


Figure 6: Energy Received (GWh), Energy Billed (GWh), and ATC Losses in Q4 2018 and Q1 2019. The quarterly average was recorded for the period under review.

Table 3: Distribution Performance Data in Q4 2018 and Q1 2019. The quarterly average was recorded for the period under review.

Period	Q4 2018	Q1 2019
Energy Received (GWh)	6,469.09	6,950.80
ATC Losses (percent)	19	20
Energy Billed (GWh)	5,227	5,576.80
Energy Billed (₦ billion)	168	176.5
Revenue Collected (₦ billion)	114.4	114.6
Collection Loss (percent)	31.90	35.07
ATC&C Losses (percent)	44.61	48.35

4.0 Appendices

4.1. Generation[23]

Oct-18	Average Hourly Energy Evacuated in a Day (MWh/h)	Daily Constraints - Total (MWh/h)	Daily Gas Constraints (MWh/h)	Daily Grid Constraints (MWh/h)	Daily Water Constraints (MWh/h)	Daily Gas Supplied, Gas-to-Power (MMSCFD)
1	3,309.58	3,203.80	800.00	2,403.80	0.00	553.25
2	3,699.96	3,494.50	792.10	2,702.40	0.00	583.23
3	3,762.53	3,380.60	1,085.00	2,295.60	0.00	584.37
4	3,868.17	3,366.60	892.50	2,474.10	0.00	605.64
5	3,781.44	3,566.70	892.50	2,674.20	0.00	617.15
6	3,778.92	3,700.20	892.50	2,807.70	0.00	600.93
7	3,618.03	4,048.80	747.50	3,301.30	0.00	556.62
8	3,560.84	3,675.00	892.50	2,782.50	0.00	529.48
9	3,702.92	3,919.50	892.50	3,027.00	0.00	559.26
10	3,390.49	3,828.30	892.50	2,935.80	0.00	513.49
11	3,729.00	3,336.00	842.00	2,494.00	0.00	590.76
12	3,928.21	3,530.60	790.90	2,739.70	0.00	627.66
13	3,783.93	3,607.40	791.80	2,815.60	0.00	571.35
14	3,784.59	3,477.80	737.50	2,740.30	0.00	581.23
15	3,802.50	3,796.20	737.50	3,058.70	0.00	578.49
16	3,501.18	3,895.50	1,187.50	2,708.00	0.00	582.07
17	3,850.45	3,416.30	922.50	2,493.80	0.00	618.16
18	4,057.45	3,510.00	1,150.00	2,360.00	0.00	638.72
19	4,114.59	3,493.50	1,305.80	2,187.70	0.00	685.27
20	3,881.20	3,668.40	1,340.00	2,328.40	0.00	615.92
21	3,926.90	3,526.10	1,340.00	2,186.10	0.00	635.10
22	3,854.33	3,432.90	1,200.00	2,232.90	0.00	620.01
23	4,014.73	3,652.90	1,200.00	2,452.90	0.00	654.14
24	3,863.92	3,414.50	885.50	2,529.00	0.00	618.39
25	3,900.14	3,118.80	873.40	2,245.40	0.00	619.34
26	4,054.92	3,143.40	818.40	2,325.00	0.00	652.14
27	3,701.99	3,155.70	1,874.80	1,280.90	0.00	682.10
28	3,465.11	3,888.00	1,992.50	1,895.50	0.00	511.48
29	2,979.23	3,285.60	1,900.50	1,385.10	0.00	556.43
30	3,718.39	3,271.80	2,013.80	1,258.00	0.00	616.59
31	3,933.80	3,462.90	2,210.00	1,252.90	0.00	630.04
TOTAL	116,319.44	109,268.30	34,894.00	74,374.30	0.00	18,588.81
AVERAGE	3,752.24	3,524.78	1,125.61	2,399.17	0.00	599.64

[23] Source: The Advisory Power Team, Office of the Vice President

Nov-18	Average Hourly Energy Evacuated in a Day (MWh/h)	Daily Constraints - Total (MWh/h)	Daily Gas Constraints (MWh/h)	Daily Grid Constraints (MWh/h)	Daily Water Constraints (MWh/h)	Daily Gas Supplied, Gas-to-Power (MMSCFD)
1	3,917.81	2,994.10	1,284.00	1,710.10	0.00	689.26
2	3,960.57	3,113.00	867.50	2,245.50	0.00	688.08
3	3,888.24	2,999.30	817.50	2,181.80	0.00	646.94
4	3,767.61	3,052.40	1,162.50	1,889.90	0.00	653.07
5	3,800.19	2,940.00	1,080.00	1,860.00	0.00	666.96
6	3,967.77	2,456.00	1,099.80	1,356.20	0.00	682.78
7	4,062.91	2,550.00	749.70	1,800.30	0.00	687.45
8	4,013.88	2,661.20	658.40	2,002.80	0.00	691.78
9	4,058.76	2,729.90	669.00	2,060.90	0.00	727.95
10	4,069.19	3,066.60	898.70	2,167.90	0.00	695.89
11	4,018.68	2,894.70	778.60	2,116.10	0.00	670.49
12	4,006.37	2,397.00	920.00	1,477.00	0.00	690.39
13	3,927.96	2,552.80	1,140.00	1,412.80	0.00	654.20
14	4,105.08	2,345.50	1,705.50	640.00	0.00	723.95
15	4,203.24	2,836.80	1,442.80	1,394.00	0.00	713.02
16	4,245.95	2,481.00	1,509.00	972.00	0.00	733.43
17	4,156.76	2,681.00	1,373.00	1,308.00	0.00	695.85
18	3,903.66	2,546.60	1,347.50	1,199.10	0.00	654.30
19	4,138.22	2,634.30	1,270.70	1,363.60	0.00	733.37
20	4,200.77	2,241.30	1,254.20	987.10	0.00	729.62
21	4,248.16	1,735.00	1,459.50	275.50	0.00	803.84
22	4,212.18	2,256.20	1,603.70	652.50	0.00	800.74
23	4,145.04	2,558.90	1,717.00	841.90	0.00	748.58
24	4,027.74	2,699.00	2,203.50	495.50	0.00	750.63
25	3,893.41	2,326.70	2,144.20	182.50	0.00	741.46
26	4,130.57	2,859.50	2,540.00	319.50	0.00	762.85
27	4,069.46	2,873.30	2,491.30	382.00	0.00	700.68
28	3,991.95	2,768.00	2,586.00	90.00	92.00	698.23
29	3,833.16	2,614.70	2,614.70	0.00	0.00	633.93
30	4,171.26	2,672.20	2,624.20	0.00	48.00	743.45
TOTAL	121,136.55	79,537.00	44,012.50	35,384.50	140.00	21,213.17
AVERAGE	4,037.89	2,651.23	1,467.08	1,179.48	4.67	707.11

Dec-18	Average Hourly Energy Evacuated in a Day (MWh/h)	Daily Constraints - Total (MWh/h)	Daily Gas Constraints (MWh/h)	Daily Grid Constraints (MWh/h)	Daily Water Constraints (MWh/h)	Daily Gas Supplied, Gas-to-Power (MMSCFD)
1	4,146.93	2,869.40	2,656.90	112.50	100.00	727.55
2	4,018.07	3,335.00	2,978.00	257.00	100.00	684.88
3	4,067.62	3,345.00	3,053.00	202.00	90.00	752.60
4	4,003.05	3,303.00	3,053.00	158.00	92.00	743.95
5	4,082.42	3,109.50	2,901.50	118.00	90.00	756.46
6	4,116.31	3,292.00	2,775.00	232.00	285.00	774.07
7	4,190.76	3,143.70	2,587.00	274.70	282.00	812.98
8	4,222.48	3,415.00	2,665.00	470.00	280.00	840.45
9	4,014.61	3,391.00	2,816.50	384.50	190.00	741.58
10	4,191.67	3,086.00	2,623.00	273.00	190.00	786.18
11	4,303.43	2,388.50	2,288.50	100.00	0.00	752.58
12	4,104.51	3,073.00	2,993.00	80.00	0.00	753.25
13	4,104.11	2,961.50	2,791.50	170.00	0.00	718.22
14	4,127.63	3,131.50	2,956.50	175.00	0.00	713.71
15	4,059.36	3,146.50	2,791.50	355.00	0.00	692.84
16	4,049.47	3,179.80	2,673.50	506.30	0.00	731.94
17	4,131.68	2,879.00	2,497.00	382.00	0.00	744.04
18	4,154.80	2,941.50	2,393.50	548.00	0.00	740.86
19	4,218.29	2,896.50	2,293.50	603.00	0.00	757.84
20	4,260.63	2,746.50	2,393.50	353.00	0.00	771.07
21	3,228.98	2,755.00	2,244.00	511.00	0.00	583.68
22	4,107.51	2,703.50	2,395.50	308.00	0.00	718.38
23	4,175.15	2,796.90	2,170.50	626.40	0.00	722.86
24	4,181.64	2,871.80	2,170.50	701.30	0.00	725.15
25	4,275.10	3,077.50	2,170.50	907.00	0.00	726.05
26	4,188.89	2,995.00	2,086.00	909.00	0.00	729.02
27	4,186.88	2,864.00	1,960.00	904.00	0.00	736.97
28	4,237.94	2,963.90	2,060.00	903.90	0.00	729.96
29	3,509.90	2,518.10	1,960.00	558.10	0.00	616.48
30	4,103.44	3,162.30	2,083.00	929.30	150.00	705.92
31	4,108.00	3,267.50	2,464.50	653.00	150.00	721.14
TOTAL	126,871.26	93,609.40	77,945.40	13,665.00	1,999.00	22,712.66
AVERAGE	4,092.62	3,019.66	2,514.37	440.81	64.48	732.67

Jan-19	Average Hourly Energy Evacuated in a Day (MWh/h)	Daily Constraints - Total (MWh/h)	Daily Gas Constraints (MWh/h)	Daily Grid Constraints (MWh/h)	Daily Water Constraints (MWh/h)	Daily Gas Supplied, Gas-to-Power (MMSCFD)
1	4,129.83	3,466.00	1,908.00	1,408.00	150.00	708.14
2	4,034.28	3,507.00	1,908.00	1,449.00	150.00	733.82
3	3,302.74	3,354.00	1,728.00	1,476.00	150.00	587.94
4	3,985.07	3,087.83	1,814.83	1,123.00	150.00	715.56
5	3,978.13	3,096.50	1,812.50	1,134.00	150.00	713.82
6	3,974.10	2,748.50	1,931.50	667.00	150.00	710.70
7	4,063.98	2,543.00	1,550.00	843.00	150.00	762.23
8	4,129.82	2,828.20	1,500.00	1,178.20	150.00	713.68
9	4,059.87	2,757.50	1,475.00	1,132.50	150.00	707.80
10	4,184.50	2,847.90	1,601.50	1,096.40	150.00	735.73
11	4,302.70	2,832.30	1,475.00	1,207.30	150.00	762.56
12	4,127.52	2,387.70	1,195.50	1,042.20	150.00	738.90
13	4,095.16	2,178.50	1,237.50	791.00	150.00	734.26
14	4,259.12	2,276.50	1,195.50	931.00	150.00	738.40
15	4,102.26	2,256.99	2,021.99	235.00	0.00	680.83
16	4,077.66	2,405.80	1,957.50	325.00	95.00	667.75
17	4,124.30	2,301.90	1,971.90	235.00	95.00	708.11
18	3,110.25	2,638.50	2,493.50	145.00	0.00	579.77
19	3,232.23	3,206.50	2,771.50	0.00	0.00	557.04
20	3,758.44	2,487.50	1,907.50	0.00	145.00	630.72
21	3,928.72	2,957.00	2,034.00	248.00	240.00	664.42
22	3,920.60	2,708.50	2,413.50	0.00	150.00	661.30
23	4,136.05	2,756.00	2,337.00	124.00	150.00	684.87
24	4,003.89	3,002.00	2,487.00	130.00	240.00	666.55
25	3,331.86	2,834.00	2,406.00	133.00	150.00	599.49
26	4,058.39	2,758.50	2,153.50	250.00	0.00	695.88
27	4,241.03	2,669.50	2,306.50	238.00	0.00	728.44
28	4,039.81	2,528.50	2,306.50	91.00	0.00	731.00
29	3,887.93	3,214.40	2,180.00	903.40	0.00	708.83
30	3,728.78	2,925.00	2,138.00	657.00	0.00	671.98
31	4,194.67	2,627.50	1,871.50	606.00	150.00	771.89
TOTAL	122,503.69	86,189.52	60,090.22	19,799.00	3,515.00	21,472.41
AVERAGE	3,951.73	2,780.31	1,938.39	638.68	113.39	692.66

Feb-19	Average Hourly Energy Evacuated in a Day (MWh/h)	Daily Constraints - Total (MWh/h)	Daily Gas Constraints (MWh/h)	Daily Grid Constraints (MWh/h)	Daily Water Constraints (MWh/h)	Daily Gas Supplied, Gas-to-Power (MMSCFD)
1	4,265.69	3,216.50	2,011.50	905.00	300.00	759.14
2	4,171.00	2,909.80	1,656.50	808.30	300.00	713.85
3	4,197.07	2,915.00	1,645.00	825.00	300.00	740.69
4	4,065.55	3,181.00	1,720.00	1,016.00	300.00	740.51
5	4,029.73	2,914.00	1,720.00	749.00	300.00	768.84
6	4,312.46	2,978.50	1,551.50	1,127.00	300.00	817.65
7	4,303.30	2,736.50	1,543.50	923.00	150.00	833.91
8	4,255.89	2,832.50	1,443.50	949.00	300.00	774.28
9	4,133.07	2,700.50	1,518.50	704.50	300.00	754.46
10	3,974.41	3,010.30	1,587.00	1,026.40	300.00	763.31
11	4,101.78	3,020.30	1,228.50	1,394.10	300.00	795.48
12	4,288.41	2,680.00	1,153.50	1,193.80	300.00	827.76
13	4,345.48	2,974.30	1,645.50	1,014.00	300.00	853.60
14	4,476.69	3,102.90	1,682.50	1,102.50	300.00	832.23
15	4,431.26	3,292.18	1,836.48	1,134.00	300.00	757.43
16	4,238.52	4,017.90	2,172.50	1,516.00	300.00	818.22
17	4,163.28	3,099.90	1,732.50	1,038.00	300.00	779.22
18	4,404.77	3,054.00	1,590.50	1,281.00	150.00	851.41
19	4,408.05	3,058.45	2,332.95	543.00	150.00	760.49
20	3,573.11	3,063.60	2,660.50	375.00	0.00	734.84
21	4,369.29	3,618.10	2,574.50	729.70	0.00	836.61
22	4,286.29	3,405.90	2,240.50	703.70	150.00	810.61
23	4,212.85	4,519.81	2,408.21	1,521.60	150.00	800.34
24	3,612.85	4,189.70	2,089.00	1,660.70	150.00	708.15
25	3,724.81	4,435.50	1,962.50	2,145.70	150.00	693.56
26	3,727.00	3,787.80	2,236.50	1,299.00	150.00	655.29
27	4,042.21	3,265.30	1,985.50	1,247.50	0.00	663.38
28	4,030.55	4,484.00	2,295.50	1,923.50	150.00	676.36
TOTAL	116,145.37	92,464.24	52,224.64	30,856.00	6,150.00	21,521.62
AVERAGE	4,148.05	3,302.29	1,865.17	1,102.00	219.64	768.63

Mar-19	Average Hourly Energy Evacuated in a Day (MWh/h)	Daily Constraints - Total (MWh/h)	Daily Gas Constraints (MWh/h)	Daily Grid Constraints (MWh/h)	Daily Water Constraints (MWh/h)	Daily Gas Supplied, Gas-to-Power (MMSCFD)
1	3,442.35	5,084.00	2,895.50	1,923.50	150.00	581.79
2	3,905.37	3,501.50	2,830.50	406.00	150.00	691.20
3	4,075.97	2,834.00	2,729.00	78.00	0.00	694.15
4	4,113.81	2,550.80	2,514.00	0.00	0.00	660.04
5	4,230.06	2,855.67	2,475.37	346.00	0.00	698.26
6	4,047.18	2,900.00	2,202.00	583.00	0.00	722.04
7	4,178.34	3,260.70	2,497.00	716.00	0.00	747.06
8	4,209.67	3,358.20	2,472.00	852.40	0.00	739.37
9	4,181.42	3,555.30	2,295.50	1,226.00	0.00	751.06
10	4,021.06	2,808.75	2,774.05	0.00	0.00	673.58
11	4,113.53	3,138.18	2,793.58	168.60	0.00	711.40
12	4,442.32	2,983.50	2,512.50	440.00	0.00	785.87
13	4,437.50	3,357.70	1,818.00	1,497.00	0.00	800.95
14	4,140.87	2,671.90	1,776.00	863.50	0.00	792.66
15	4,427.21	2,843.62	1,797.52	1,013.50	0.00	777.93
16	4,196.96	3,400.90	1,928.50	1,445.50	0.00	725.91
17	3,981.78	3,076.90	1,844.00	889.50	300.00	736.91
18	4,307.98	3,081.60	1,861.50	890.60	300.00	784.03
19	4,314.55	2,644.55	1,941.05	553.50	150.00	786.58
20	4,539.55	3,247.70	2,269.50	790.50	150.00	817.61
21	4,354.86	4,517.20	2,037.50	2,189.20	150.00	740.20
22	3,541.87	3,748.10	2,183.50	1,564.60	0.00	638.94
23	4,140.72	3,736.00	2,301.50	1,434.50	0.00	709.43
24	4,108.31	3,648.70	2,314.50	1,184.20	150.00	697.18
25	4,254.23	3,392.10	2,479.50	733.50	150.00	719.00
26	4,313.05	3,581.07	2,549.77	857.50	150.00	714.49
27	4,457.89	3,259.20	2,103.00	867.50	150.00	730.82
28	4,426.94	3,429.20	2,174.00	966.50	150.00	722.56
29	4,476.10	3,462.00	2,010.50	1,111.50	150.00	745.26
30	3,957.05	3,363.50	1,884.00	1,139.50	150.00	723.57
31	3,994.26	3,528.10	1,579.50	1,458.60	300.00	684.95
TOTAL	129,332.76	10,2820.64	69,844.34	28,190.20	2,700.00	22,504.80
AVERAGE	4,172.02	3,316.79	2,253.04	909.36	87.10	725.96

4.2. Distribution[24]

Period	Q4 2018	Q1 2019	Q4 2018	Q1 2019
DisCos	Energy Received (GWh)	Energy Received (GWh)	Energy Received (MW)	Energy Received (MW)
AEDC	901.00	952.00	408.06	440.74
BEDC	600.82	676.81	272.11	313.34
EKEDC	786.00	862.00	355.98	399.07
EEDC	549.00	605.00	248.64	280.09
IBEDC	801.25	897.99	362.89	415.74
IE	1,000.46	1,039.07	453.11	481.05
JEDC	284.00	333.00	128.62	154.17
KED	559.00	593.00	253.17	274.54
KEDCO	495.57	476.69	224.44	220.69
PHED	491.99	515.24	222.82	238.54
TOTAL	6,469.09	6,950.80	2,929.84	3,217.96
AVERAGE	646.91	695.08	292.98	321.80

[24] Source: Association of Nigerian Electricity Distributors (ANED)

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