Nextier POWER

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NIGERIA ELECTRICITY MARKET INTELLIGENCE REPORT

Q4 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

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Glossary of Terms

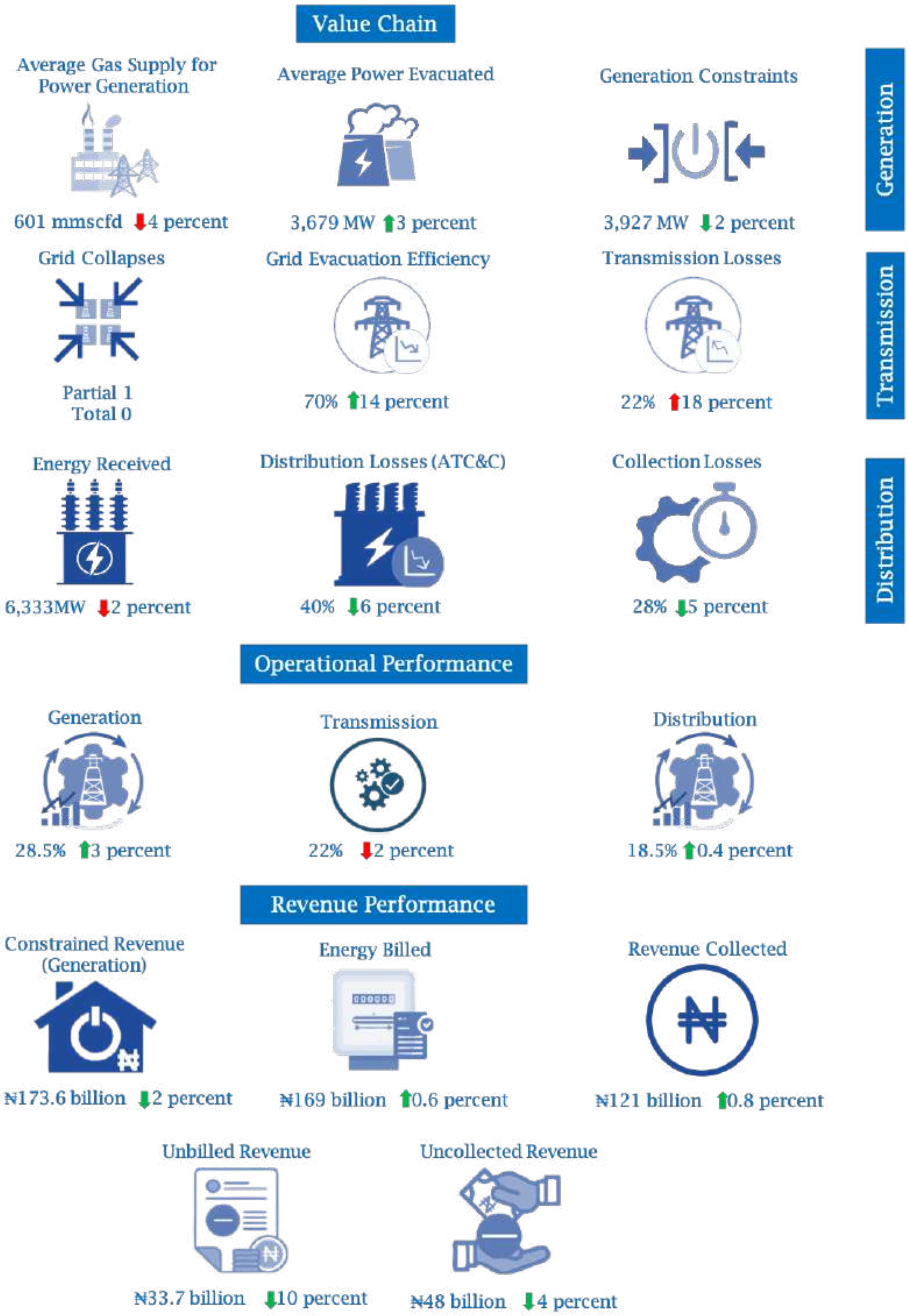
AEDC	Abuja Electricity Distribution Company
ANED	Association of Nigerian Electricity Distributors
ATC	Aggregate Technical and Commercial
ATC&C	Aggregate Technical, Commercial and Collection
BEDC	Benin Electricity Distribution Company
BPE	Bureau for Public Enterprise
DisCos	Distribution Companies
EEDC	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 collection losses.
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 electricity at the generation-transmission interface for supply to the transmission-distribution 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.

Synopsis

The data presented below is for Q4 2019 with Q3 2019 as the baseline used in the comparison.



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.

Better market performance can be achieved through 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 fundamental 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. Still, the reasons why the turbines were not available would require a 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 (Q4 2019), about 28.5 percent of the installed generation capacity was utilised and the generated electricity evacuated to the national grid. Factoring transmission and distribution losses, only about 18.5 percent of the electricity were supplied to the end-users.

These inefficiencies mean that only about 3,679 MW of the installed capacity was dispatched to the grid. Of this amount, only 2,868 MW of electricity was transmitted and 2,391 MW of electricity was distributed and billed to electricity consumers. The distributed electricity was about one-tenth of the peak demand.

The recorded Aggregate Technical, Commercial and Collection (ATC&C) losses were 40 percent and collection losses were about 28 percent. The electricity market lost a combined revenue of about ₦255 billion during the period. These losses were mainly a result of the generation constraints, unbilled revenue to consumers and uncollected revenue from 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 would 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 been unable to provide an 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. The debt 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, paid 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 about 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.

1.0 Generation

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

Since 2015, Nigeria's installed generation capacity has increased by 4 percent from about 12,522 megawatts[2] (MW) to about 13,000 MW[3]. 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 broader 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 3,679 MW.

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

The Eligible Customer Regulation, which was issued in 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

12,910 MW ↔

Average Power Evacuated

3,679 MW ⬆3 percent

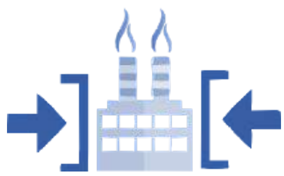
Peak Power Generation

5,157 MW ⬆1 percent

Operational Performance

28.5% ⬆3 percent

Average Gas Constraints



2,202 MW ⬆28 percent

[2] The Advisory Power Team, Office of the Vice President, "Nigeria Power Baseline Report," Power Africa, 2015.

[3] For the period under review, the total installed capacity (including both grid-connected and unconnected capacities) remains at about 12,910 MW. Thermal power plants (gas and steam) accounted for about 11,020 MW (85 percent) of the total installed capacity. Hydropower plants accounted for about 1,890 MW (15 percent) of the total installed capacity.

Average Grid Constraints	Average Water Constraints	Constrained Revenue
1,635 MW ↓29 percent	0 MW ↓100 percent	₦173.6 billion ↓2 percent

Average Gas Supply for Power Generation	MMSCFD to MW Conversion	Peak Demand Forecast
601 MMSCFD ↓4 percent	2,902 MW ↓3 percent	25,790 MW ↔

Three GenCos are currently implementing the Eligible Customer Regulation under bilateral agreements 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, Inner Galaxy, KAM Steel 2, Kam Integrated, KAM Steel Line 1, Ashaka Cement, Olam Flour Mills, and Lordsmith[4].

The intent is that, over the long run, unserved[5] and underserved[6] 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[7].

However, the regulation is widely considered to be progressing at a slow pace. Perhaps, the market is not in an ideal condition for a successful implementation of this regulation. In an ideal electricity market, the electricity supply should match or exceed the electricity demand. Currently, the Nigeria Electricity Market does not meet this requirement.

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

[4] Four of these Eligible Customers that applied in July 2018 are still operating without permits.
[5] An area within a distribution network without an existing distribution system.
[6] An area within a distribution network with an existing but poorly supplied or non-functional distribution system.
[7] 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. The main reason for the parties to sign these contracts is to hedge the electricity price (both from the supply and the demand side), and also, to ensure that supply meets demand in the event of power shortages. 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.

Constraints, Gas Supply for Power Generation and Operational Performance. The period under review is Q4 2019 with Q3 2019 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 alignment of the gas and power generation sectors.

For the period under review, gas-fired power plants accounted for about 85 percent of the total installed generation capacity in the country.

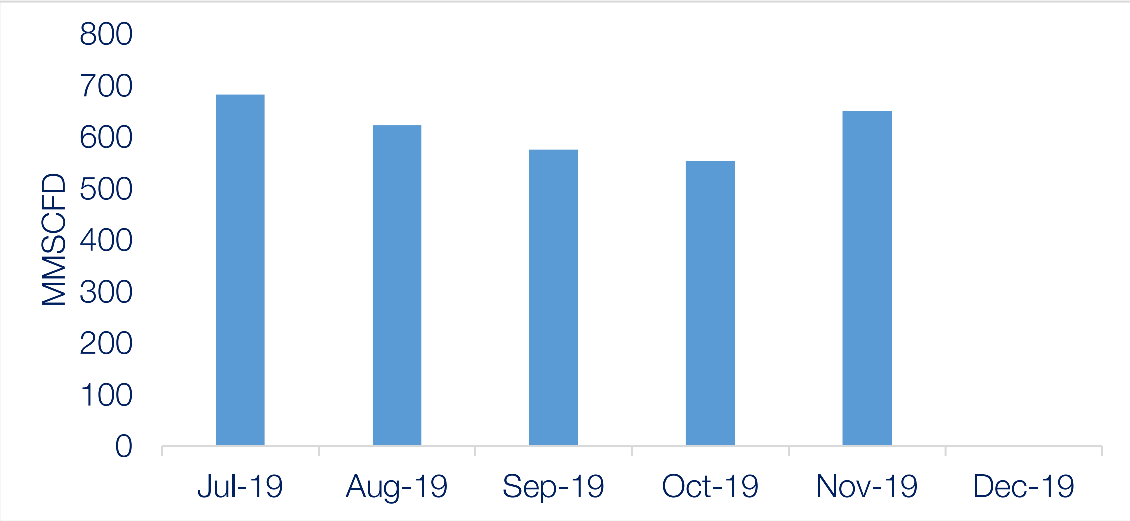


Figure 1: Average Gas Supply for Power Generation between July 2019 and December 2019. There was no available data for December

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 Q4 2019 was about 601 million standard cubic feet per day (MMSCFD). This was a 4 percent decline from Q3 2019 (626 MMSCFD). Converting the quarterly average gas supply to electricity amounted to about 2,807 MW. This was about a 3 percent reduction from Q3 2019 (2,902 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[8] and the suppressed[9] loads.

[8] 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.

[9] 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.

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 remained at about 25,790 MW.

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.

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 (Q4 2019), Nigeria recorded the highest peak generation of 5,157 MW in November 2019. This was a 1 percent rise from Q3 2019 (5,093 MW in July 2019). The rise did not correlate to the 4 percent drop in gas supply for power. The average volume of gas supplied to thermal power plants also dropped[10] by 5 percent between July and November.

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, the total average constraints recorded was about 3,927 MW. This was a 2 percent drop from Q3 2019 (4,013 MW).

In Q4 2019, an average of 2,202 MW could not be generated due to the unavailability of gas. In comparison to Q3 2019 (1,593 MW), gas constraints increased by 28%. The reason for the increase could be partly attributed to the 4 percent decline in the volume of gas supply during the period. Another possible reason for the increase could be from increased outages and vandalism of gas supply assets, as well as frequent repairs and maintenances during the period.

During the same period, there were no water constraints recorded due to poor water management. This was a 100 percent decline from the 9 MW constraint recorded in Q3 2019.

Grid constraints[10] result from the unavailability of transmission and distribution network infrastructures. In Q4 2019, average grid constraints[11] were 1,635 MW, a 29 percent decline from the 2,289 MW recorded in Q3 2019. As a result of the constraints, grid evacuation

[10] Between July 2019 and November 2019, the average volume of gas supplied by the Nigerian National Petroleum Corporation (NNPC) to thermal power plants decreased from 682 MMSCFD to 650 MMSCFD.

[11] Due to frequency imbalance (in the transmission network) caused by changes in the distribution companies' load demand. Also, there are transmission line constraints during electricity evacuation caused by network outages, collapses, and other infrastructural limitations.

efficiency[12] was about 70 percent in Q4 2019, a 14 percent rise from the 61 percent recorded in Q3 2019.

Accordingly, generation constraints were driven mainly by gas constraints (56.1 percent), grid constraints (541.6 percent), and water constraints (0 percent). The remaining 2.3 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 ₦173.6 billion, a 2 percent drop from Q3 2019 (₦177.2 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.

For the period under review, the average power evacuated to the grid was about 3,679 MW. This was a 3 percent increase from Q3 2019 (3,558 MW).

The improvement could have been as a result of several performance parameters related to the generation-transmission interface, including the slight 1 percent rise in peak power generation, 29 percent reduction in grid constraints and 14 percent increase in grid evacuation efficiency.

Although the total gas constraints (caused mainly by low gas supply) increased by 28 percent during the period, this change did not have a significant impact on the evacuated power. This is because the combined grid and water constraints also dropped significantly (about 129 percent) 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)[13] for the generation segment was about 28.5 percent. This was a slight 3 percent improvement from the 27.6 percent recorded in Q3 2019. The increase can be squarely attributed to the 3 percent decline in power evacuated during the same period.

It also means that, on the average, only about 28.5 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 60 percent.

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

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

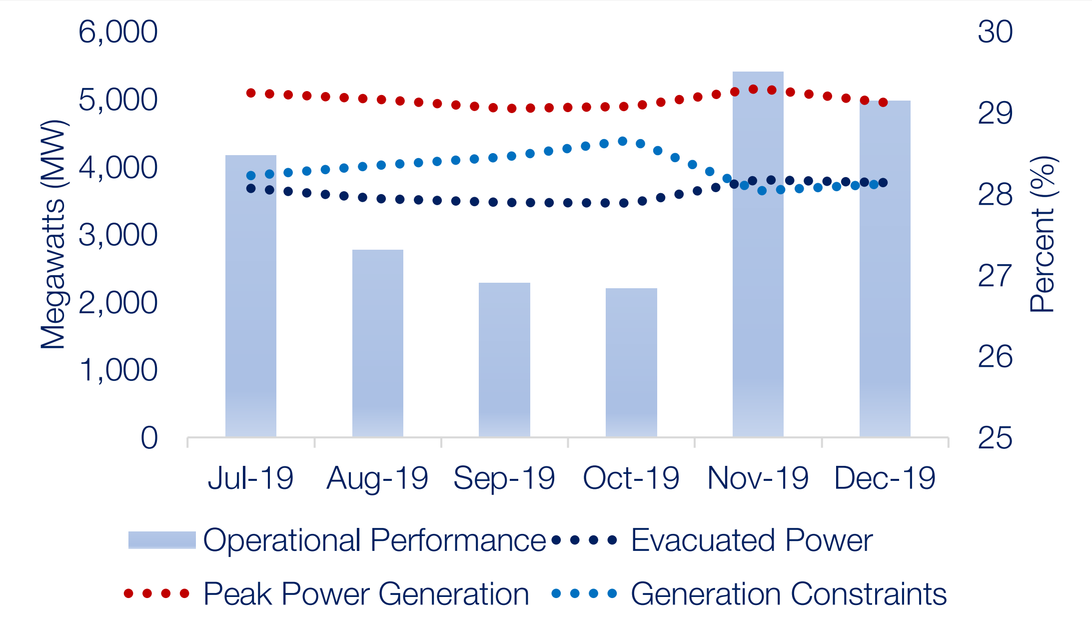


Figure 2: Operational Performance, Peak Power Generation, Evacuated Power and Generation Constraints between July 2019 and December 2019. The monthly average was recorded for the period under review.

Table 1: Generation Performance Data in Q3 2019 and Q4 2019. The monthly average was recorded for the period under review. (* - There was no available data for December)

Period	Q3 2019			Q4 2019		
	July	August	September	October	November	December
Evacuated Power (MW)	3,676	3,526	3,473	3,464	3,809	3,763
Peak Power Generation (MW)	5,093	4,998	4,861	4,894	5,157	4,952
Peak Demand Forecast (MW)	25,790	25,790	25,790	25,790	25,790	25,790
Generation Constraints (MW)	3,872.26	4,020.14	4,146.83	4,395.96	3,643.78	3,742.24
Gas Supply for Power Generation (MMSCFD)	681.90	622.06	575.32	552.64	649.84	*
Operational Performance (percent)	28.47	27.31	26.90	26.83	29.50	29.15

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's core functions consist of the Operator of the Nigeria Electricity Market (ONEM)[14], Nigeria System Operator (NSO)[15] and the Transmission Service Provider (TSP)[16].

Here's some context. The Government of Nigeria retained ownership of the Transmission Company of Nigeria during the unbundling and subsequent privatisation of the 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[17]. 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 ↔

Grid Collapses

Partial 1, Total 0

Grid Evacuation Efficiency

70% ⬆14 percent

Transmission Losses

22% ⬆18 percent

Operational Performance

22% ⬇2 percent

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[14] 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.

[15] 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.

[16] 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.

[17] A four-year management contract was initialled 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 20,000 MW by 2021. The four TREP milestones include system frequency control, adequate spinning reserve, functional Supervisory Control and Data Acquisition (SCADA)[18], and a critical investment in lines and substations. The programme also includes plans to develop a competent and well-motivated workforce.

Expanding the infrastructure and improving the 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 (just 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, procuring fibre optic and Automated Meter Reading (AMR) technologies[19], implementing SCADA and Energy Management Systems (EMS)[20] and expanding transmission networks.

Recently in August 2019, the Nigerian Electrification Roadmap (NER) initiative conceptualized after a meeting between President Muhammadu Buhari and German Chancellor Angela Merkel. The initiative is intended to resolve existing challenges in the power sector and expand the capacity for future power needs.

By addressing problems at the transmission and distribution interfaces, the plan aims to have three phases:

- Phase 1: Increase the operational grid capacity from 5,000 MW to 7,000 MW
- Phase 2: Increase operational grid capacity from 7,000 MW to 11,000 MW
- Phase 3: Increase the operational grid capacity from 11,000 MW to 25,000 MW

The commercial terms are still being negotiated and the final proposal is targeted to be signed in the coming months.

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 Q4 2019 with Q3 2019 as baseline used for comparative analysis.

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[18] SCADA is an acronym for Supervisory Control and Data Acquisition. Simply put, SCADA is a computer system that monitors and controls a process or series of operations. SCADA systems are typically used to control geographically dispersed assets. These assets are often scattered over thousands of square kilometres. Concerning the supply of electricity, SCADA monitors substations, lines, transformers, and other transmission and distribution assets. It is an effective tool for system operations, as well as monitoring and grid management.

[19] Automated meter reading (AMR) is a technology used in utility meters for collecting the data that's needed for billing purposes. It ensures that all energy is accurately metered, and every market participant has access to the data.

[20] Energy Management System (EMS) is a SCADA system without monitoring and control functions. More specifically, EMS refers to the collective suite of grid network applications, as well as the generation control and scheduling applications. Simply put, SCADA is the software and EMS is the hardware.

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, busbars[21], transformers, etc.

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, speculative. The simulation also includes the constraints of the transmission network. The wheeling capacity, at the end of Q4 2019, remained at about 8,100 MW.

In practice, Nigeria's national grid operates at a wheeling capacity close to 5,500 MW. The grid has also been unable to supply electricity to match its wheeling capacity. Regardless of the exact 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 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, to optimise the wheeling capacity and electricity supply.

2.2. Grid Collapses

The national grid recorded 13 grid system collapses (12 total, and one 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.

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[22] from the Federal Ministry of Power, Works and Housing (FMPWH) to improve industry performance and coordination.

The Spinning Reserve of TCN (as recorded on the NCC daily operational report) is typically either 40 or zero MW. As of December 31, 2019, the recorded spinning reserve

[21] A busbar is a strip of metal used to conduct electricity within an electrical substation, distribution board, electric switchboard or other electrical equipment. A busbar is usually a flat or hollow piece of copper, brass or aluminium. It allows heat to be released quickly because of its relatively large surface area.

[22] The Federal Ministry of Power, in a bid to restructure the power sector, exercised policy directives towards improving industry coordination. The document titled "Power Sector Policy Directives and Timelines, June 2019" covered directives to sector stakeholders, including National Electricity Regulatory Commission (NERC), Nigerian Bulk Electricity Trader (NBET), Transmission Company of Nigeria (TCN) and Bureau of Public Enterprises (BPE). The document also addresses several issues centred on performance, collaboration, communications, capacity improvement, and many others.

was zero MW. The spinning reserve should have been at least 368 MW (10% of the evacuated power – 3,680 MW).

The proposed amount of procured electricity is 260 MW, which still falls short of the required 368 MW. It is, however, progress towards achieving grid stability.

For the period under review, the total number of grid collapses recorded was one (1 collapse). It remained unchanged from Q3 2019 (1 collapse).

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"*. However, this measurement does not include other recipients of electricity such as industrial and special customers[23], as well as the GenCos' imported energy[24].

The TLF calculated for billing purposes provides better accuracy and authenticity, as it includes all recipients of electricity. This is because factors that make up these losses have been aggregated into the measurement. These factors relate to the electricity generated, electricity consumed by the GenCos, unbilled electricity, stolen electricity, non-payments, measurement errors in the transmission network, etc.

TCN continues to implement several loss-reduction measures that will expand and stabilise the grid. These proactive measures include line maintenance, completion of 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 3,679 MW (see section 1.5). For the period under review, the total average energy received at the DisCos was 6,333 GWh (2,868 MW). This was a 2 percent drop from Q3 2019 (6,433 GWh, about 2,914 MW).

Consequently, the recorded transmission losses were about 22 percent. This was an 18 percent increase from Q3 2019 (18 percent). The logical reason for the increase was that in comparison to Q3, more electricity was evacuated to the grid and less electricity was received by the DisCos.

[23] Industrial customers use premises for manufacturing goods, including welding and ironmongery (manufacture of iron goods such as steel). Special customers include customers such as agriculture and agro-allied industries, water boards, religious houses, government and teaching hospitals, government research institutes, and educational establishments. Some of these customers are supplied electricity from the 132kV and 330kV transmission network.

[24] Energy importing occurs when GenCos that are supposed to supply energy to the grid participate in receiving energy from the grid. Here, the GenCos are considered as DisCos or special customers in the market. This is to ensure accurate energy auditing and billing processes. Bi-directional meters can measure both the energy generated and received (from other GenCos) to the effect.

The transmission losses calculated in this report only includes the loss difference between electricity sent to the grid and electricity received by the DisCos (except Yola Distribution Company). It does not include other recipients of electricity such as industrial and special customers, as well as the GenCos' imported energy.

2.4. Operational Performance

The operational performance is recorded as a percentage of the installed generation capacity (about 12,910 MW).

For the period under review, the average operational performance of the transmission segment was about 22.2 percent. This was a 2 percent drop from Q3 2019 (22.6 percent). The recorded decline can be logically attributed to the 18 percent rise in transmission losses and 2 percent drop in electricity transmitted to the distribution companies, during the same period.

It also means that only about 22 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 about 35 percent.

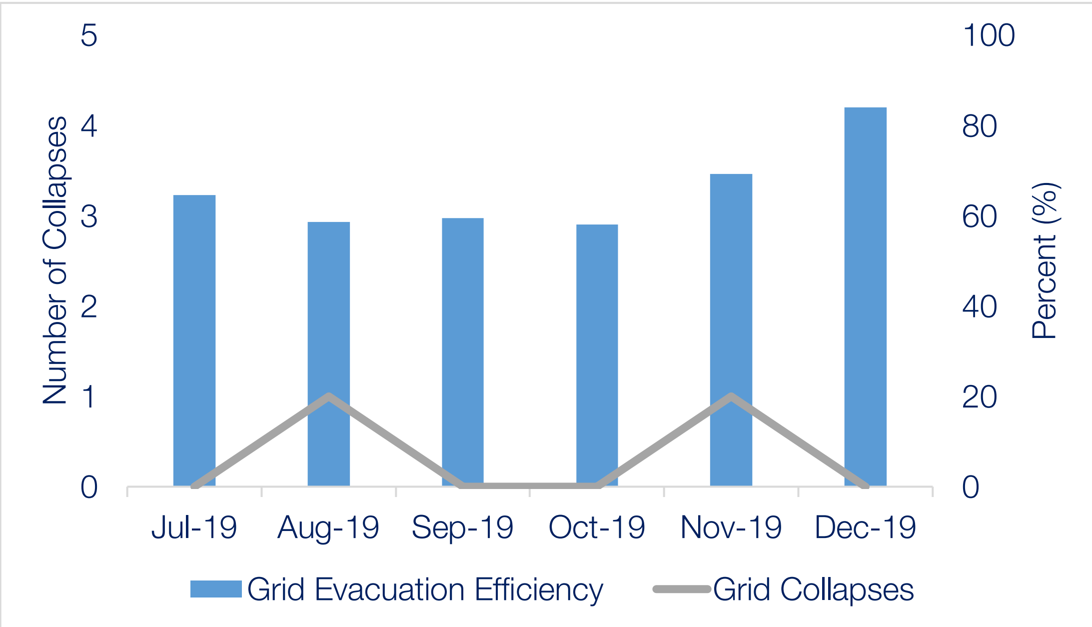


Figure 3: Average Grid Evacuation Efficiency and Total Number of Grid Collapses between July 2019 and December 2019.

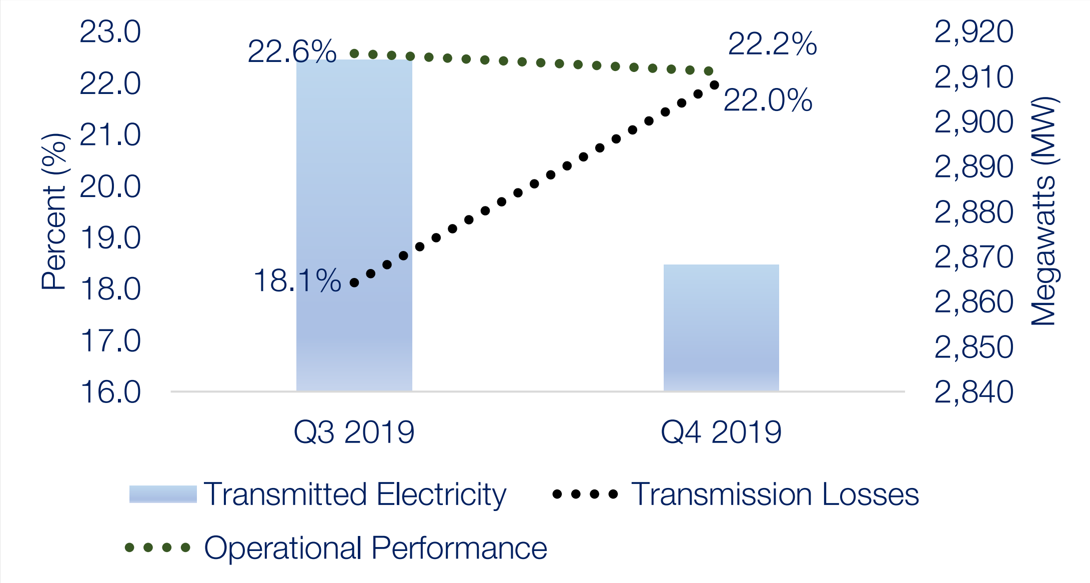


Figure 4: Transmitted Electricity, Transmission Losses and Operational Performance in Q3 2019 and Q4 2019. The quarterly average was recorded for the period under review.

Table 2: Transmission Performance Data in Q3 2019 and Q4 2019.

Period	Q3 2019			Q4 2019		
	July	August	September	October	November	December
Wheeling Capacity (MW)	8,100	8,100	8,100	8,100	8,100	8,100
Grid Collapses	0	1	0	0	1	0
Grid Evacuation Efficiency (percent)	64.55	58.68	59.50	58.11	69.28	83.95

Period	Q3 2019	Q4 2019
Losses (percent)	18.12	22.03
Transmitted Electricity (MW)	22.57	22.22
Operational Performance (percent)	2,913.50	2,868.21

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, Energy Billed, Revenue Collected, Distribution (Technical, Commercial and Collection) Losses and Operational Performance. The period under review is Q4 2019 with Q3 2019 as baseline used for comparative analysis.

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.

Energy Received

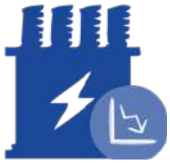
6,333 GWh ↓2 percent

Energy Billed

5,279 GWh ↑6 percent

₦ 169 billion ↑7 percent

Distribution Losses (ATC&C)



40% ↓6 percent

Revenue Collected

₦121 billion ↑2 percent

Collection Loss

28% ↓5 percent

Operational Performance

18.5% ↑0.4 percent

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 total average energy received at the Distribution Companies (DisCos)[25] was about 6,333 GWh (2,868 MW). This was a slight 2 percent drop from Q3 2019 (6,433 GWh, about 2,914 MW).

The recorded drop could have been as a result of several performance parameters related to the transmission sub-sector, including the 18 percent increase in transmission losses and 2 percent drop in electricity transmitted to the distribution companies.

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 result from the energy that is consumed but not accounted for. This occurrence can be related to illicit activities, such as meter bypass, illegal connections, meter tampering and energy theft. An erroneous estimate (or under-billing) of 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 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 collection losses.

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 inability to collect up to 50 percent of its revenue to theft and vandalism. The company collected about ₦1

[25] Data does not include Yola Distribution Company.

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 40 percent. This was a 6 percent drop from Q3 2019 (43 percent). The main reason for the drop was the improvements in the amount of electricity invoiced to customers and revenue collected from customers during the period.

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[26]. 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[27], as well as revenue collection.

For the period under review, the recorded ATC losses during electricity distribution were about 17 percent. This was an 8 percent reduction from Q3 2019 (18 percent).

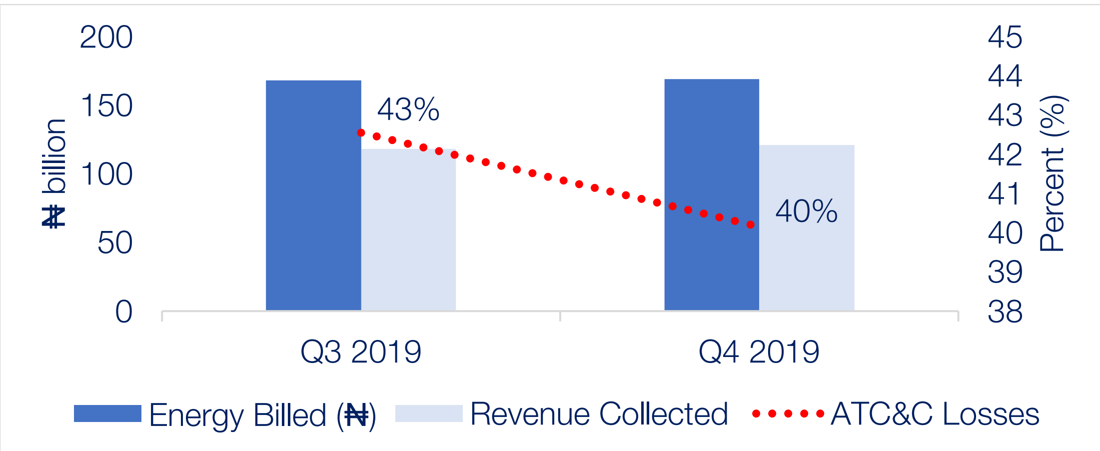


Figure 5: Energy Billed (Naira), Revenue Collected and ATC&C Losses in Q3 2019 and Q4 2019. The quarterly average was recorded for the period under review.

The logical reason for the reduction was that in comparison to Q3, less electricity was received by the DisCos and more electricity was invoiced to customers. Consequently, the total

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

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

energy billed[28] from the Distribution Companies (DisCos) was about 5,279 GWh. This was an 0.4 percent rise from Q3 2019 (5,259 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. For resolution, consumer enumeration exercises can ensure that all existing and potential customers are registered, identified and categorised. Their details should be taken, and 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 ₦121 billion. This was a 2 percent increase from Q3 2019 (₦118 billion). This resulted in a collection loss of 28 percent – a 5 percent drop from Q3 2019 (30 percent).

3.3. Operational Performance

The operational performance is recorded as a percentage of the installed generation capacity (about 12,910 MW).

For the period under review, the average operational performance of the distribution sub-sector was 18.5 percent. This was a marginal 0.4 percent improvement from Q3 2019 (18.4 percent).

It also means that only about 18 percent of the total installed capacity gets distributed to the end-user for consumption.

[28] The energy billed amounted to about ₦ 169 billion – an 0.6 percent increase from Q3 2019 (₦ 168 billion).

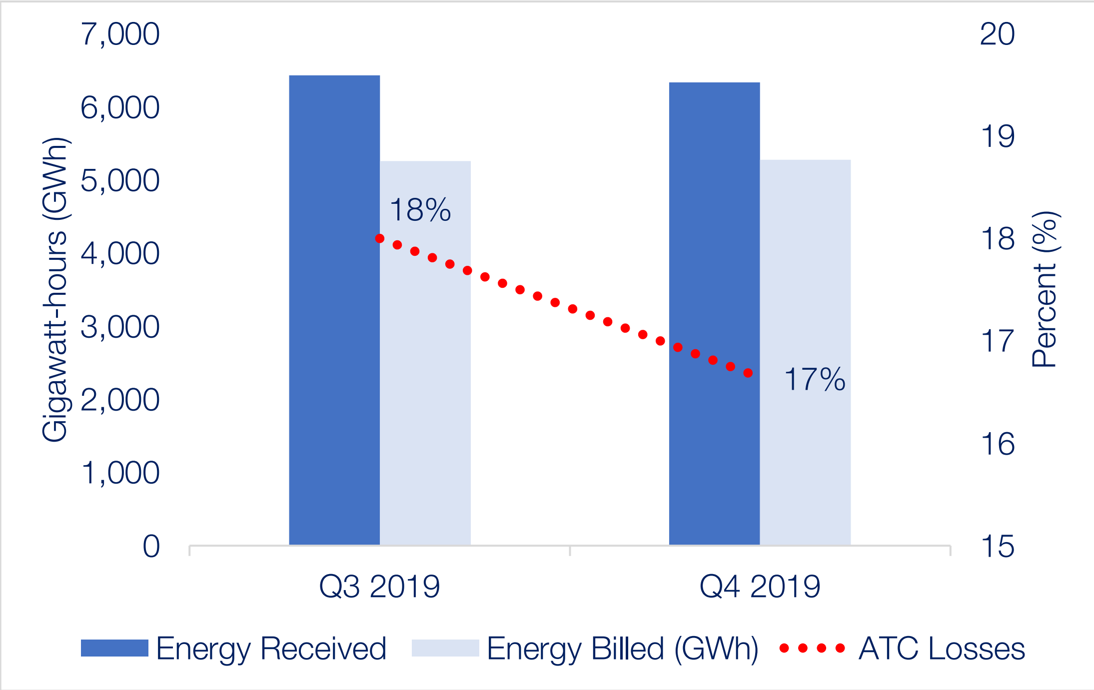


Figure 6: Energy Received (GWh), Energy Billed (GWh), and ATC Losses in Q3 2019 and Q4 2019. The quarterly average was recorded for the period under review.

Table 3: Distribution Performance Data in Q3 2019 and Q4 2019. The quarterly average was recorded for the period under review.

Period	Q3 2019	Q4 2019
Energy Received (GWh)	6,433	6,333
ATC Losses (percent)	18	17
Energy Billed (GWh)	5,259	5,279
Energy Billed (₦ billion)	168	169
Revenue Collected (₦ billion)	118	121
Collection Loss (percent)	29.76	28.40
ATC&C Losses (percent)	42.54	40.15

4.0 Appendices

4.1. Generation Data[29]

Jul-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	3,526.06	3,489.00	1,993.00	1,496.00	0.00	625.46
2	3,598.15	3,479.90	1,835.50	1,627.00	0.00	658.88
3	3,776.06	3,735.80	1,835.50	1,734.00	145.00	665.99
4	3,577.45	3,780.50	1,938.50	1,697.00	145.00	673.52
5	3,515.22	4,277.50	1,896.50	1,891.00	145.00	655.85
6	3,676.25	4,189.00	2,036.50	1,662.50	145.00	702.65
7	3,552.24	4,792.00	2,018.00	1,969.00	145.00	663.84
8	3,515.94	4,015.50	1,784.50	1,866.00	145.00	666.82
9	3,837.60	3,366.70	1,195.50	1,675.00	0.00	687.93
10	3,830.95	3,677.50	1,648.50	1,554.00	0.00	774.50
11	3,544.69	3,731.10	1,195.50	2,315.60	0.00	652.26
12	3,438.10	4,099.40	1,363.50	2,405.90	0.00	617.43
13	3,444.95	4,347.70	1,787.50	2,215.00	0.00	662.69
14	3,410.53	4,881.80	1,787.50	3,094.30	0.00	662.69
15	3,473.39	3,842.50	1,591.50	2,251.00	0.00	660.46
16	3,789.10	3,739.50	1,371.50	2,228.00	0.00	706.33
17	3,999.52	4,036.40	1,430.50	2,459.00	0.00	735.88
18	3,891.64	4,331.10	1,845.50	2,447.20	0.00	708.04
19	3,688.76	4,135.30	1,895.50	2,197.40	0.00	710.58
20	3,645.43	3,520.90	2,012.00	1,365.00	0.00	677.10
21	3,681.63	4,041.70	1,887.00	2,096.00	0.00	689.03
22	3,746.29	3,908.40	1,887.00	1,962.70	0.00	724.07
23	3,889.50	3,466.00	1,862.00	1,545.30	0.00	735.00
24	3,990.74	3,636.40	1,600.00	1,993.10	0.00	708.46
25	3,729.19	4,064.50	1,600.00	2,421.20	0.00	676.88
26	3,829.07	3,904.20	1,600.00	2,304.20	0.00	698.80
27	3,825.38	3,591.20	1,430.00	2,161.20	0.00	706.34
28	3,587.65	3,558.60	1,405.00	2,153.60	0.00	653.53
29	3,592.53	3,169.20	1,455.00	1,601.70	0.00	655.60
30	3,603.94	3,523.30	1,328.50	2,082.30	0.00	634.40
31	3,750.30	3,707.50	1,581.50	2,126.00	0.00	687.91
TOTAL	113,958.25	120,040.10	52,098.50	62,597.20	870.00	21,138.92
AVERAGE	3,676.07	3,872.26	1,680.60	2,019.26	28.06	681.90

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

Aug-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	3,733.72	4,358.50	1,455.00	2,791.00	0.00	663.65
2	3,321.18	3,818.20	1,455.00	2,250.70	0.00	633.93
3	3,405.85	3,964.60	1,455.00	2,352.00	0.00	651.99
4	3,321.21	4,171.20	1,455.00	2,603.70	0.00	616.95
5	3,255.05	3,988.50	1,455.00	2,421.00	0.00	611.30
6	3,408.15	4,054.50	1,455.00	2,487.00	0.00	645.98
7	3,447.75	4,259.50	1,635.00	2,512.00	0.00	645.73
8	3,325.93	4,051.80	1,455.00	2,439.80	0.00	610.59
9	3,512.01	4,173.40	1,641.00	1,784.90	0.00	622.76
10	3,482.55	3,539.00	1,278.50	2,148.00	0.00	529.29
11	3,816.86	4,070.40	1,430.00	2,527.90	0.00	673.90
12	3,753.95	4,203.90	1,405.00	2,686.40	0.00	682.87
13	3,782.04	4,089.50	1,405.00	2,572.00	0.00	680.91
14	3,859.98	3,828.00	1,328.50	2,277.00	0.00	690.38
15	3,622.34	4,009.30	1,353.50	2,433.30	0.00	657.61
16	3,833.66	3,973.60	1,328.50	2,422.60	0.00	691.36
17	3,773.40	3,705.80	1,455.00	2,098.40	0.00	651.09
18	3,744.82	3,962.20	1,253.50	2,596.20	0.00	612.93
19	3,673.13	3,690.60	1,380.00	2,198.10	0.00	620.99
20	3,679.81	3,630.90	1,253.50	2,264.90	0.00	580.67
21	3,607.04	3,953.20	1,506.50	2,334.20	0.00	594.95
22	3,608.79	4,122.60	1,506.50	2,616.10	0.00	634.78
23	3,584.74	4,349.70	1,506.50	2,764.30	0.00	615.16
24	3,513.37	4,078.90	1,531.50	2,468.50	0.00	586.89
25	3,258.71	4,365.00	1,363.00	2,892.00	0.00	589.79
26	3,482.30	4,507.50	1,363.00	2,924.50	0.00	576.40
27	3,357.88	4,151.10	1,321.00	2,610.10	0.00	605.08
28	3,674.30	3,871.10	1,296.00	2,531.70	0.00	643.65
29	3,620.09	4,175.90	1,212.00	2,917.60	0.00	629.81
30	2,472.09	3,736.90	1,170.00	2,519.00	0.00	445.99
31	3,361.70	3,768.90	1,212.00	2,511.30	0.00	586.37
TOTAL	109,294.40	124,624.20	43,320.00	76,956.20	0.00	19,283.75
AVERAGE	3,525.63	4,020.14	1,397.42	2,482.46	0.00	622.06

Sep-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	3,176.52	4,417.50	1,179.60	3,154.10	0.00	540.88
2	3,361.87	4,413.90	1,296.00	2,962.00	0.00	482.28
3	3,421.09	4,927.60	1,296.00	3,521.60	0.00	560.42
4	3,181.03	4,377.70	1,296.00	3,045.40	0.00	534.63
5	3,389.81	4,153.70	1,506.50	2,647.20	0.00	579.86
6	3,395.55	4,521.00	1,380.50	2,920.50	0.00	591.14
7	3,240.14	3,861.50	1,170.00	2,643.40	0.00	569.18
8	3,255.72	4,368.10	1,296.00	2,962.10	0.00	564.33
9	3,376.13	4,416.80	1,658.50	2,758.30	0.00	566.90
10	3,637.87	3,416.40	1,380.00	1,926.40	0.00	617.34
11	3,633.10	4,221.20	1,633.00	2,588.20	0.00	618.00
12	3,755.91	4,217.10	1,633.00	2,584.10	0.00	637.51
13	3,767.09	4,531.60	1,591.00	2,940.60	0.00	609.12
14	3,310.16	4,548.00	1,591.00	2,957.00	0.00	570.67
15	3,305.67	4,554.40	1,591.00	2,963.40	0.00	592.69
16	3,372.24	4,587.80	1,591.00	2,996.80	0.00	575.50
17	3,367.38	3,892.40	1,128.50	2,541.40	0.00	565.71
18	3,530.53	3,751.50	1,128.50	2,400.50	0.00	598.13
19	3,396.10	3,930.40	1,296.50	2,521.40	0.00	615.97
20	3,595.93	3,651.30	2,012.00	1,526.80	0.00	542.70
21	3,419.32	4,645.30	2,177.00	2,255.80	0.00	504.58
22	3,034.68	3,935.50	2,717.50	1,218.00	0.00	484.12
23	3,498.28	4,294.70	2,651.50	1,533.20	0.00	530.56
24	3,712.80	3,772.30	2,584.50	1,187.80	0.00	589.91
25	3,854.55	3,716.00	2,364.50	1,239.30	0.00	627.01
26	3,857.15	3,863.50	2,144.50	1,719.00	0.00	611.96
27	3,756.82	4,014.30	1,976.00	1,925.80	0.00	603.74
28	3,674.50	3,859.70	1,961.00	1,786.20	0.00	633.43
29	3,542.12	3,744.10	1,919.00	1,712.60	0.00	585.28
30	3,380.10	3,799.70	1,911.00	1,776.20	0.00	556.14
TOTAL	104,200.16	124,405.00	51,061.10	70,915.10	0.00	17,259.69
AVERAGE	3,473.34	4,146.83	1,702.04	2,363.84	0.00	575.32

Oct-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	3,369.27	4,324.30	2,157.50	2,054.30	0.00	595.18
2	3,216.42	4,567.70	2,031.00	2,424.20	0.00	516.42
3	3,279.56	4,798.00	2,238.00	2,447.50	0.00	529.99
4	3,405.88	4,553.40	2,073.00	2,480.40	0.00	538.27
5	3,445.93	4,696.40	1,878.00	2,818.40	0.00	535.88
6	3,237.77	4,798.00	1,878.00	2,920.00	0.00	488.40
7	3,485.19	4,066.30	1,626.00	2,440.30	0.00	524.02
8	3,436.16	4,383.80	1,846.00	2,425.30	0.00	548.29
9	3,630.52	3,947.40	1,846.00	2,101.40	0.00	554.64
10	3,742.13	3,863.90	1,635.50	2,228.40	0.00	589.24
11	3,706.52	5,274.90	1,762.00	3,512.90	0.00	581.70
12	3,225.72	4,444.20	1,862.00	2,582.20	0.00	534.74
13	3,479.74	4,503.30	1,726.00	2,777.30	0.00	546.16
14	3,608.68	4,843.20	1,635.50	2,982.70	0.00	584.47
15	3,400.85	4,194.40	1,677.50	2,401.90	0.00	522.63
16	3,499.72	4,058.30	1,551.00	2,352.30	0.00	542.10
17	3,587.12	4,847.90	1,674.00	3,133.90	0.00	580.44
18	3,365.42	4,753.10	1,547.50	3,205.60	0.00	550.45
19	3,348.65	4,890.00	1,631.50	3,258.50	0.00	511.27
20	3,103.85	4,351.00	1,379.50	2,751.50	0.00	469.09
21	3,487.55	4,462.50	2,054.00	2,408.50	0.00	589.98
22	3,779.56	4,708.50	2,180.50	2,528.00	0.00	615.81
23	3,527.95	4,517.50	1,889.00	2,588.60	0.00	571.99
24	3,563.10	4,087.00	2,238.50	1,810.00	0.00	585.94
25	3,634.56	4,420.40	2,115.50	2,266.30	0.00	625.09
26	3,505.39	4,062.40	1,989.00	1,699.10	0.00	517.62
27	3,351.76	4,751.90	2,655.00	1,984.40	0.00	542.55
28	3,271.23	3,979.00	1,865.50	2,113.50	0.00	545.20
29	3,557.69	3,677.30	1,352.00	2,325.30	0.00	598.24
30	3,519.70	3,805.60	1,530.50	2,275.10	0.00	457.27
31	3,621.14	3,643.10	1,522.00	2,121.10	0.00	638.68
TOTAL	107,394.73	136,274.70	57,047.00	77,418.90	0.00	17,131.75
AVERAGE	3,464.35	4,395.96	1,840.23	2,497.38	0.00	552.64

Nov-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	3,669.34	4,244.80	1,427.50	2,667.30	0.00	626.95
2	3,416.03	4,082.00	1,554.00	2,418.00	0.00	570.19
3	3,429.58	4,183.20	1,554.00	2,519.20	0.00	551.63
4	3,765.14	3,956.30	1,427.50	2,462.20	0.00	598.05
5	3,868.15	3,886.50	1,262.50	2,557.40	0.00	616.27
6	3,855.02	3,876.40	1,262.50	2,613.90	0.00	616.93
7	3,840.25	3,866.30	1,262.50	2,540.80	0.00	582.16
8	3,808.96	1,042.50	1,042.50	0.00	0.00	542.33
9	2,546.49	4,311.10	1,356.00	2,842.60	0.00	513.79
10	3,610.05	4,559.00	1,356.00	3,093.00	0.00	528.24
11	3,856.30	3,396.70	1,482.50	1,914.20	0.00	617.69
12	3,878.58	3,334.00	1,382.50	1,951.50	0.00	643.92
13	3,722.76	3,454.60	1,256.00	2,086.10	0.00	612.17
14	3,533.74	3,446.00	1,256.00	2,190.00	0.00	583.85
15	3,882.84	4,029.40	1,547.50	2,481.90	0.00	643.92
16	3,714.44	3,905.50	2,232.50	1,673.00	0.00	642.40
17	3,819.71	3,709.50	2,067.50	1,642.00	0.00	693.22
18	4,152.33	3,261.00	2,362.00	899.00	0.00	754.62
19	4,214.14	3,454.70	2,446.50	1,008.20	0.00	750.32
20	4,214.14	3,454.70	2,446.50	1,008.20	0.00	711.45
21	3,870.50	4,100.50	2,521.50	1,469.00	0.00	627.34
22	3,775.27	3,213.70	2,113.50	1,100.20	0.00	662.22
23	4,034.94	3,469.60	2,185.00	1,220.60	0.00	737.69
24	3,874.68	3,605.20	2,146.50	1,293.70	0.00	677.64
25	3,965.06	3,075.80	2,146.50	869.30	0.00	723.40
26	4,166.93	3,775.60	2,538.00	1,177.60	0.00	747.55
27	3,843.58	3,504.50	2,580.00	864.50	0.00	702.64
28	4,025.54	3,632.60	2,580.00	733.50	0.00	739.26
29	3,993.35	3,835.30	2,833.00	682.10	0.00	738.04
30	3,913.58	3,646.50	2,748.50	691.00	0.00	739.30
TOTAL	114,261.42	109,313.50	56,377.00	50,670.00	0.00	19,495.18
AVERAGE	3,808.71	3,643.78	1,879.23	1,689.00	0.00	649.84

Dec-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	3,815.59	3,530.50	3,295.50	65.00	0.00	3,530.50
2	3,717.67	3,687.50	3,517.50	0.00	0.00	3,687.50
3	3,751.62	3,573.40	3,475.50	0.00	0.00	3,573.40
4	3,837.95	3,470.30	3,375.50	0.00	0.00	3,470.30
5	3,793.91	3,612.60	3,517.40	0.00	0.00	3,612.60
6	3,880.81	4,156.70	3,352.50	599.00	0.00	4,156.70
7	3,799.33	3,924.70	3,352.50	367.00	0.00	3,924.70
8	3,848.61	3,669.10	3,046.00	421.00	0.00	3,669.10
9	4,007.80	3,546.50	3,122.50	254.00	0.00	3,546.50
10	4,139.80	3,482.50	2,869.50	443.00	0.00	3,482.50
11	2,146.11	3,546.50	3,122.50	254.00	0.00	3,546.50
12	753.12	3,366.50	2,885.50	311.00	0.00	3,366.50
13	3,091.60	3,556.00	3,007.50	378.50	0.00	3,556.00
14	3,939.93	3,758.70	2,800.50	788.20	0.00	3,758.70
15	3,878.35	3,778.30	2,800.50	917.80	0.00	3,778.30
16	3,843.81	3,531.50	2,965.50	506.00	0.00	3,531.50
17	4,037.39	3,417.50	2,965.50	392.00	0.00	3,417.50
18	4,037.00	3,417.50	2,965.50	392.00	0.00	3,417.50
19	4,120.16	3,353.30	2,670.50	622.80	0.00	3,353.30
20	4,257.51	3,892.90	2,870.00	930.30	0.00	3,892.90
21	4,087.18	3,896.80	2,705.00	859.30	0.00	3,896.80
22	3,967.87	4,007.30	2,830.00	1,117.30	0.00	4,007.30
23	3,866.96	3,958.00	2,636.50	1,101.50	0.00	3,958.00
24	4,096.69	3,951.50	2,536.50	1,355.00	0.00	3,951.50
25	4,216.60	3,902.20	2,410.00	1,432.20	0.00	3,902.20
26	4,123.34	3,861.80	2,343.00	1,458.80	0.00	3,861.80
27	4,046.98	4,029.50	2,343.00	1,578.00	0.00	4,029.50
28	3,935.83	4,162.20	2,523.00	1,540.80	0.00	4,162.20
29	3,780.18	4,087.00	2,523.00	1,284.00	0.00	4,087.00
30	3,936.49	3,954.30	2,318.00	1,425.80	0.00	3,954.30
31	3,897.84	3,926.20	2,318.00	1,508.40	0.00	3,926.20
TOTAL	116,654.03	116,009.30	89,463.90	22,302.70	0.00	116,009.30
AVERAGE	3,763.03	3,742.24	2,885.93	719.44	0.00	3,742.24

4.2. Distribution Data[30]

Period	Q3 2019	Q4 2019	Q3 2019	Q4 2019
All DisCos	Energy Received (GWh)	Energy Received (GWh)	Energy Received (MW)	Energy Received (MW)
Total	6,433	6,333	2914	2868

[30] Source: Association of Nigerian Electricity Distributors (ANED). Data does not include Yola Distribution Company.

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