HOUSEHOLDS' WILLINGNESS TO PAY FOR IMPROVED QUALITY OF ELECTRICITY SUPPLY IN SELECTED CITIES IN NIGERIA

BY

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ABSTRACT

Power outages and blackouts characterise household electricity supply despite the desire of Nigerians to have improved quality of electricity supply that is reliable with the appropriate level of voltage and where outages will not last more than a few hours daily. Households' willingness to pay (WTP) is a requirement for the attainment of improved quality of electricity supply. Literature on attainment of stable electricity supply have focused more on the technical and organisational requirements with little attention to customers' willingness to pay for such service most especially in Nigeria. This study, was therefore designed to investigate the determinants of household willingness to pay for improved quality of electricity supply and how much they are willing to pay in selected cities in Nigeria.

The Random Utility Theory guided this study while a survey research method was adopted. Four major cities namely: Abuja, Ibadan, Lagos and Port Harcourt were purposively selected.A discrete choice with follow-up elicitation technique and a structured questionnaire focusing on social economic characteristics, quality of existing electricity supply and willingness to pay for improved quality of electricity supply was randomly administered to 680 households (Abuja =170, Ibadan = 170, Lagos =170 and Port Harcourt =170), identified using the statistical sample size determination formula. Descriptive statistics was used to analyse the impact of electricity supply on household welfare, while Ordered Probit model helped in identifying the factors that determine household willingness to pay (WTP) for improved quality of electricity supply, and Contingent Valuation Method (CVM) was used to determine how much households were willing to pay for the improved quality of electricity supply. Values from analysis were validated at 0.05 level of significance.

More than 25% of households in the different cities spent between N10,000-N20,000 in repairing or replacing damaged home appliances due to power instability, while more than 50% indicated that poor quality of electricity supply in form of inadequate supply and fluctuating voltage from the electricity distribution companies adversely affected their daily activities and consequently, their welfare. Household income (β= 0.115), reliability of supply (β= 0.243) and cost of alternative supply (β= 0.199) were the determinants of household WTP for improved quality of electricity supply. Households in Abuja, Lagos, Ibadan and Port Harcourt were willing to pay an average amount of N36.00±14.95, N36.30±14.15, N38.30±11.43 and N50.20±10.96 per kWh of electricity respectively. This is more than one and half times the current tariffs they pay in each of these cities if the quality of electricity supply improves.

Household income, reliability of supply and cost of alternative supply influenced households' willingness to pay for improved quality of electricity in the selected cities. The welfare cost of unreliable power supply is high, and influenced households' willingness to pay for improved quality of electricity supply. It is imperative thatthe electricity distribution companies as well as other stakeholders invest on infrastructure to improve the quality of electricity supply in Nigeria.

Keywords: Households'willingness to pay, Contingent valuation method, Improved quality of electricity supply, Selected cities in Nigeria.

Word count: 479

DEDICATION

This thesis is dedicated to God Almighty; the source of my inspiration and existence throughout my academic pursuits.

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I am eternally to God Almighty for the success of this research work in the Centre for Petroleum, Energy Economics and Law (CPEEL). Indeed, He has been more than faithful and a trillion years won't still be enough to sing His praises for His marvelous work in my life. It is indeed a profound and satisfying feeling to have fulfilled on of my desires in life. I owe it all to You, Lord.
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CERTIFICATION

I certify that this work was carried out by Emmanuel Ikechukwu Onyeuchein the Centre for Petroleum, Energy Economics and Law, University of Ibadan, Ibadan.

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
ARUM	Additive Random Utility Model
ATC&C	Aggregate Technical, Commercial and Collection
CV	Compensating Variation
CVM	Contingent Valuation Method
DISCOs	Distribution Companies
ECN	Electricity Corporation of Nigeria
EPSR	Electric Power Sector Reform
EV	Equivalent Variation
GDP	Gross Domestic Product
GENCOs	Generation Companies
GWh	Giga-Watt Hour
HPM	Hedonic Pricing Method
IOCs	International Oil Companies
IPP	Independent Power Producers
kW	Kilowatt
kWh	Kilo-Watt Hour
LGA	Local Government Area
MW	Megawatts
MYTO	Multi Year Tariff Order
NAs	Native Authorities
NBS	Nigerian Bureau of Statistics
NDA	Niger Dams Authority
NDPHC	Niger Delta Power Holding Company
NEMSA	Nigerian Electricity Management Services Agency
NEPA	National Electric Power Authority

NEPP	National Electric Power Policy
NERC	Nigerian Electricity Regulatory Commission
NGEU	Nigerian Government Electricity Undertaking
NIPP	National Integrated Power Projects
NNPC	Nigerian National Petroleum Corporation
PACP	Presidential Action Committee on Power
PH	Port Harcourt
PHCN	Power Holding Company Nigeria
PPA	Power Purchase Agreement
PTFP	Presidential Task Force on Power
ROI	Return on Investment
RUM	Random Utility Model
SEK	Swedish Krona
TCF	Trillion Cubic Feet
TCN	Transmission Company of Nigeria
US$	United States Dollars
WTA	Willingness to Accept
WTP	Willingness to Pay

CHAPTER ONE

INTRODUCTION

1.1 Overview of the Study

Reliable and good quality electricity supply is essential for the economic growth and development of any country (Khanna and Rao, 2009). Inadequate supply of energy limits economic growth, impedes socio-economic development, and adversely affects the standard of living of households. Improved electricity supply results in improved standards of living as households rely on electricity for carrying out a range of domestic activities such as lighting, cooking, washing and ironing among others. Withtechnological advancement, people are becoming more dependent on electricitybecause mosthigh-tech devices and household equipment are powered by electricity. Hence, it can be concluded that electricity is the fastest growing form of energy delivered all over the world.

Nigeriaelectricity net consumptionincreased from 14,270 GWh in 2002 to 23,940 GWh in 2014 (IES, 2015). Recent data from World Bank also shows that the quantum of electricity consumed in Nigeria increased from the 123.57kWh per capita in 2004 to 144.53 kWh per capita in 2018 (WDI, 2019). Most Nigerian households engage in income earning activities from their homes using their computers and the internet while others engage in small scale economic activities such as laundry services, hairdressing, and tailoring among others that require the use of electricity. Leisure, which is an important variable in a worker's utility function, is also affected by electricity since some acts of leisure require the use of electric energy. Vassileva, Wallin and Dahlquist (2012)noted that increasing energy consumption is one of the admissible concerns severalsocieties are experiencing in recent times. Some of the reasons pointed out as the causes of these increasing energy consumption include population growth, advancement in technologies, and increased comfort. Indeed, it is becoming difficult to live without the use of electricity supply. As a result of thetremendous and considerable dependence on electricity, households' activities areaffected whenever electricity is interrupted.

The quality of supply comprises of three distinctive dimensions, namely: reliability or continuity of supply, voltage quality, and commercial quality.

Continuity or reliability of supply is analogous to the availability of electricity supply. This dimension of the quality of electricity supply is the most significant for customers since the availability of electricity is essentialin accomplishingseveraltasks. The fewer and shorter the duration of the occurrence of blackouts or outages, the better the quality ofpower supply from the customers or end users'perspective. Hence, continuity of supply is estimated by the number and duration of supply interruptions.

Voltage quality incorporates every technical aspect of the distributed electricity excluding power outages. It is simply referred to as the usability or usefulness of electricity when power interruptions are held constant or do not occur. In situations when this quality dimension is deficient or very poor, diversechallenges may arise in electrical processes and the use of electrical appliances. Voltage quality is typically more intricate to regulate because it comprisesof many quality issues and sequentially each issue has several dimensions.

Commercial quality involves the directactivities or business dealings involvingthe electricity companies (either Distribution Companies or Generation Companies, or both) and the end users (customers).It encompasses both supply and electricity retail, as well asnumerousmodes of contacts between the electricity companies and customers such as complaint handling and call center performance. Thus, the quality of electricity supply affects the welfare of households.

The Distribution Companies (DISCOs) should be responsible and accountable in guaranteeing these three dimensions of electricity service to their customers and the customers should be willing to pay to maintain or improve the electricity service quality.

1.2 Problem Statement

Despite the importance of electric power supply to Nigerian households, electricity supply has been unreliable and epileptic. There are regular power outages, and often no prior notification to consumers before these outages. Nigeria's economic growth potentials will continue to remain unrealised if the power sector challenges are notaddressed. Access to electricity is still a major concern for a vast percentage of the population and it has not increased more than 60% (Aliyu, Ramli and Saleh, 2013; Eleri, Otu, Ugwu and Onuvae, 2012). Recent data from the World Bank database put access to electricity in Nigeria at 54.4% (2019) presently compared to its value at 59.3% in 2016 which had been the highest the previous 30 years (WDI, 2019).Most times, even when there is power supply, the quality of supply is so poor that customers prefer the use of their personal generators which give them more reliable services than that provided by the Electricity Distribution Companies (IseOlorunkanmi, 2014). Oseni (2017) stated in his studythat the average Nigerian household experiences power outages and blackouts for a long period of about 19 hours daily.A significant proportion of the supply shortfall is met with generating sets at consumer locations with some of these generators operating between 15-18 hours a day.[1]

There are several factors that account for the lingering challenge of inadequate and unreliable power supply.First, is the high demand for electricity which significantly exceeds supply. The demand-supplydisparityarises because of several reasons including inconsistent energy policies, poor managerial efficiency, and poor maintenance of existing plants in the country(Ohajianya, Abumere, Owate and Osarolube, 2014).

The total installed capacity of the generating plants in the country is about 12,500 MW, made up of gas thermal and hydropower plants with a percentage of 87.5% and 12.5% respectively. However, the available capacity for onward transmission to the final consumers is currently between 3,500MW to 5,000MW for a population above 190 million people. More than half of the number of power stations which are operational are over 2 decades old. The ageing power plants coupled with poor maintenance result inregular load shedding (Ezechukwu, 2013). In addition, there is the overloaded transmission and distribution networks(Ogunji, Atilade and Coker, 2013). Electricity distribution and transmission is characterised by high technical and commercial losses which make it difficult for the distribution companies to recoup returns on their investments from end users (Ezechukwu, 2013).The electricityservice providers have low cost recoveryas households pay tariffs lower than the average cost of power supply. Thus, this have been a serious concern and a big burden for the service providers over the years.There has also been the problem of inconsistent gas supply to fuel the generating plants in Nigeria andsetbacks in fixing faulty electricity infrastructureon time which furtherexacerbates consistent power supply challenges. These developments illustrate the crisis in the electricity sector.

It is a known knowledge that the power sector is characterised by substantive up-front fixed costs, and it takes time for its capacity to be fully utilized. Significant steps have been taken

[1] A 2014 World Bank document on Diesel Power Generation: Inventories and Black Carbon Emissions in Nigeria stated that backup generators compensates for the excess consumers' demand on electricity that cannot be met by the current power supply.

since theestablishment of the Nigerian Electricity Regulatory Commission (NERC) as the power sector regulatory body in addressing some of these issuesusing the tariff methodologicalapproach called the Multi Year Tariff Order (MYTO). The MYTO aims to guarantee that the licensees (electricity service providers) fairly charge the consumers for the services they provide and that the amount charged is sufficient to finance their operational activities as well as allow reasonable earnings and normal profits for effective and efficient operation.However, the actual cost reflective tariff is yet to be achieved even as NERC has progressively been trying to adjust the electricity tariffs to cost recovery levels.There has been consistent outcryby Nigerian householdsand stakeholders in the electricity industry for improvement in the quality of electricity service from the service providers.

Frequent and unanticipated power interruptions result to social and economic losses by households. These households could be willing to pay an extra amount on the regular electricity tariff if an improved electricity service with good quality is guaranteed.After all, the cost of running other conventional backup power generators over time is high.

There are several losses experienced by electricity customers due to erratic power supply; household electrical appliances such as televisions, refrigerators, and others are damaged. Although, some domestic tasks that depends on power supply, such as vacuum cleaning,laundry andironing can be rescheduled after power is restored,but activities that cannot be postponed such as watching your favourite television program or listening to a radio show at a scheduled time, the loss associated with the disruption may vary and could be frustrating.Presently, people experience inconvenience when their mobile devices such as mobile phones, tablets, etc., run out of power and they are unable to access the internet or the widely used social media such as Facebook and WhatsApp. Important data are lost when computers shut down abruptly by power interruptions and this is experienced by many researchers in Nigeria. People with serious health challenges such as respiratory diseases cannot connectto health support systems, such as respirators or infusions that require constant electricity in their homeswithout having a standby backup generator because power interruptions lasting only a few hours could be devastating andlethal. A room without air-condition during the typical hot dry season in Nigeria for some people can be very discomforting. Non-functioning security or street lights due to these outages canincrease the rate of robbery in that neighbourhood. Presently, with the escalating digitization of researchresources and online courses, power outages constitute a major impediment for students. Working with timelines and submitting assignments online before a deadline is unachievable when there is constant power failure.

Often times,frequent unannounced power outages are accompanied by electrical arcing and shocks that some of these household appliances may not be able to withstand. Thus, causing them to break down and consequently, becoming a loss to the owners who will incur extra costs in either repairing or replacing them. Also, the response time for the DISCOs in rectifying or attending to the power supply challenges faced by households is a great concern. Sometimes, households are left with erratic power or no power at all due to electrical faults for long periods even after the customers have sent a complaint to the electricity provider.

The poor electricity narrative evident in the unending, inadequate and poor-quality electricity supply has not changed significantly despite more than a decade of implementing market-oriented sector reform and billions of dollars spent in the industry. Also, there is the weak private sector investment response to the unbundling, privatisation and restructuring of the electricity industry.This development has been a major factor in the largely unchanged industry narrative since privatisation. The expectation was that the reform would catalyse sufficient investment in electricity infrastructure across the value chains and bring to an end the chronic shortages in generation and distribution. Gross underfunding of the sector due to the weak investment response of privatization and unbundling has ensured that the huge investment required to improve the availability and quality of electricity delivered to consumers has not been forthcoming.

Furthermore, the quadrupling of electricity tariff paid by consumers since the MYTO was introduced and implemented between 2008 and 2018 has not resulted in noteworthy improvement in the quantity and quality of service delivery. Unsurprisingly, the rising tariff amidst lack of significant improvement in the supply reliability and adequacy has provoked strong public opposition in recent years especially from residential electricity customers. This may be partly due to the fact that end-users of electricity do not think the services delivered merit the increased tariffs.

How much each household will be willing to pay for an improved electricity supply will differ across electricity consumers depending on the extent to which these persistent power outages and blackouts cost the particular household.

In the midst of these arguments, some of the research questions that arise include:

i. What are the social and economic cost of frequent and unanticipated power outages to households?
ii. What are the factors that influence consumers' willingness to pay (WTP) for uninterrupted electricity supply?
iii. How much are consumers willing to pay for an improved quality of electricity supply?

1.3 Objectives of the Study

The broad objective of this research is to investigate households' willingness to pay for improved quality of electricity supply. The specific objectives investigated and analyzed in this study include:

i. Assess the impact of the quality of electricity supply on household welfare.
ii. Investigate the factors that influence consumers' willingness to pay for an improved quality of electricity supply.
iii. Estimate how much consumers are willing to pay for reliable and improved quality of electricity supply.

1.4 Justification for the Study

The importance of improved quality of electricity supply for households cannot be over emphasized. This study is justified for several reasons:

First, studies have been conducted in the developed countries and these studies revealed that households are willing to pay significant amounts to avoid or avert power outages and willing to accept significant amounts for at least one additional outage in a year(Pepermans, 2011; Carlsson and Martinson, 2004). However, regular power outages are not the norm in these countries as in the case in Nigeria and some Africa countries.Thus, this study fills part of the gap in the literature for Nigeria and Africa.

Secondly, studies in Nigeria on this subject are limited (Oseni, 2017; Babawale and Awosanya, 2014)and thus, estimates from this study are expected to be invaluable to the distribution companies, the electricity regulators and researchers. Apart from Oseni (2017), no recent such study on willingness to pay for reliable electricity service in Nigeria. The study by Oseni (2017) showed the extent to which self-generation might affect WTP for reliable electricity service in Nigeria. This study goes beyond that by assessing the current quality of the existing power supply, and investigating the factors that affects households' WTP for improved electricity service with good quality.

Third, this study brings to light how much power outages are costing households by eliciting their WTP to avoid these unannounced power outages. This would help the government, the generation and distribution companies to have an insight of the social and economic cost of power outages and consequently put in measures to address the problem.

Also, no prior study has examined households' WTP for improved electricity service in more than three (3) geographical location in Africa. Kateregga (2009) carried out his study in three Ugandan suburbs, Abdullah and Mariel (2010) carried out their study in Kisumu District, Kenya and Twerefou (2014) in Tema city, Ghana. In Nigeria, only Oseni (2017) carried out his studies in two locations; Osogbo and Lagos. In fact, all the studies carried out in Nigeria has been within a geopolitical region (South western part of Nigeria). The study was carried out in four cities (Abuja, Ibadan, Lagos and Port Harcourt) within three geopolitical regions (North Central, South West and South South) in Nigeria.The scope of this study extends the existing literature especially in Nigeria.

Furthermore, it will also inform the power sector regulatory body, NERC to have a good idea on how much the average household in the selected cities is willing to pay for a more reliable and improved quality of power supply. This will aid the regulators in tariff adjustments and development of performance indicators for the electricity providers to operate effectively and efficiently.

1.5 Scope of the Study

The scope of this studyare four (4)major cities in Nigeria, namely: Abuja, Ibadan, Port Harcourt and Lagos. These cities were chosen because of their diverse geographical locations, high number of active customers connected to the network grid as well as differences in electricity tariff. No research on this subject area has used more than two cities in Nigeria for its case study to the best of my knowledge (Oseni, 2017; Babawaleand Awosanya, 2014). Given the need for generalization of the finding of this thesis for the whole country, four major cities are selected.

1.6 Plan of Study

This research is organized intofive chapters. Chapter one dwells on the introduction, the research problem as well as the research questions that arise. Other subsections in this chapter include the study objectives, justification, scope and the plan of study.Chapter two discusses the backgroundof the study laying emphasis on the overview of the electricity sector in Nigeria and review some literatures relevant to the study. Chapter threehighlights the research methodology. Chapter four presents and discusses the results of the study.Chapter five presents the conclusion of the study, recommendations based on the findings of this study,limitations encountered in the course of the study, contribution to knowledge and areas for further research.

CHAPTER TWO
LITERATURE REVIEW

The availability and reliability of power supply is at the core of economic, social and technological development.

The chapter discusses the background to the study which includes an overview of the Nigerian economy, the electricity sector, electricity tariffs, quality of electricity service, as well as policy and institutional developments. The chapter further reviews literatures relevant to the study and discusses the theoretical framework employed in the study.

2.1 Nigerian Economy

Nigeria has a population of about 198 million and this population size constitutes 47% of the population in West Africa. The country is a federation that comprises of 36states with societies which are multi-ethnic and culturally diverse. The country is well endowed with natural resources with oil and gas the most valuable. Nigeria is the biggest oil exporter andalso has the largest natural gas reserves in Africa with reserves of approximately 202 trillion cubic feet (TCF) according to recent data from the Nigerian National Petroleum Corporation (NNPC).

Much of the non-oil growth over the last decade in Nigeria resulted from reform of the communications sector and increased investment and expansion of the agriculture sector. These developments have had substantialbenefits on the welfare of the people and improved the efficiency of businesses across the country. There have also beennotable achievements in the banking and finance sectors.

It is a fact that economic growth and national development depends crucially on adequate electricity supply. The significance and relevance of energy in the economic development process particularly for emerging economies is well documented in the literature (Iwayemi, 2008; Okafor, 2012; and Sambo, 2008).Altinay and Karagol (2004) identified an increasing energy demand for most developing countries in their study. Some available literatures have shown thatelectricity consumption have positive effects on the economic growth of countries (Kraft and Kraft, 1978; Wolde-Rufael 2009; Yoo 2005).

Electric power is a malleable form of energy that is afundamental infrastructural input for economic development. Economic agents (firms and consumers) have wide-ranging demands for electricity in every economy which are influenced by determinants such as urbanization, industrialization, standard of living, population growth, and modernization and advancement of the agricultural sector.

Figure 2.1 below shows annual per capita GDP growth rate in Nigeria from 1970 to 2017.

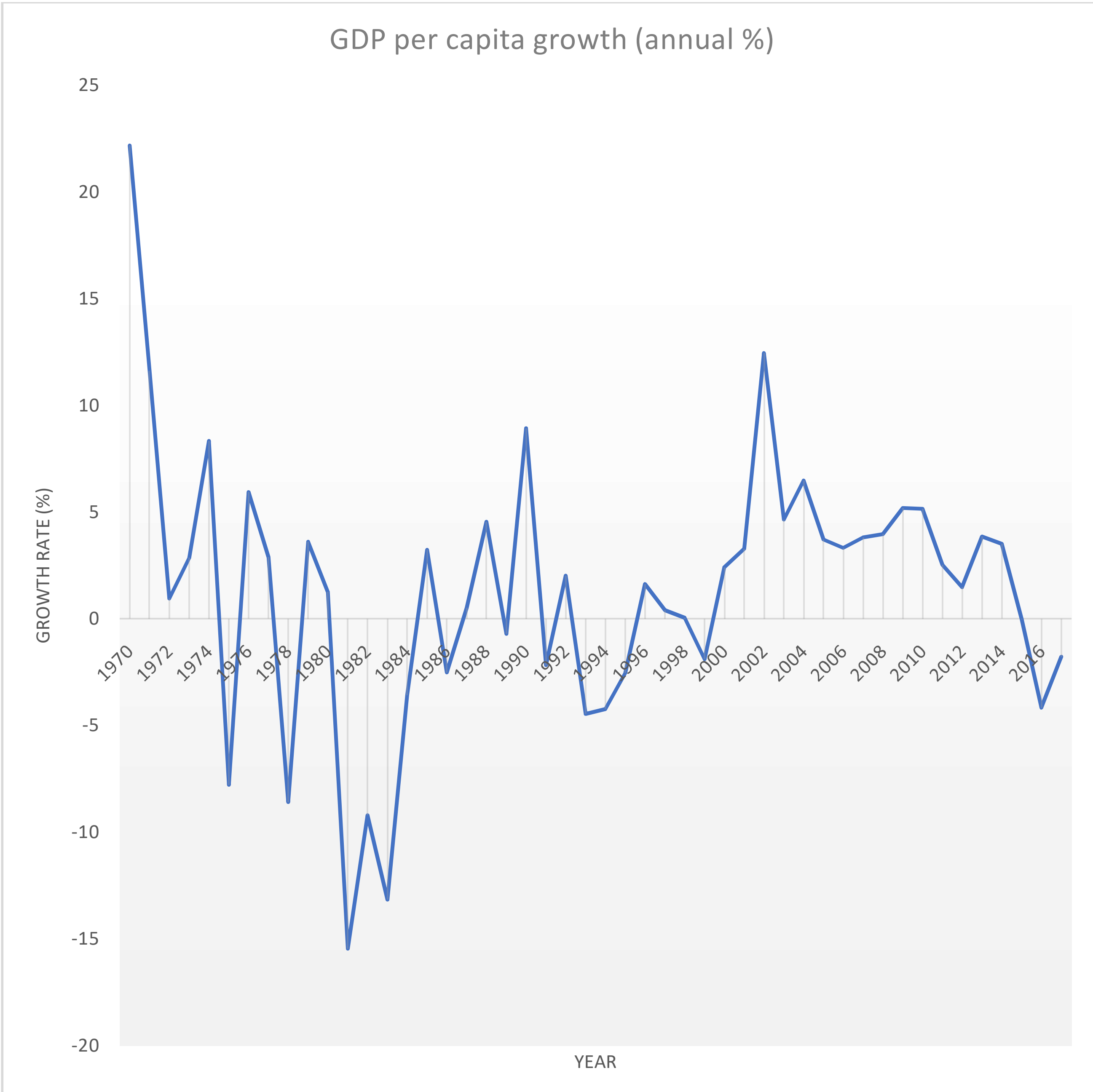

Figure 2.1. Nigeria Gross Domestic Product Annual Growth Rate

Source:World Bank Development Indicator, 2019.

Nigeria has vast energy resourceswhich conceivably shouldprovide the country with extensive opportunities to grow her economy and consequently improve the standard of living of its citizens. Data from the NNPC annual report reveal that the countryhas reserves estimated at 35 billion barrels of oil, 202 trillion cubic feet of gas, 4 billion metric tons of coal and lignite, as well as undetermined reserves of tar sands, hydropower and solar radiation, among others.

The supply of reliable, adequate and affordable electricity isessential for the growth andrapid industrialization of any society. Amongst the notable infrastructure deficit gaps in Nigeria is the electricity sector.

The electricity sector in Nigeria is marred by low generating capacity when compared to the installed capacity and as a result, a huge proportion of householdsin Nigeria do not have access to uninterrupted electricity supply (Ezechukwu, 2013). Nigerians currently experience regular power outages and poor power quality, and the gap between electricity demand and supply continues toexpandannually as industrialization and population increase.

Only about 54.4% of Nigerians have access to electricity, with just about 30% of their demands being met (WDI, 2019). Also, recurrent power supply outages are substituted with private generating sets.Some of these generators operate more than 15 hours a day[2]. Outages and blackouts are a norm and households are left with limited choice but to depend on biomass fuel and backupgenerating sets to compensate for the inadequate and unreliable electricity supply from the national network grid.

Figure 2.2 shows the percentage of population in Nigerian that has access to electricity from 1990-2019 while Figure 2.3 shows the percentage of population in Nigerian that has access to electricity compared to other selected countries in the year 2000 and 2016 when the data was last updated. Figure 2.4 shows percentage of Nigerians connected to the electricity grid. Figure 2.5 shows a plot of Nigeria electric power consumption per capita compared to its GDP per capita from 1971 to 2017.

Figure 2.6 below shows Nigeria electric power consumption per capita compared to some other selected countries in Africa, Europe, Asia and America.

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[2]A 2014 World Bank document on Diesel Power Generation: Inventories and Black Carbon Emissions in Nigeria stated that backup generators compensates for the excess consumers' demand on electricity that cannot be met by the current power supply.

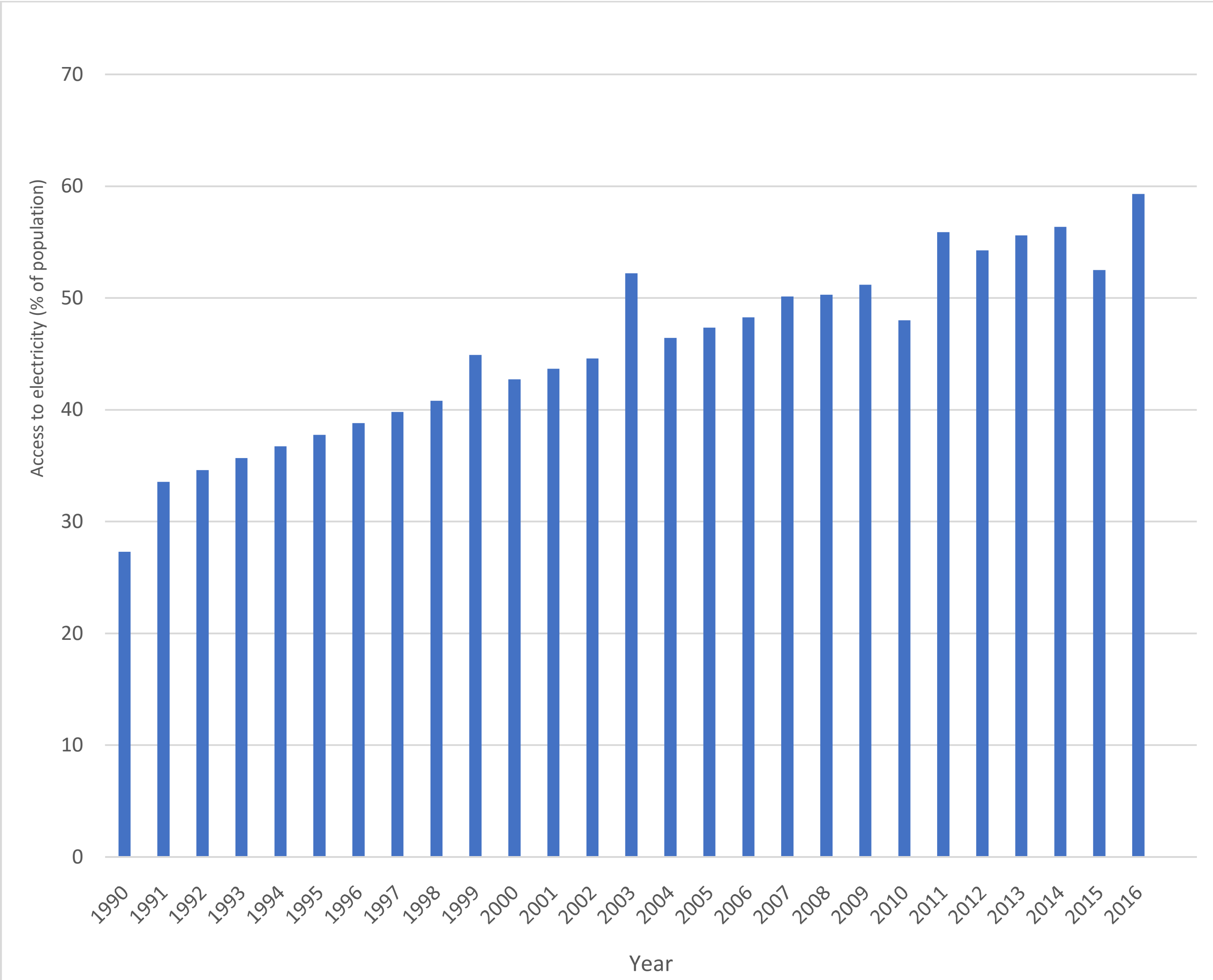

Figure 2.2. Nigeria Access toElectricity(% of population) 1990-2019

Source: World Bank Indicators, 2019

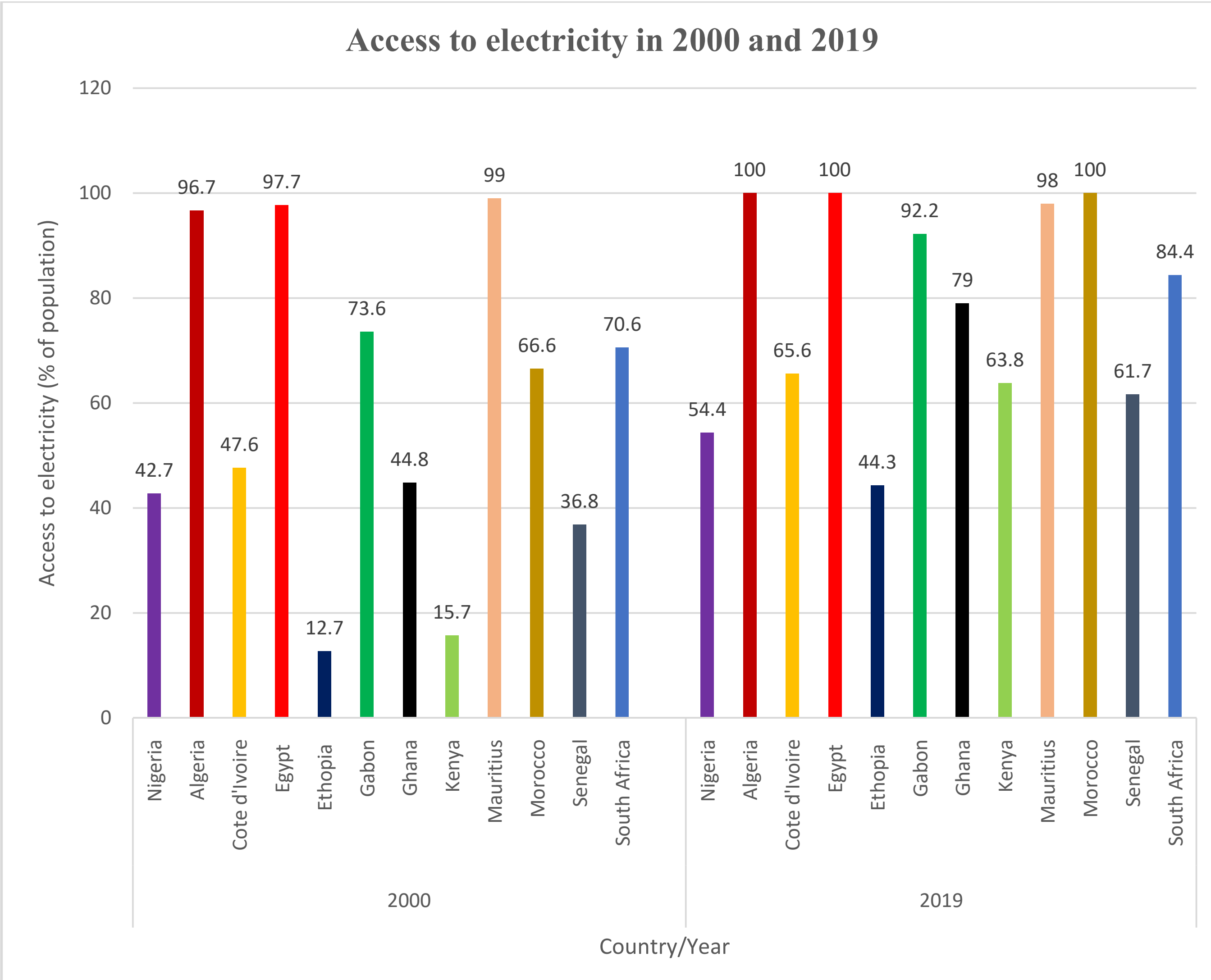

Figure 2.3. Access to Electricity in Selected Countries (2000 and 2019)

Source: World Bank Indicators, 2019.

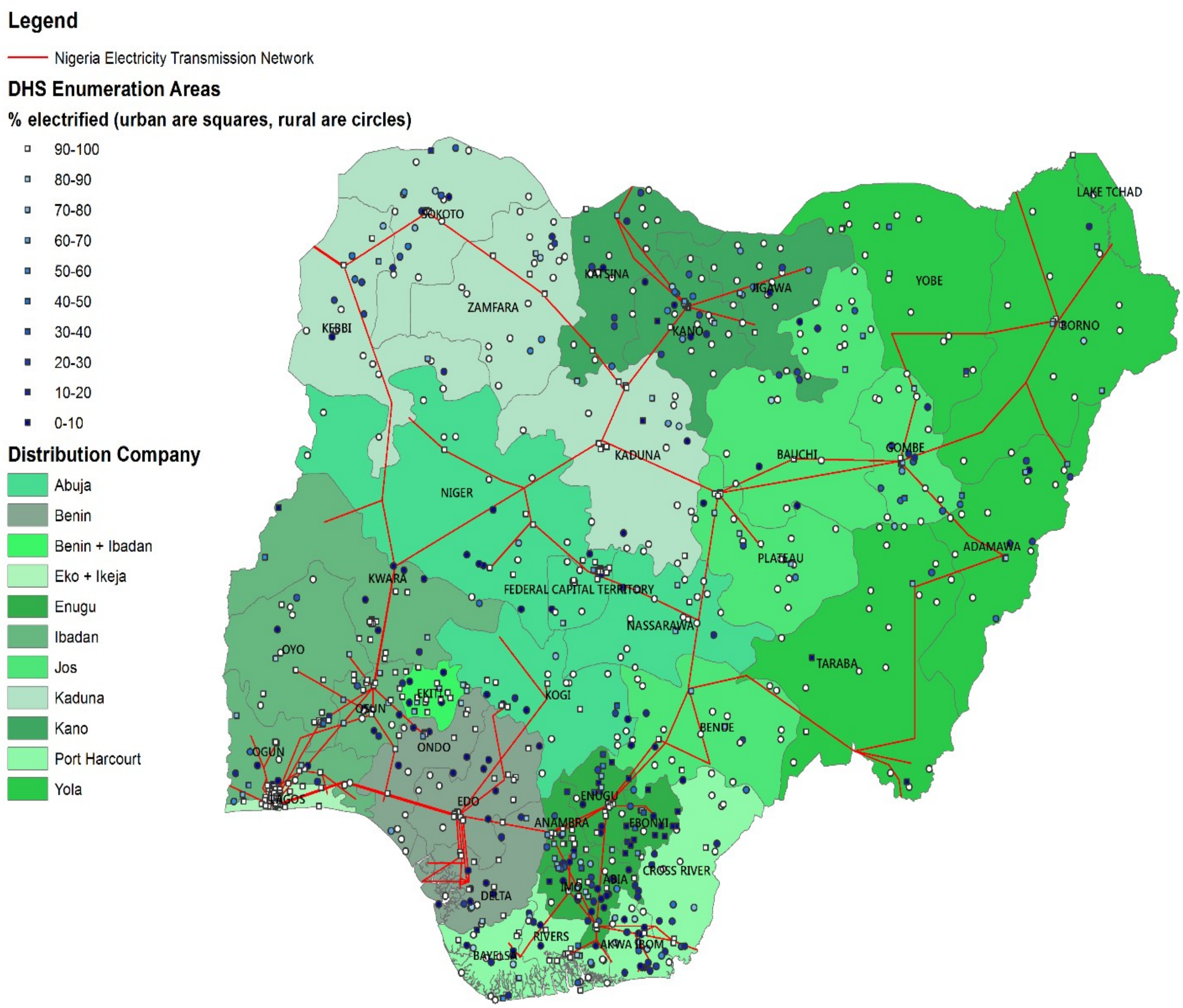

Figure 2.4. Percentage of Nigerians connected to the grid

Source: Africa Development Bank, 2018.

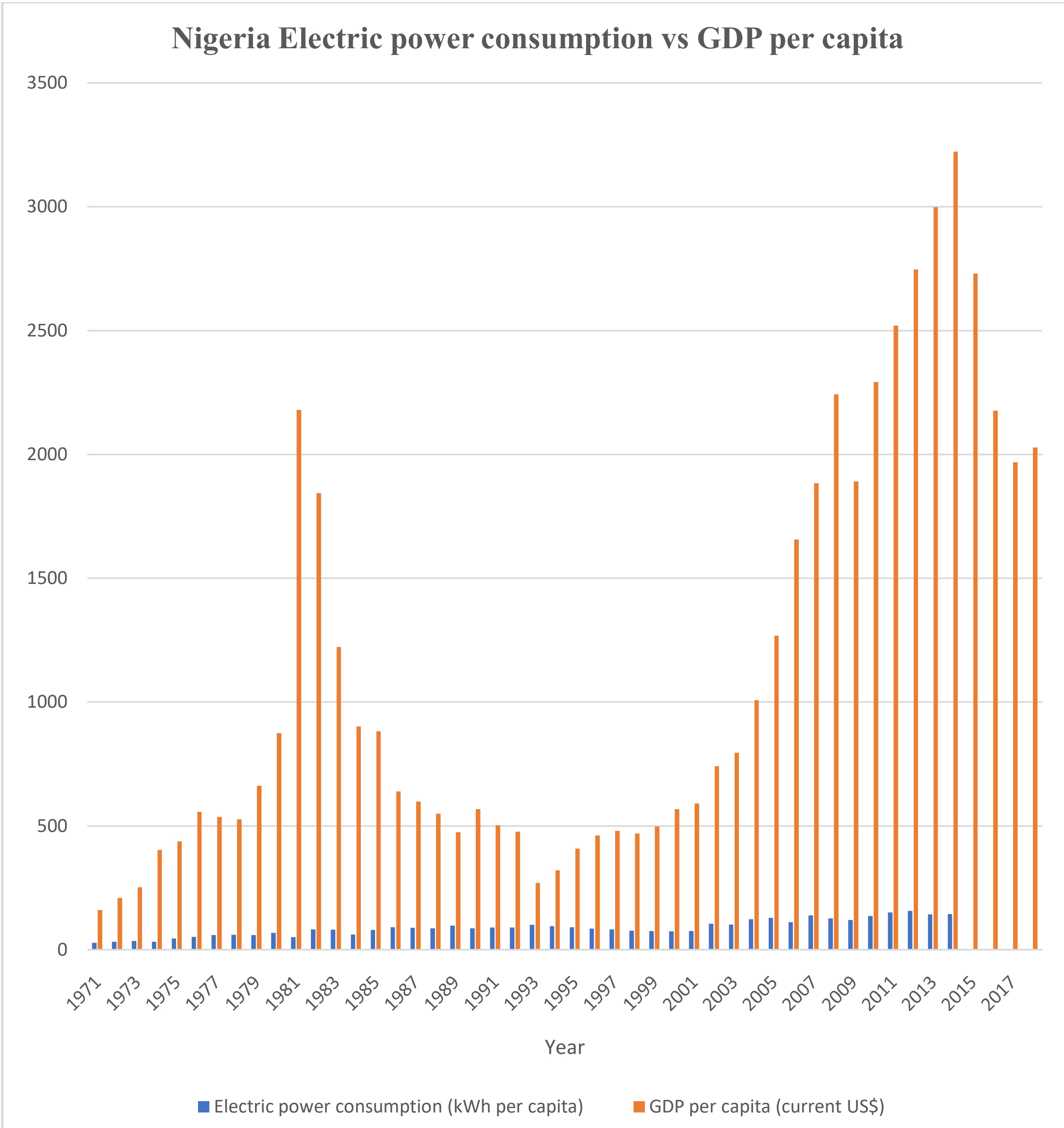

Figure 2.5. Electric Power Consumption (kWh per capita) Vs. GDP per Capita (Current $US)

Source: World Bank Indicators, 2019.

From Figure 2.5,Nigeria electricity consumption (kWh per capita) stands at 144.53 (WDI, 2019). As the graph abovedepicts, over the past 43 years, this indicator reached a maximum value of 156.80 in 2012 and a minimum value of 28.57 in 1971. In comparison to the GDP per capita of Nigeria, thecurrent value for GDP per capita (current US$) is $2,028.18. Over the past 58 years, the value for this indicator has fluctuated between $3,222.69 in 2014 and $160.25 in 1971.

The Nigerian economy is a mixed economy with majority of middle-income earners. The economy is an emerging market with notable expansion in the financial, communications, service, technology, manufacturing, and entertainment sectors. The Nigeria economy is ranked in terms of nominal GDP as the 27th largest economy in the world. In terms of purchasing power parity, the Nigeria economy is ranked as the 22nd largest economy.

In 2013, Nigeria's manufacturing sector was listed as the largest in Africa, hence, making it the largest economy on the continent that produces a large proportion of goods and services for other West African countries[3].

The gap between the country's electric power consumption per capita and GDP per capita is wide.

For a country with a population of over 190 million, the electric power consumption per capita is way too small compared to other African countries with smaller economies and population (see Figure 2.6). There is a huge electricity shortfall due to inadequate generation, transmission and distribution capacity in the face of a high level of suppressed demand in Nigeria.

[3]KPMG Manufacturing Sector Report, 2016: Manufacturing in Africa.

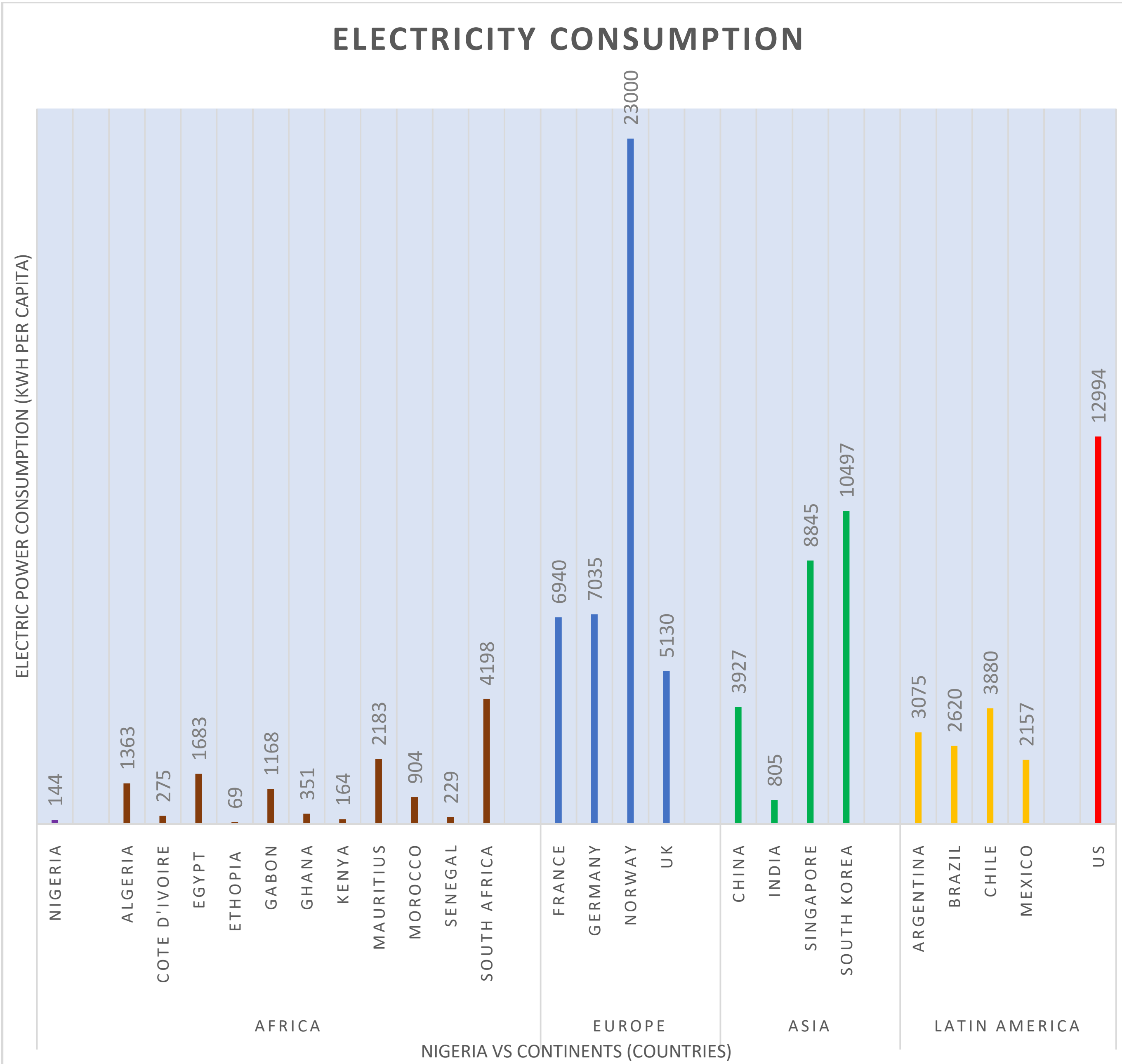

Figure 2.6. Electricity Consumption (kWh per Capita) across Regions

Source: World Development Indicator, 2019.

2.2 Historical Trend on Electricity in Nigeria

The history of the evolution of the Nigerian electricity sector can be traced as far back as the end of the 19^{th} century. In 1898, the first power generating plant with a total capacity of about 60kW was installed and commissioned in Marina, Lagos State by the Nigerian colonial administration. After the amalgamation of the Northern and Southern territories to conceive the present Nigeria in 1914, some other cities across the country followed suit and began to develop electricity supply systems.During the first 50 years (1898-1949), electricity was generated for use in government quarters, offices and residences of individuals with high status in the society.

Table 2.1 below shows major cities that first had electric power supply.

Table 2.1.The History of Electricity Supply in Nigeria Cities

Cities	Year
Lagos	1898
Port Harcourt	1928
Kaduna	1929
Enugu	1933
Maiduguri	1934
Yola	1937
Zaria	1938
Calabar	1939
Warri	1939

Source: Author Compilation

2.2.1 Electricity Corporation of Nigeria (ECN) and Niger Dams Authority (NDA) Establishment

The Federal government of Nigeria and Native Authorities (NAs) owned systems wereautonomous operational entities for a long time until 1946 when the Public Works Department (PWD) ceased having total control over the electricity generating plants and distribution system operations in Nigeria. A body called the Nigerian Government Electricity Undertaking (NGEU) was inaugurated as an annex of the PWD to manage all the operational assets of electricity supply in Lagos (Awosope, 2014).In 1950, the Electricity Corporation of Nigeria (ECN)was established as a central entity under the ordinance No.15 of 1950 by the Colonial Government to manage all the distinct electricity supply networks across the country.

ECN officially took over all electricity supply operations in 1951 by integrating all the Nigerian government andNAs owned generating plants and systems across Nigeria.[4]ECN controlled and managed all the operations of electricity supply in Nigeria as the central utility company in the country. The corporation was responsible for the supply of electricity to capable and willing buyers across the country.

The increasing electricity demand led to the execution of a few projects in Oji River, Kano, Ijora and Ibadan power stations in order to improve the availability and quality of power supply.

In February 1956, the Ijora power station was commissioned. The power station served several towns such as Ijebu-Ode, Shagamu, Ikorodu amongst others. This improvement in power delivery ushered in the socio-economic development of these areas before other regions of the country.

In 1962, theNiger Dams Authority (NDA) was established. NDA became fully operational and wereresponsible for harnessing the hydropower potential in Nigeria. This paved way to the construction of Kainji Dam in 1962 which wasfinally completed in 1968.

In 1966, with the collaboration of ECN and NDA, the entire grid network began operations which linked Kainji with Lagos. The Kainji-Kaduna network was extended to Zaria and Kano. In the Southern part of Nigeria, the Oshogbo-Benin-Ughelli and Benin-Onitsha-Afam (Alaoji) networks were constructed.

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[4]Nigerian Electricity Regulatory Commission. In 1951, the Electricity Corporation of Nigeria was established by an Act of Parliament. https://nerc.gov.ng

Despite the tremendous size of Nigeria, the network grid (popularly referred to as National grid) now links the 36 states and the Federal Capital Territory; Abuja.

On April 1st, 1972, ECN and NDA merged to form National Electric Power Authority (NEPA).In 1973, the first manager was appointed. The new corporation, NEPA was charged with the responsibility of the national grid expansion across the country. During this period, NEPA completed two hydro plants at Shiroro and Jebba with an installed capacity of 600MW and 540MW respectively.

Figure 2.7 below depicts the Electricity industry structure under NEPA.

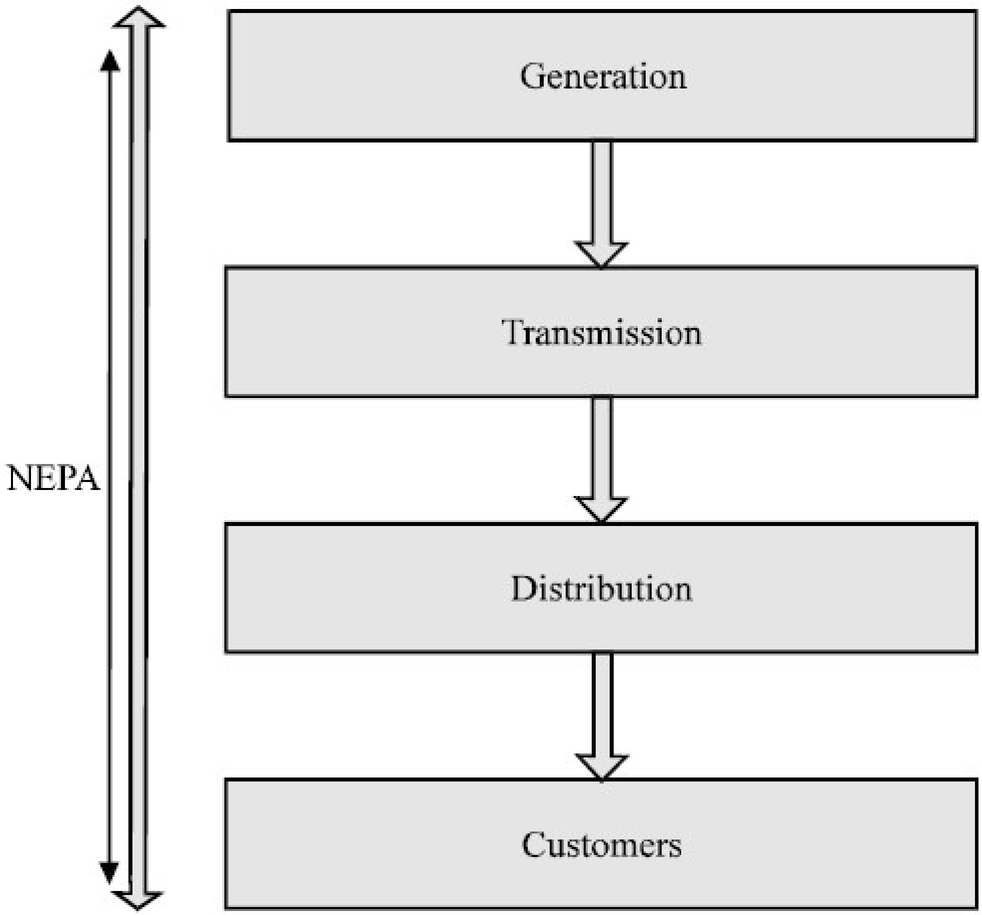

Figure 2.7. The Vertical Integration Model of the Electricity Industry

Source: Author

2.2.2 The Establishment and Unbundling of Power Holding Company Nigeria

As a result of the Government effort to reform the electricity sector, an act was enacted in 1999 that led to the establishment of the Power Holding Company Nigeria (PHCN). All NEPA liabilities and assets were to be transferred to PHCN. On the 5th of May, 2005, PHCN was officially commissioned.

Similarly, the National Integrated Power Projects (NIPP),an initiative of the government was inaugurated in 2004 to address and resolve the issues of insufficient power generation and facilitate the addition of more electricity capacity to the available capacity across the country. This initiative is supervised and managed by the Niger Delta Power Holding Company (NDPHC).

In 2005, PHCN was unbundled into 18 successor companies comprising ofsix (6) generating companies (GENCOs), one (1) transmissioncompany (i.e. Transmission Company of Nigeria-TCN), andeleven (11) distribution companies (DISCOs)[5].

As a result of the magnitude of investment required as well as national issues to maintain and upgrade the network grid, TCN is fully owned and controlled by the Federal Government. However, the management of TCN is handled by a Canadian firm, Manitoba Hydro Company. The government stake on the GENCOs is 20% with the remaining 80% of equity sold to private investors. All the DISCOs have been sold to private investors. Although, the government is still holding 40% as only 60% of equity was sold.

The generation and distribution of power supply have been managed by the private sectors ever since the Nigerian government transferred ownership to the prospective owners.

2.2.3 The Establishment of Nigerian Electricity Regulatory Commission (NERC)

NERC was inaugurated in November 2005, and commissioned with the responsibility of tariffs regulation and monitoring of the quality of services of the power utility companies. Tariffs in the Nigerian electricity industry were depressed by government order before the reform. The old NEPA was barred by decree from any form of tariffs' increment, even when the cost of electricity supplykept increasing. This resulted tolow productivity of electricity and invariably

[5]The Electric Power Sector Reform (EPSR) Act was enacted in 2005 and NERC was established as an independent regulatory body for the electricity industry in Nigeria. Also, PHCN was formed as a transitional corporation comprising of the 18 successor companies (6 GENCOs, TCN and 11 DISCOs) created from NEPA.

the dearth of investment in the network. Conclusively, the outcome was the inevitable collapse of the system.

Cost reflective tariff is very crucialin achieving sustainable success with the power sector reform in as much as the idea still seem controversial and politically explosive to some segment of the populace.

The EPSR Act 2005, isolated NERC from the direct control of the government politics in order to avoid any form of regulatory capture. Due to the fact that the tariff is an outcome of scientific and technical analysis as well as modelling, NERC are obligated to fix the tariff after due process and consultation with all stakeholders. The stability and credibility of the methodology for determining the MYTO, provides assurance to investors who are particular about their Return on Investment (ROI) to continue to patronize the Nigerian electricity market.As long as the regulatory landscape is free of regulatory capture, and the regulation of the Nigerian electricity market remains legitimate and credible, foreign and local private sector investments will continue to flow into the Nigerian electricity market.

2.3 The Structure of the Nigeria Power Sector

The vertical integrated model initially adopted prior to the reform had the generation, transmission and distribution incorporated as one single entity referred to as the NEPA.NEPA was unbundled by the electricity reform into successors companies before it was finally privatized as discussed earlier. The sector has evolved since after privatisation. The following sub-sections provides an overview of each of the sectors presently.

2.3.1 Generation Sector

Prior to the enactment of the National Power Policy of 2001, the Electricity Act of 1990 was in operation and was amended through the Electricity (Amendment) decree of 1998 which allowed private sector participation in electricity generation. This encouraged the entrance of the Independent Power Producers (IPPs) into power generation. The IPPs have contributed to the improvement of generating capacity.

These IPPscomprises of generation companies that supplypower to the national network grid and embedded generation companies which are usually assigned to industries that heavily depend on adequate and reliable electricity supply.

There are three (3) private IPPs that supplies power to the grid; Shell and AGIP are international oil companies (IOCs)and the third IPP is being run by AES Corporation. The IPPs have proven to be very reliable in the supply of power to the national grid networks as they account for over 40% of Nigeria's generating capacity.

However, most of the government owned generating plants were not optimally operating to their full capacityand the additional generating capacity provided by the Independent Power Producers was still deficient to meet the constant increasing demand for power, thus, the government embarked on an electricity investment programme scheme called the National Integrated Power Project (NIPP). In 2005, the NDPHC was commissioned and charged to manage these investments in NIPP assets worth US$8.4 billion.The NIPPs comprises of 10 power generating plants with the necessary gas supply, transmission and distribution infrastructure for their efficient operations.

There is a total of 25 grid-connected generating plants in Nigeria and the total installed capacity is approximately 12,500MW[6]. Many of these plants are faced with numerous challenges such as faults and leakages, transmission network trips, poor maintenance and delay in repair. These challenges prevent these generating plants from operating in their optimal capacity and unavailable for power evacuation to the grid. Approximately 87% of the grid connected power plants are gas fired, while the remaining 13% are hydroelectric power plants.

At the beginning of 2014, the Federal government had projected that generation would peak at a minimum of 5,000 megawatts (MW) and possibly hit 6,000MW by the end of the year. However, the year ended with generation hovering between 3,800 and 4,000MW. This huge difference between installed and available generating capacity has been blamed on the incessant vandalism of gas pipelines across the country.Officials of the Ministry of Power said, these disruptions prevented the sector from attaining the years' projection.

[6]GET.invest Energy Sector Report, 2019. Nigeria generating power plants has a total installed capacity of about 12,500MW, made up of gas thermal and hydropower plants with a percentage of 87.5% and 12.5% respectively. https://www.get-invest.eu/market-information/nigeria/energy-sector/

In 2017, according to NBS, the power generation statistics for the second quarter in 2017 reflected that a total average of about 2,503 GWh of energy was generated by power stations consisting of 25 generating plants within the period under review (NBS, 2017).

The major problem plugged to this sector of the market has been lack of generating capacity and deficiency of gas for the capacity available. Table 2.2 and 2.3 below shows the successor generation companies and otherLegacy plants owned by PHCN respectively. Also, Table 2.4 shows the status of Nigeria's NIPPs in 2019.

Figure 2.8 shows the distribution of thermal and hydropower plants across Nigeria. Table 2.5 shows the 25-grid connected generating power plants across the country and Figure 2.9 shows a detailed infographic representation of Nigeria's power generating efficiency with reference to Table 2.5.

Table 2.2. Successor Generation Companies

	GENCO	Type	Installed Capacity (MW)	Available Capacity (MW)
1.	Afam Power	Gas fired	987.2	178
2.	Egbin Power	Steam	1320	1030
3.	Shiroro Hydro Electric	Hydro	600	565
4.	Kanji Hydro Electric	Hydro	760	199
5.	Ughelli Power	Gas fired	942	373
6.	Sapele Power	Gas fired	1020	178
	Total		5629	2523

Source: Nigerian Electricity Regulatory Commission (NERC), 2018

Table 2.3. Other Generation Companies owned by PHCN (Legacy Plants)

	GENCO	Type	Installed Capacity (MW)	Available Capacity (MW)
1.	Omotosho Power	Gas fired	500	161
2.	Geregu Power	Gas fired	414	284
3.	Jebba Hydro Electric	Hydro	570	560
4.	Olorunsogo Power	Gas fired	304	161
	Total		1788	1166

Source: Transmission Company of Nigeria(TCN), 2014

Table 2.4: Nigeria's National Integrated Power Projects (NIPPs)

NIPP	Plants Installed Capacity (MW)	Plants Average Available Capacity (MW)	Status
Olorunsogo II	754	260	Completed
Sapele	507.6	219	Completed
Omotosho II	512.8	306	Completed
Geregu II	506.1	328	Completed
Ihovbor	507.6	374	Completed
Alaoji	1074	158	Completed
Calabar	634.5	N/A	Completed
Gbarain	253.8	N/A	Completed
Egbema	380.7	N/A	Completed
Omoku	264.7	60	Completed

* N/A – Not Available

Source: Niger Delta Power Holding Company (NDPHC), 2019

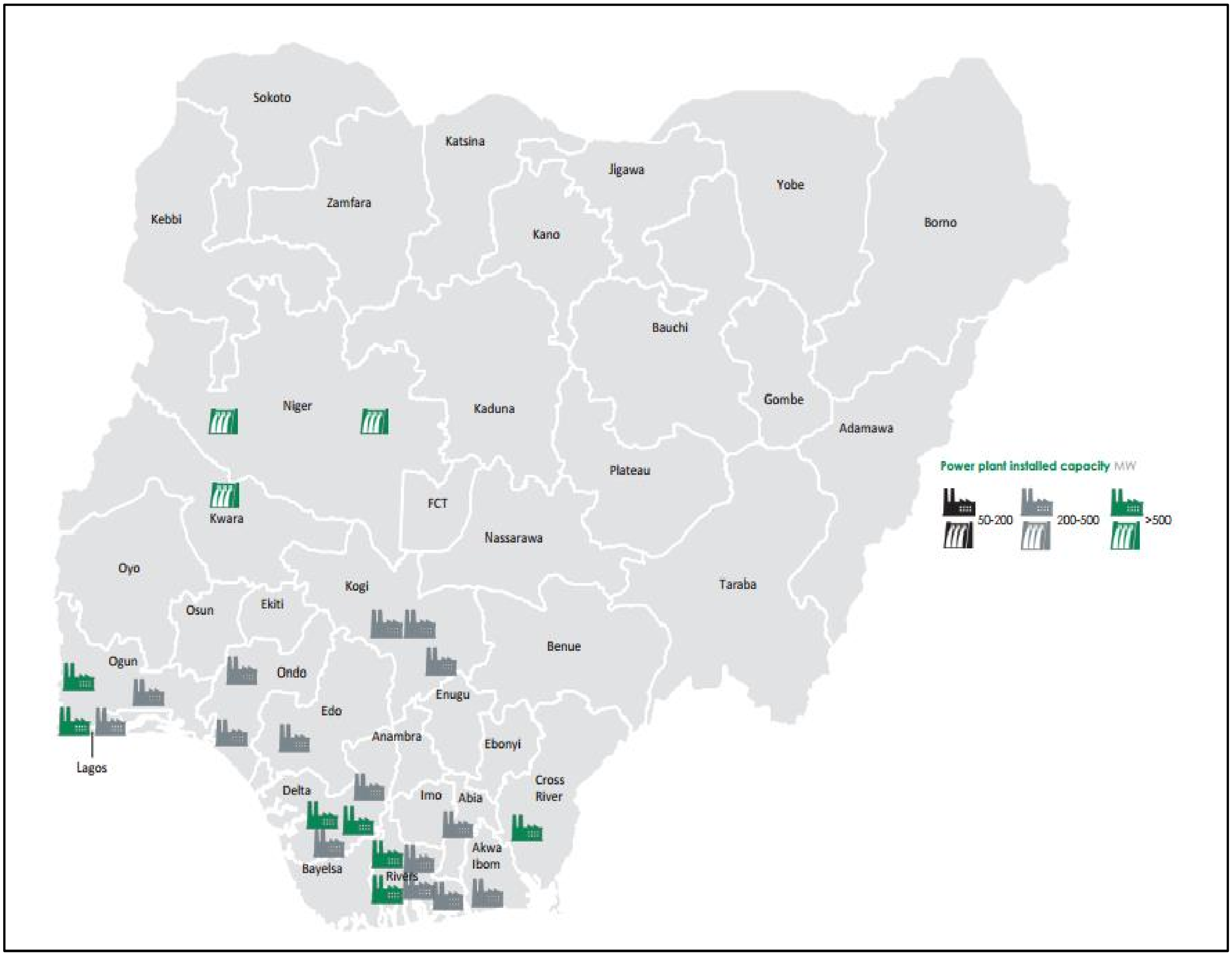

Figure 2.8. Hydropower and Gas-fired Plants Distribution across Nigeria

Source: Nigerian Electricity Supply Industry Statistics (NESISTATS), 2019.

Table 2.5: Grid-Connected Generating Power Plants across Nigeria[7]

Generating Plant	Installed Capacity (MW)	Average Available Capacity (MW)	Average Operational Capacity (MW)
AES Gas	180	175	-
Rivers IPP	136	-	-
Trans Amadi	150	-	-
Omoku	110	-	-
ASCO	294	270	-
Afam IV-V	724	3	2
Ibom	190	`91	76
Odukpani NIPP	561	234	64
Okpai	900	536	375
Transcorp	480	463	374
Afam VI	685	587	455
Jebba	570	431	262
Sapele	504	219	69
Geruga Gas	414	159	131
Omotosho Gas	335	280	163
Olorunsogo Gas	335	277	189
Kainji	720	444	173
Shiroro	600	508	153
Alaoji NIPP	720	158	67
Sapele NIPP	450	184	111
Ihovbor NIPP	434	374	182
Olorungo NIPP	760	260	171
Gerugu NIPP	450	328	179
Omotosho NIPP	`500	306	169
Egbin Plant	1,320	941	539

[7]GET.invest Energy Sector Report, 2019.
https://www.get-invest.eu/market-information/nigeria/energy-sector/

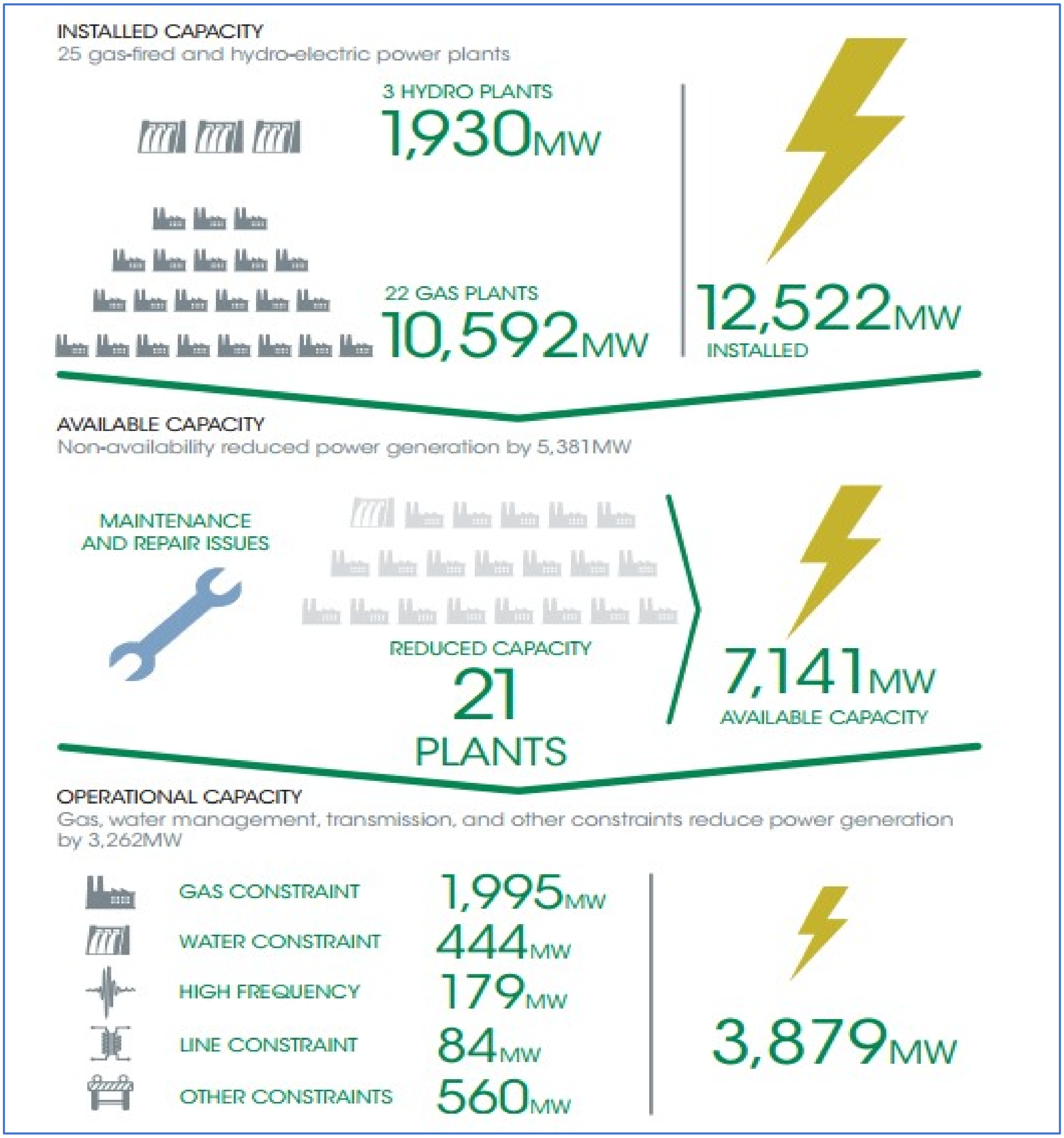

Figure 2.9. Generating Efficiency of Power Plants in Nigeria

Source: NESISTATS, 2019.

2.3.2 Transmission Sector

The Transmission Company of Nigeria (TCN) remains under the ownership Federal Government. However, it was handed over to a Canadian enterprise, Manitoba Hydro International as a management contract. The duty of the management company is to run it in an efficient manner. The TCN is split into three operational functions:

1. System Operator (SO)
2. Market Operator (MO)
3. Transmission Service Provider (TSP)

The transmission network in the country is radial, meaning that the power is conveyed from the main branch to sub-branches and then is split from the sub-branches again. It is the cheapest system but also the most unreliable and is often avoided for networks in densely populated areas due to the lack of alternate routes should a part of the system become faulty. The unreliable structure of the system is one of the issues that the TCN is currently dealing with. The figures below show the current transmission network and the plans to build a 'super-grid'. The main barrier to achieving this goal has been access to funding.

Figure 2.10 shows the structure of TCN with their functions while Figure 2.11 shows TCN present network grid of the whole country and Figure 2.12 shows their proposed grid network.

Transmission losses on the network lines stand at 7.7%[8]. There are 159 substations and transmission lines running about 15,022 KM in Nigeria's transmission network. System collapse incidence on the transmission grid have reduced in the last 9 years.

[8]Based on the last updated data from Nigerian Electricity Regulatory Commission as at February, 2019. Although, the MYTO targets a transmission loss of 8.05%, TCN still struggles to maintain the losses not to go above the benchmark.

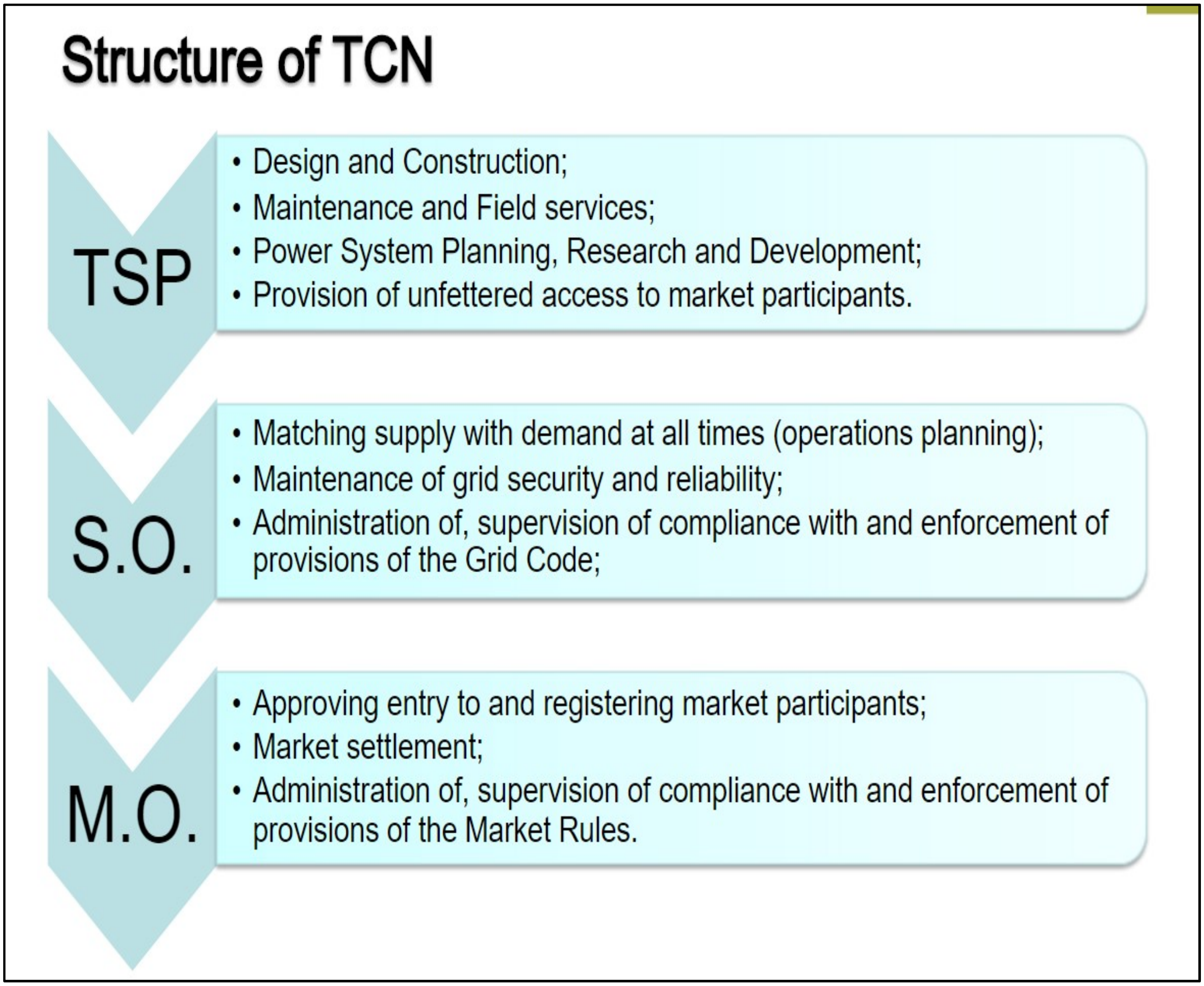

Figure 2.10. Structure of TCN

Source: Presentation on future of TCN (by Bada A.S., 2016)

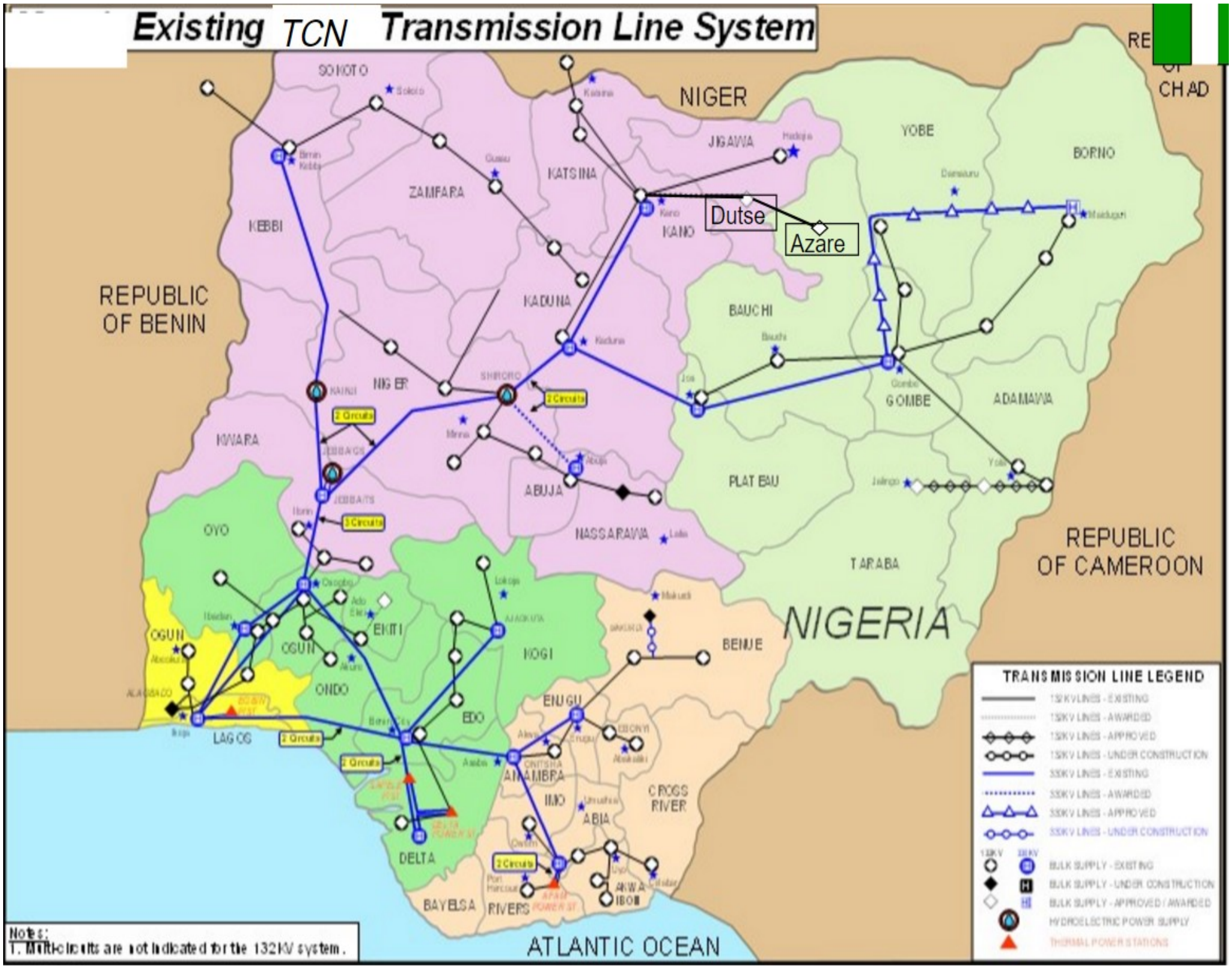

Figure 2.11. Nigeria Transmission Network

Source: Transmission Company of Nigeria, 2014

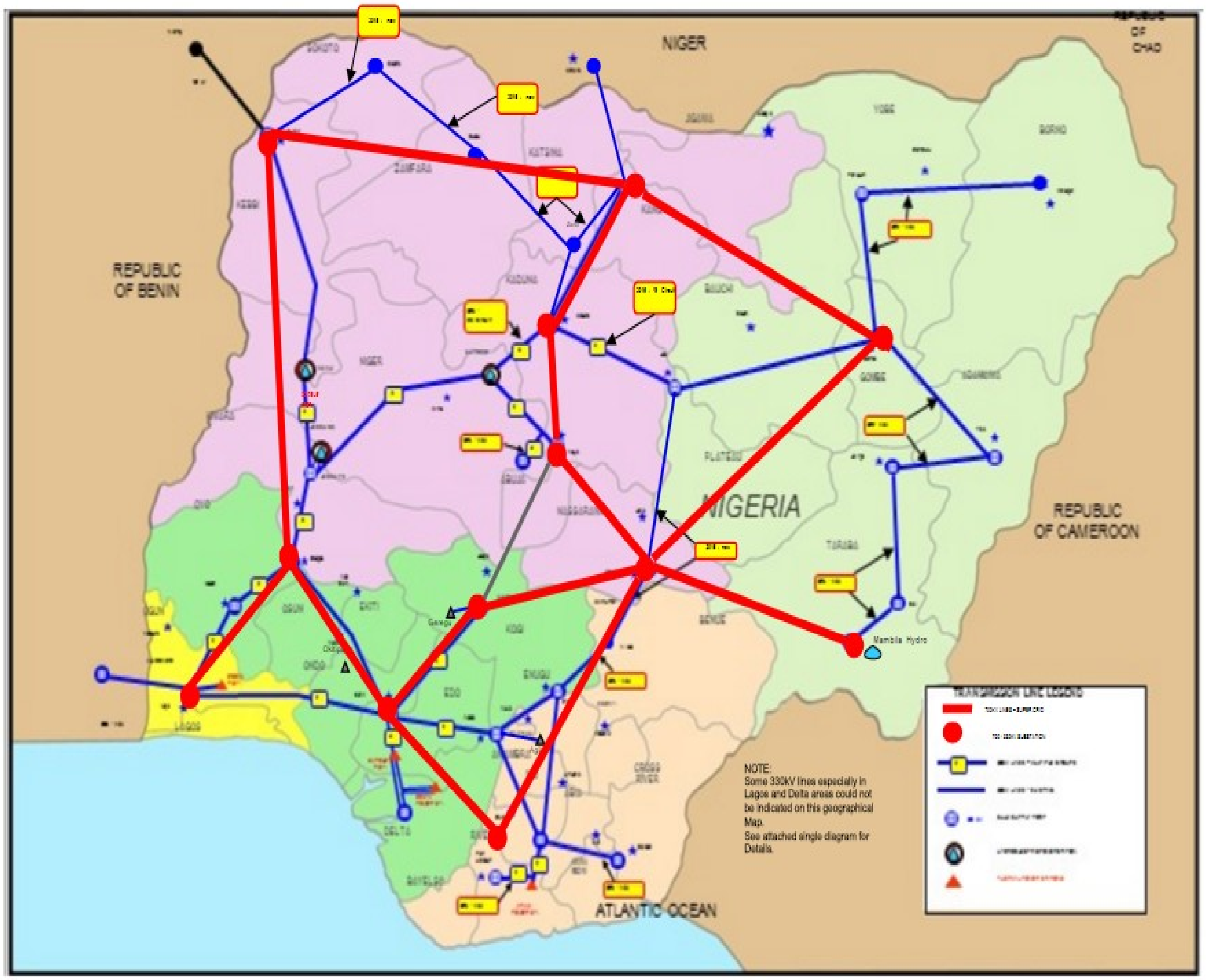

Figure 2.12. Nigeria Transmission Proposed Super-Grid Network

Source: TCN, 2014

The Federal government of Nigeria had set a target which is part of a Transmission Master Plandesigned by TCNto boost the power transmission wheeling capacity to a minimum of 10,000 megawatts (MW) in the year 2020. However, some stakeholders in the nation's electricity sector envisions the projection as only a mirage that is far fetched[9].This Master Plan is expected to gulp a huge sum of about N805.7 billion ($2.238billion) and it equally targets to achieve a wheeling capacity of 15,000MW by 2025.

TCN claims it has about 8,100MW transmission capacity, but in the real sense, only an average 4,000MW is available. Thus, most stakeholders including electricity customers believe the target is a fabrication for political propaganda because power supply in Nigeria has remained inadequate and unreliable. The transmission network in the country are old and obsolete and a huge number of assets scattered across the country require urgent repair and effective maintenance. No wonder the constant system collapses almost every month in the country for the pass 2 decades. Nigeria has experienced over 190 systems collapse that caused severe nationwide outages in the last 9 years (TCN, 2019).

Figure 2.13 shows the number of power system collapse in the country for over 30 years.

[9]The Energy section of 'The Guardian' reported that TCN had set 2020 target to boost power transmission wheeling capacity to 10,000MW as part of a Transmission Master Plan.TCN claimed it has about 8,100MW transmission capacity, however, only an average of 4,000MW is wheeled to consumer making most stakeholders to believe the target was fabricated for political propaganda as power supply in Nigeria has remained epileptic. https://guardian.ng/energy/tcn-insists-10000mw-wheeling-capacity-feasible-by-july-2020/

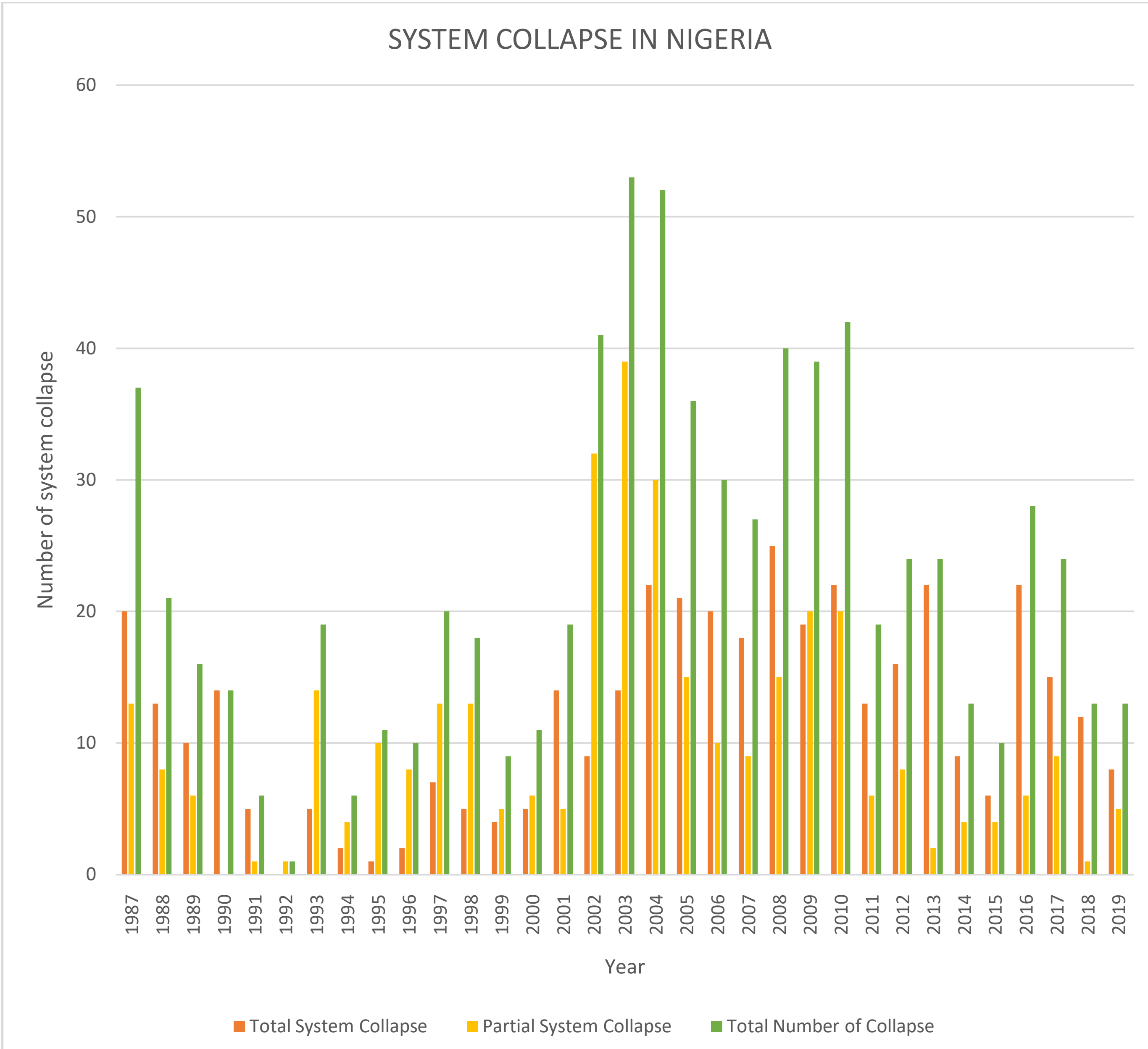

Figure 2.13. System Collapse in Nigeria

Source: Transmission Company of Nigeria, 2019

2.3.3 Distribution Sector

There are a total of eleven (11) DISCOs in the country created after the unbundling of the electricity industry. DISCOs were created on a regional basis and have operational jurisdictions over their regions. Two separate DISCOs operate in Lagos State due to its high level of commercial activity and the remaining nine DISCOs each supply multiple states. Figure 2.14 shows each DISCO and the states they are responsible for servicing while Figure 2.15 shows a comprehensive structure of the Nigerian electricity industry presently.

Each of the DISCOs face similar problems ranging frompoor distribution infrastructure, high aggregate technical, commercial and collection (ATC and C) losses, determining accurate number of customers in their franchised jurisdiction, expansion and development of their network, proper metering of customers as well as settling their obligations in the market.

The distribution network grid mainly operates on 11kV and 33kV which are low and medium voltage level respectively. The distribution network accounts for an extra 12.5% of technical losses before electricity reaches the final end-users. Due to these losses usually referred to as ATC and C losses, most DISCOs can't recoup their ROI since they don't have sufficient electric power and hence, operate at low capacity.

The Aggregate Technical, Commercial and Collection (ATC and C) losses can be simply defined as the sum total of technical losses from the power system network, commercial losses and shortage due to inability to collect the total billed amount for energy sent out (Kirankumar, 2013).

The technical losses occur as a result of the inherent attributes of the equipment and facilities used in the transmission and distribution of electric power.

Commercial losses on the other hand, occur as a result of ineffective and inefficient billing process that are incapable of accounting and capturing all billable energy sent out for consumption.

Finally, the failure of utilities to recoup or recover revenues in conformity with the billed energy results in collection losses[10].

[10]Independent Energy Watch Initiative, 2016. The Nigerian Electricity Tariff and the ATC and C Losses Paradox – Are we paying for Services or Losess?

http://www.iwin.org.ng/index.php/ ndphc/item/2235-the-nigerian-electricity-tariff-and-the-atc-c-l.

Table 2.6 shows information on the DISCOs number of customers, distribution network distance and the distribution network allocation from TCN. Figure 2.16 shows the Electric power transmission and distribution losses (% output) from 1971 to 2014 while Figure 2.17 to Figure 2.27 depict the aggregate technical, commercial and collection losses in all the DISCOs from 2017 to 2019, the most recent update by NERC.

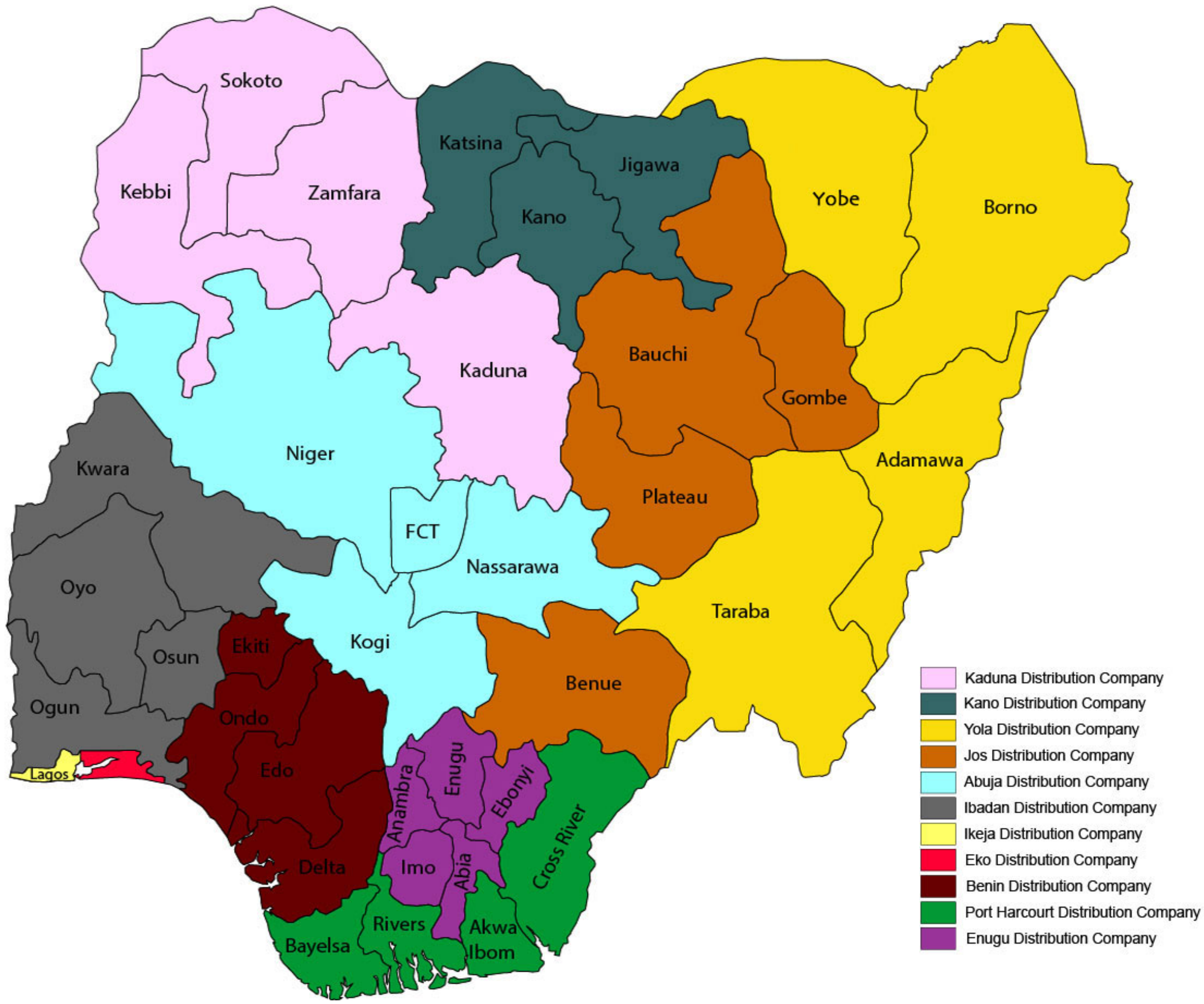

Figure 2.14. Geographical distribution of Nigeria's DISCOs

Source: NERC, 2019.

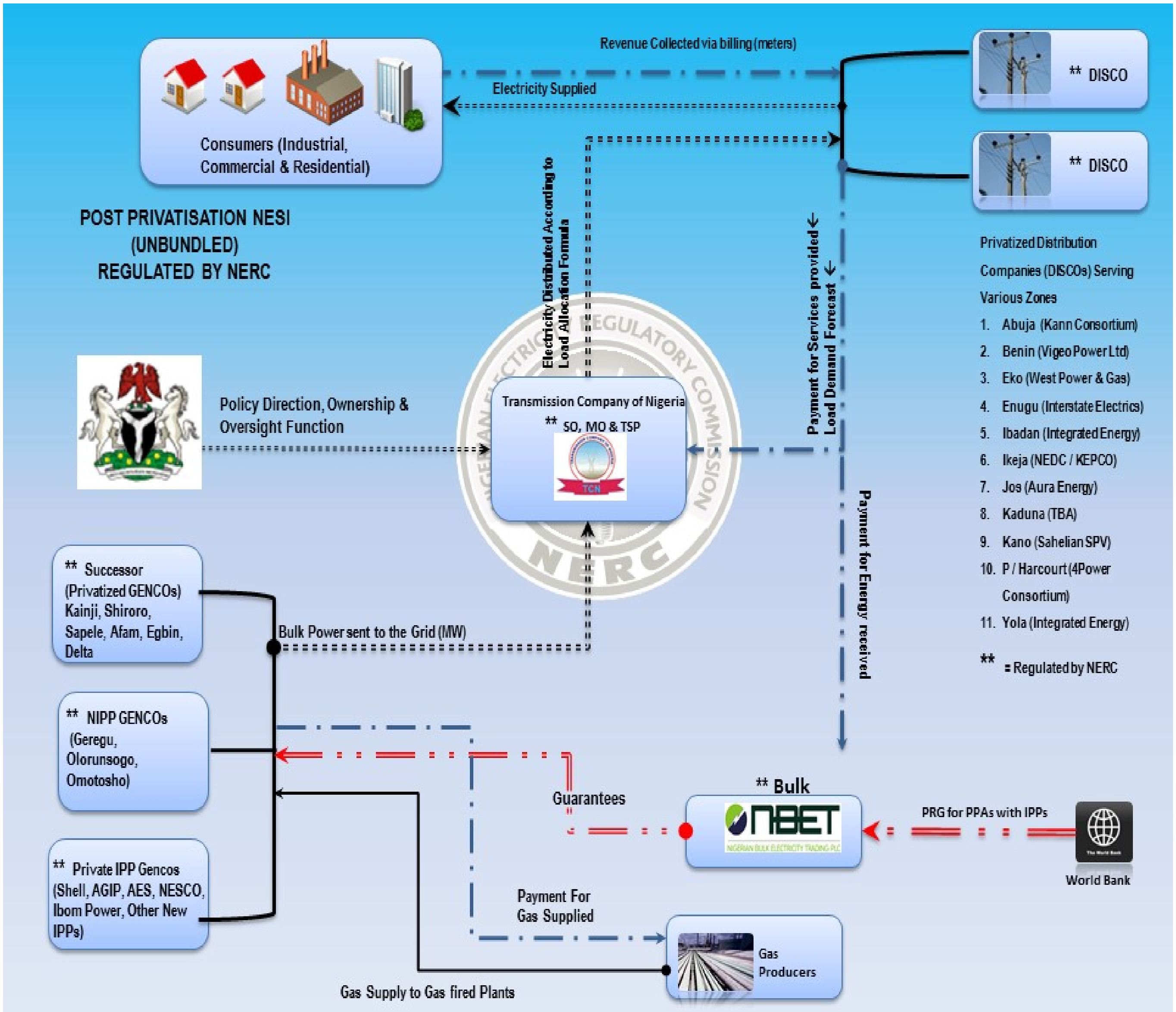

Figure 2.15. A Pictorial Representation of Nigerian Electricity Industry

Source: Nigerian Electricity Regulatory Commission, 2015

Table 2.6. DISCOs Customers, Distribution Network Distance and Energy Allocation

Location	Number of Customers(Thousands)	Length of Distribution Network (Kilometers)	Energy Allocation Variation (Percentage of Network Grid Supply)
Abuja	848,813	107,254	12%
Benin	1,219,925	104,702	15%
Eko	518,289	8,093	13%
Enugu	837,790	25,078	9%
Ibadan	1,558,393	24,355	9%
Ikeja	1,067,386	12,466	11%
Jos	460,152	12,227	8%
Kaduna	436,267	26,653	7%
Kano	590,319	21,041	6%
Port Harcourt	583,869	17,989	8%
Yola	341,118	6,505	4%

Source: NERC, TCN and GET.invest Energy Sector Report, 2019.

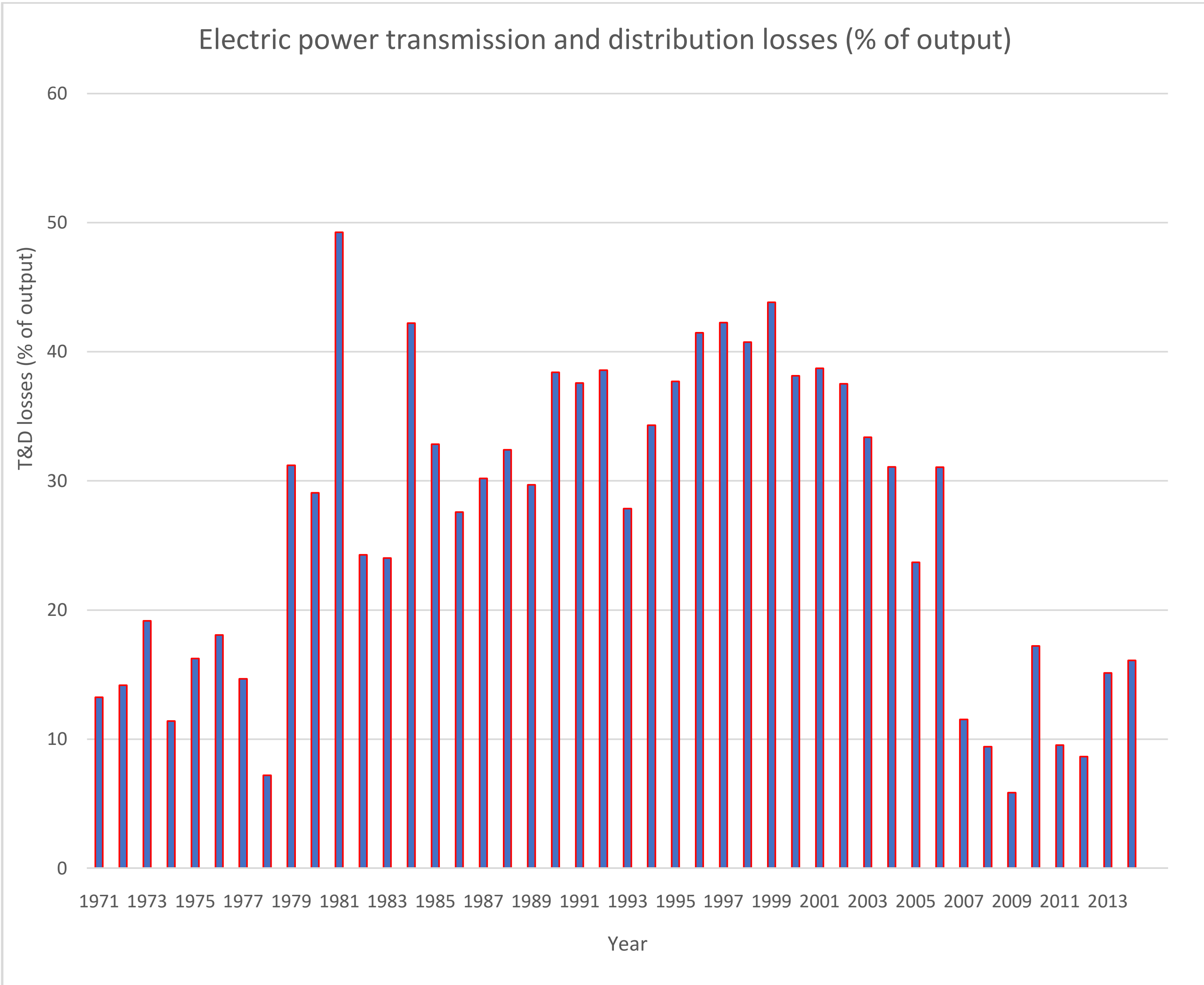

Figure 2.16. Electric Power Transmission and Distribution Losses in Nigeria

Source: World Development Indicator, 2019.

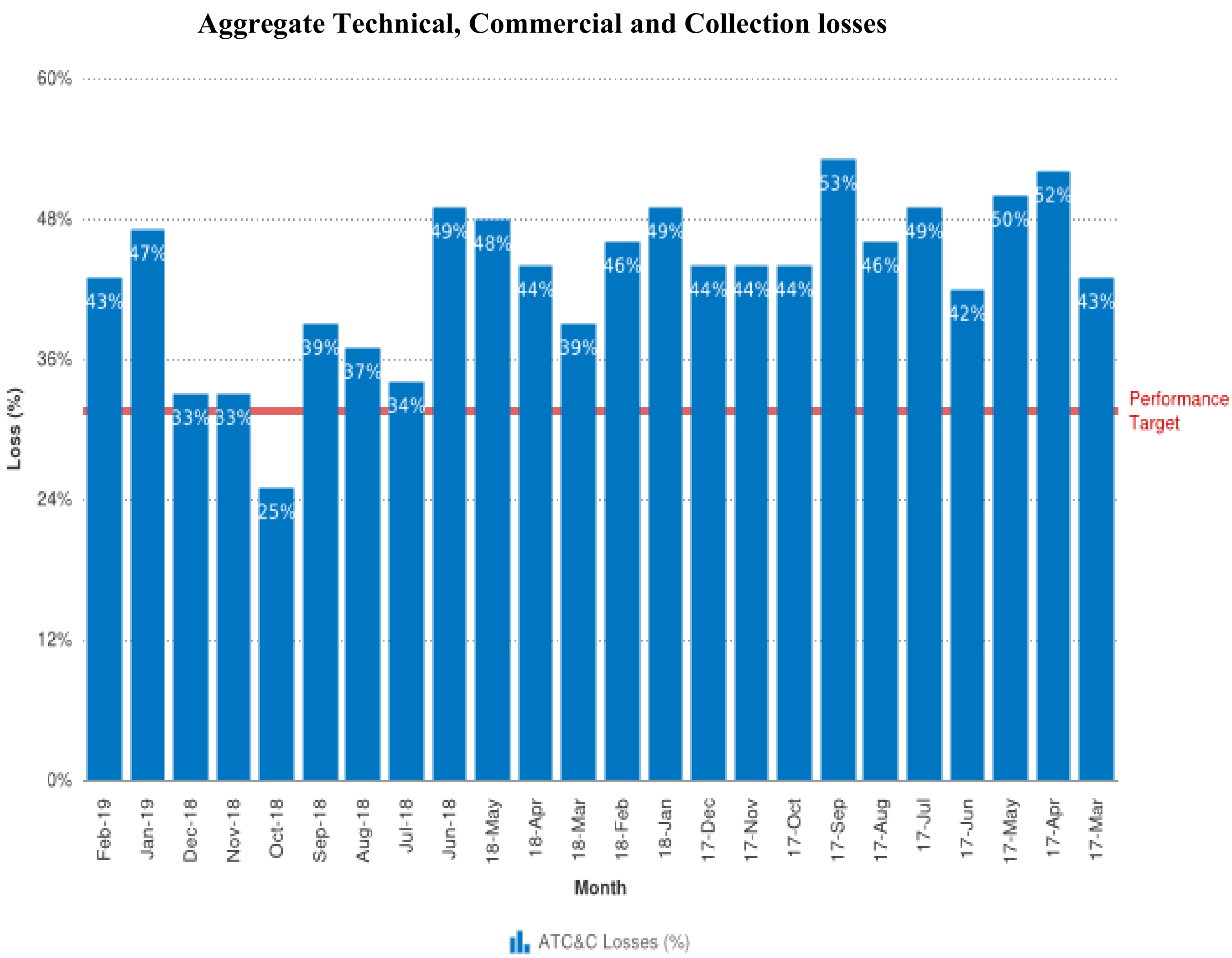

Figure 2.17. Abuja DISCO Aggregate Technical, Commercial and Collection losses

Source: NERC, 2019.

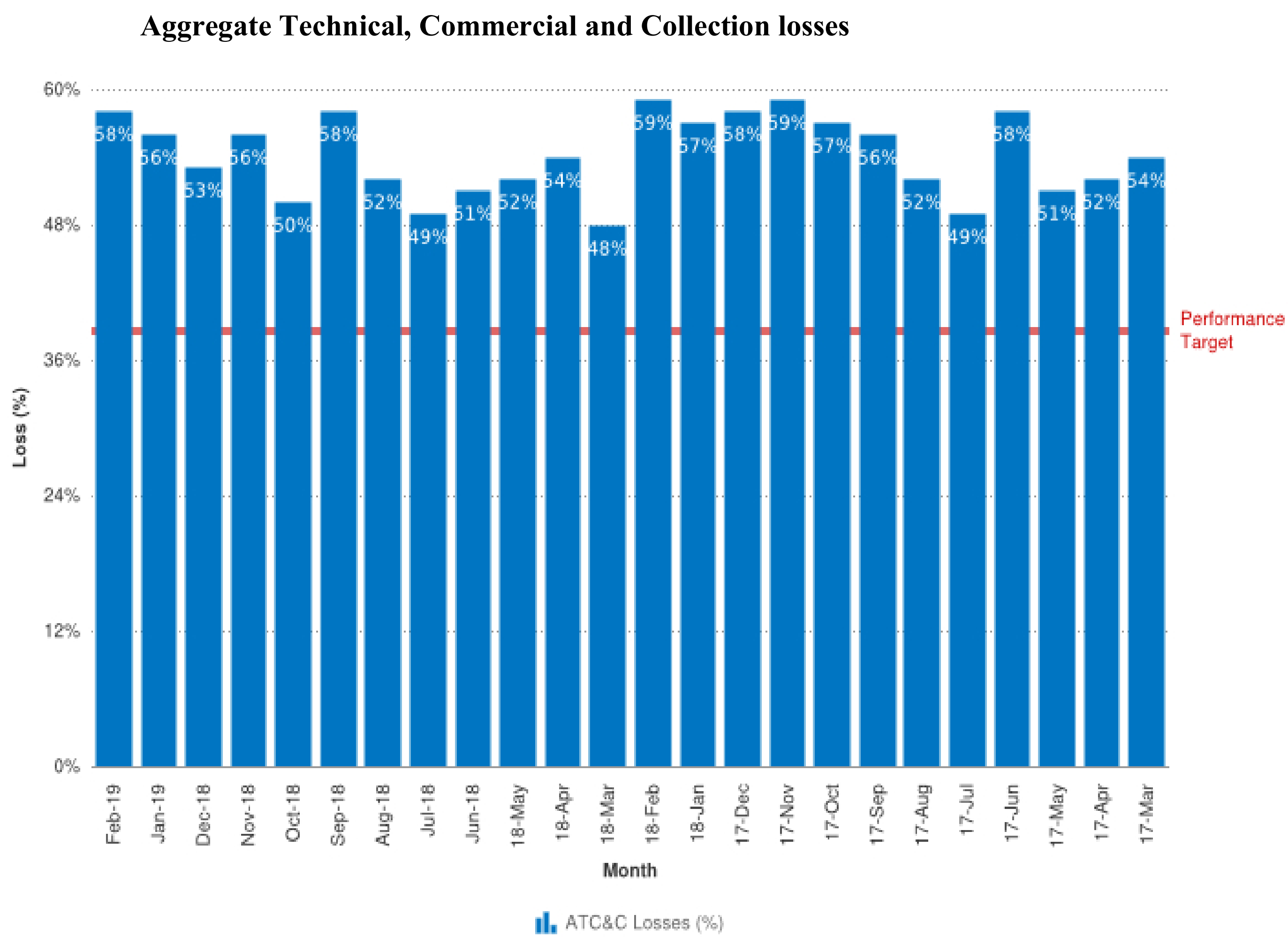

Figure 2.18. Benin DISCO Aggregate Technical, Commercial and Collection losses

Source: NERC, 2019.

Aggregate Technical, Commercial and Collection losses

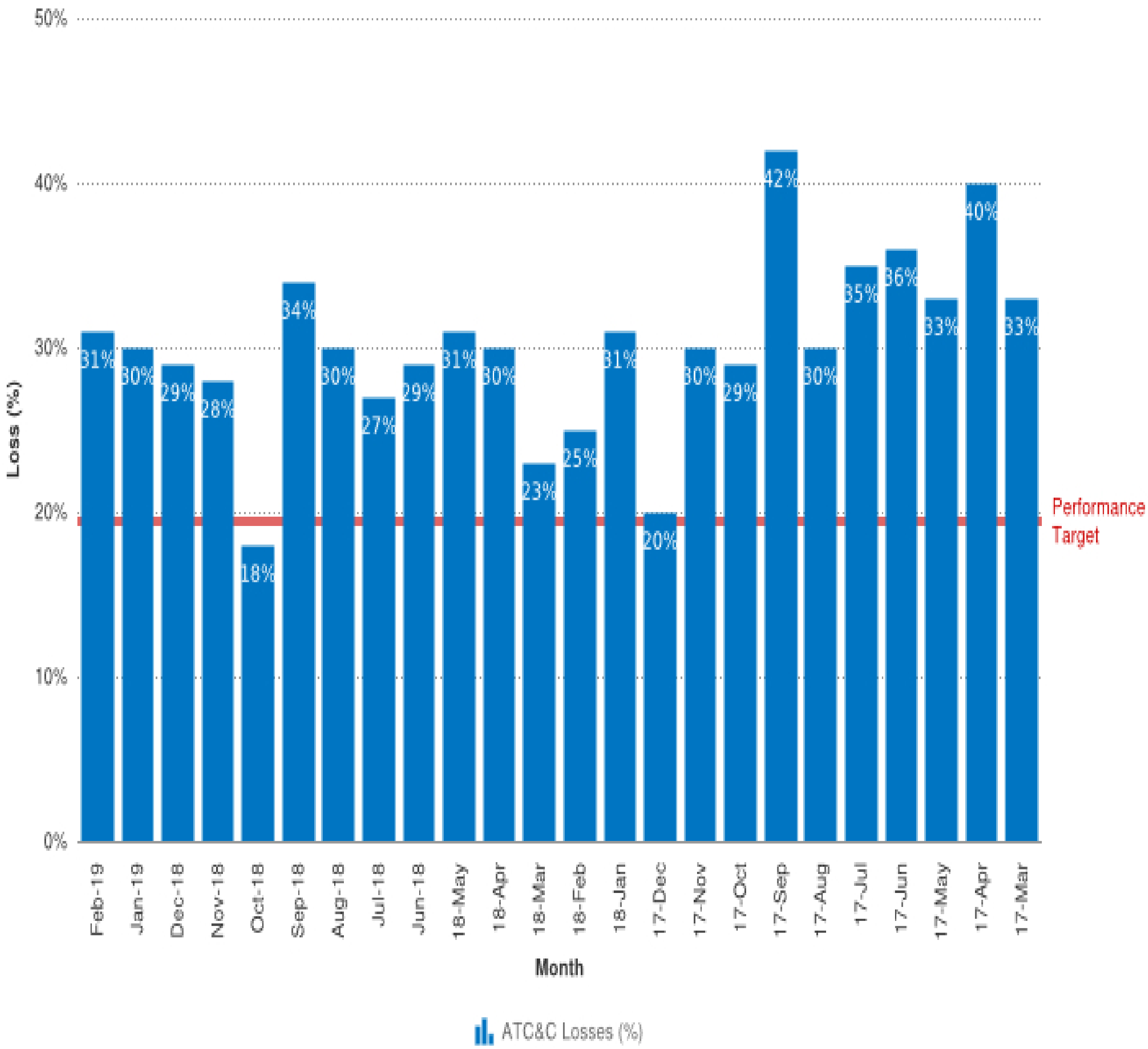

Figure 2.19. Eko DISCO Aggregate Technical, Commercial and Collection losses

Source: NERC, 2019.

Aggregate Technical, Commercial and Collection losses

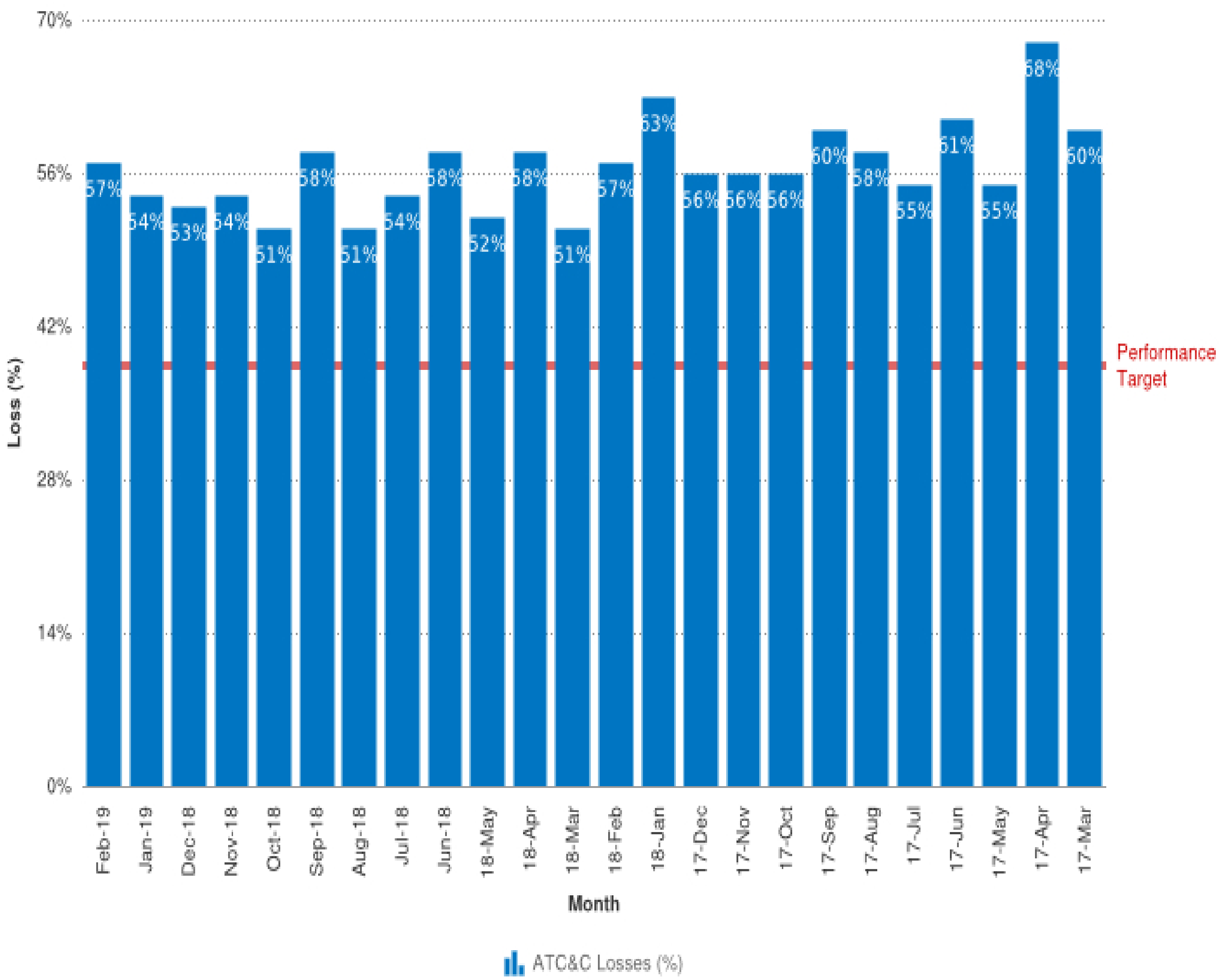

Figure 2.20. Enugu DISCO Aggregate Technical, Commercial and Collection losses

Source: NERC, 2019.

Aggregate Technical, Commercial and Collection losses

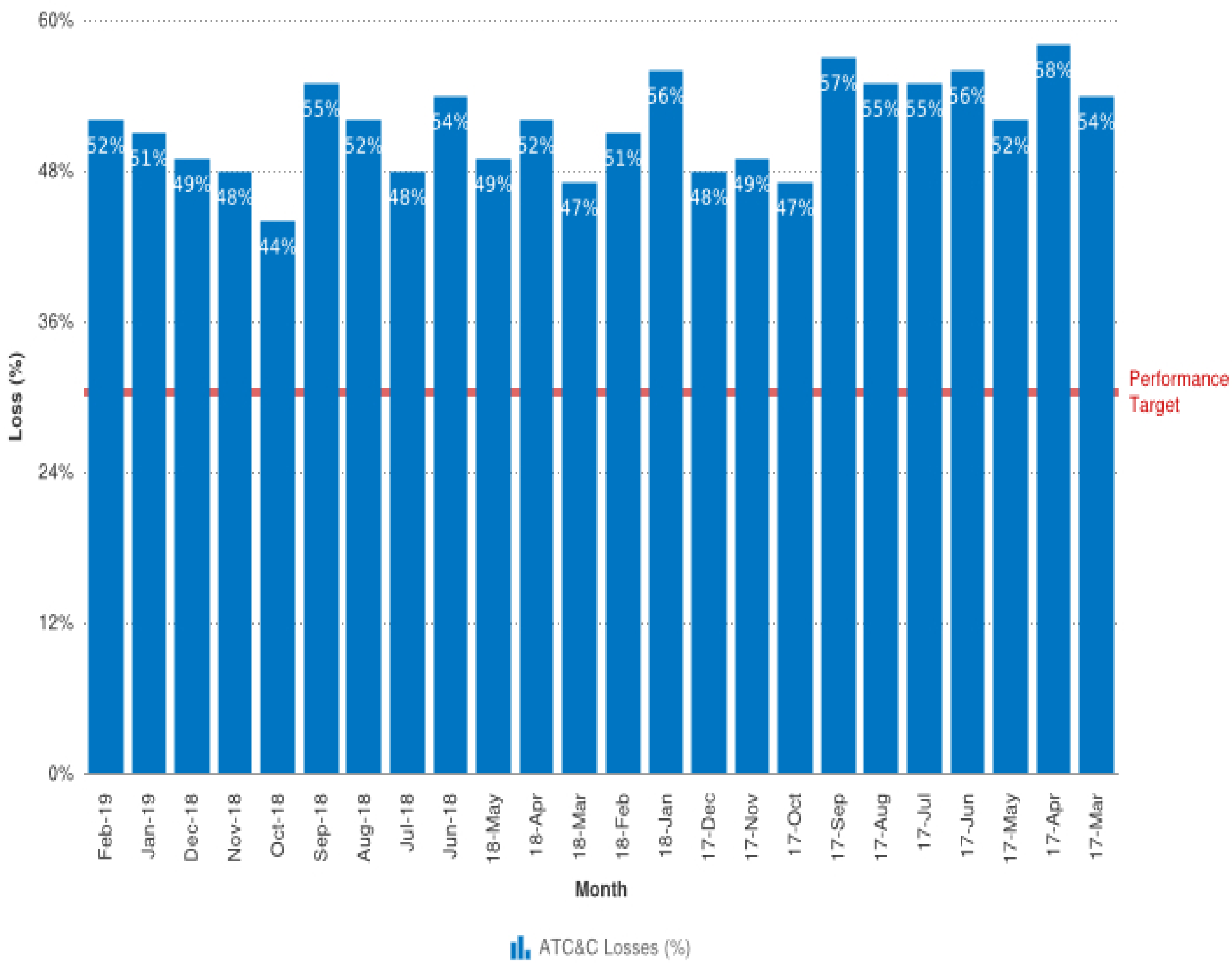

Figure 2.21. Ibadan DISCO Aggregate Technical, Commercial and Collection losses

Source: NERC, 2019.

Aggregate Technical, Commercial and Collection losses

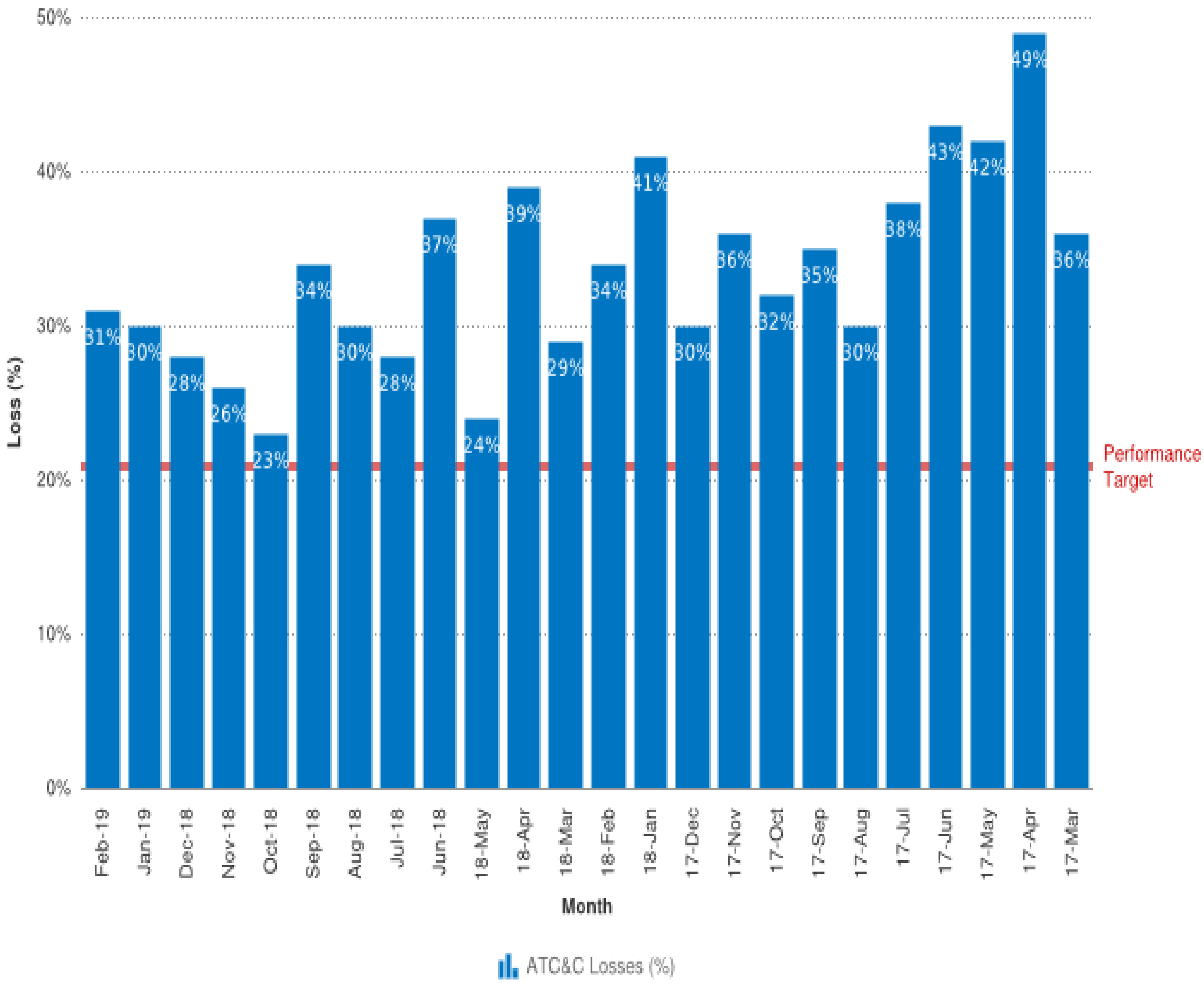

Figure 2.22. Ikeja DISCO Aggregate Technical, Commercial and Collection losses

Source: NERC, 2019.

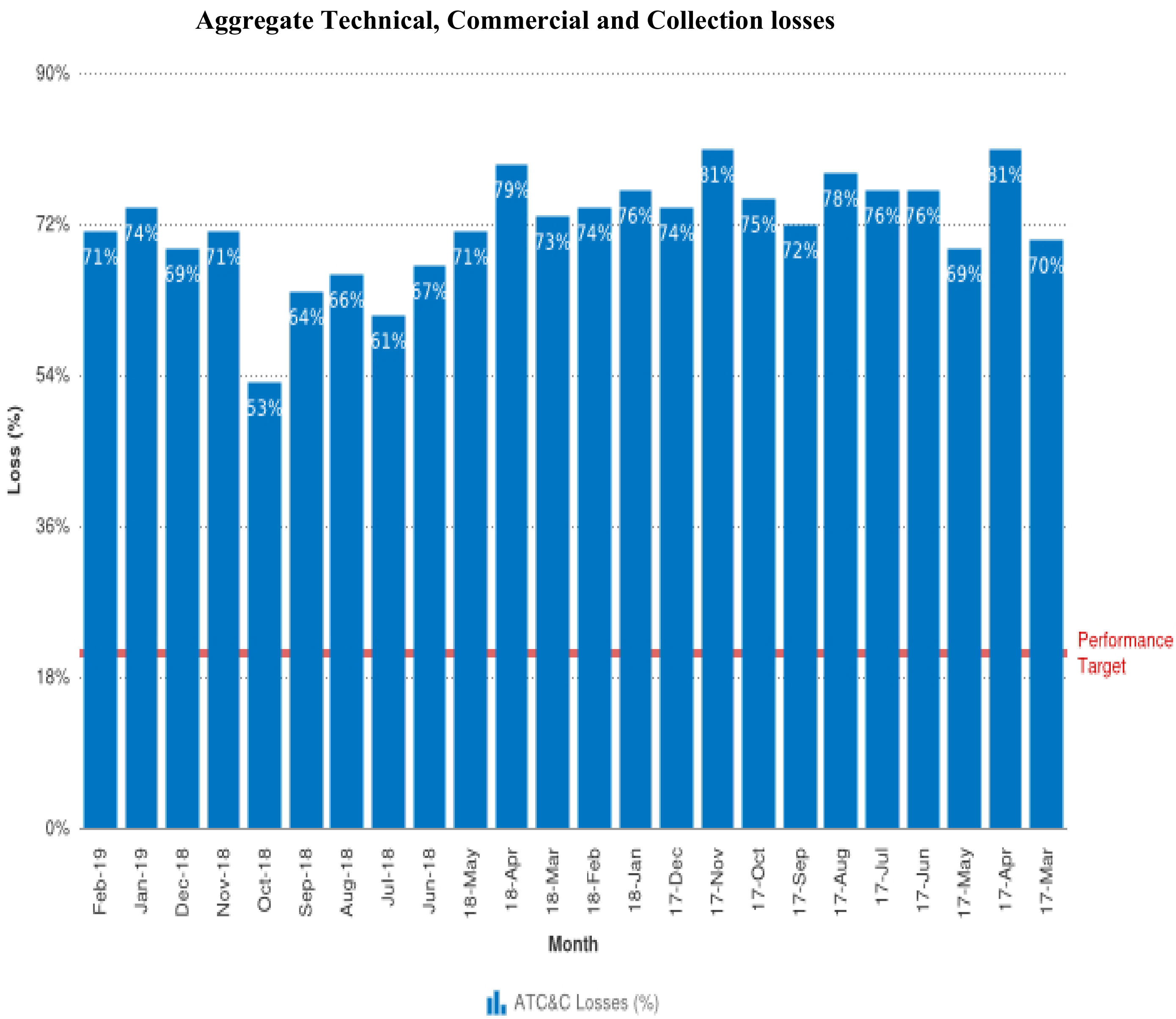

Figure 2.23. Jos DISCO Aggregate Technical, Commercial and Collection losses

Source: NERC, 2019.

Aggregate Technical, Commercial and Collection losses

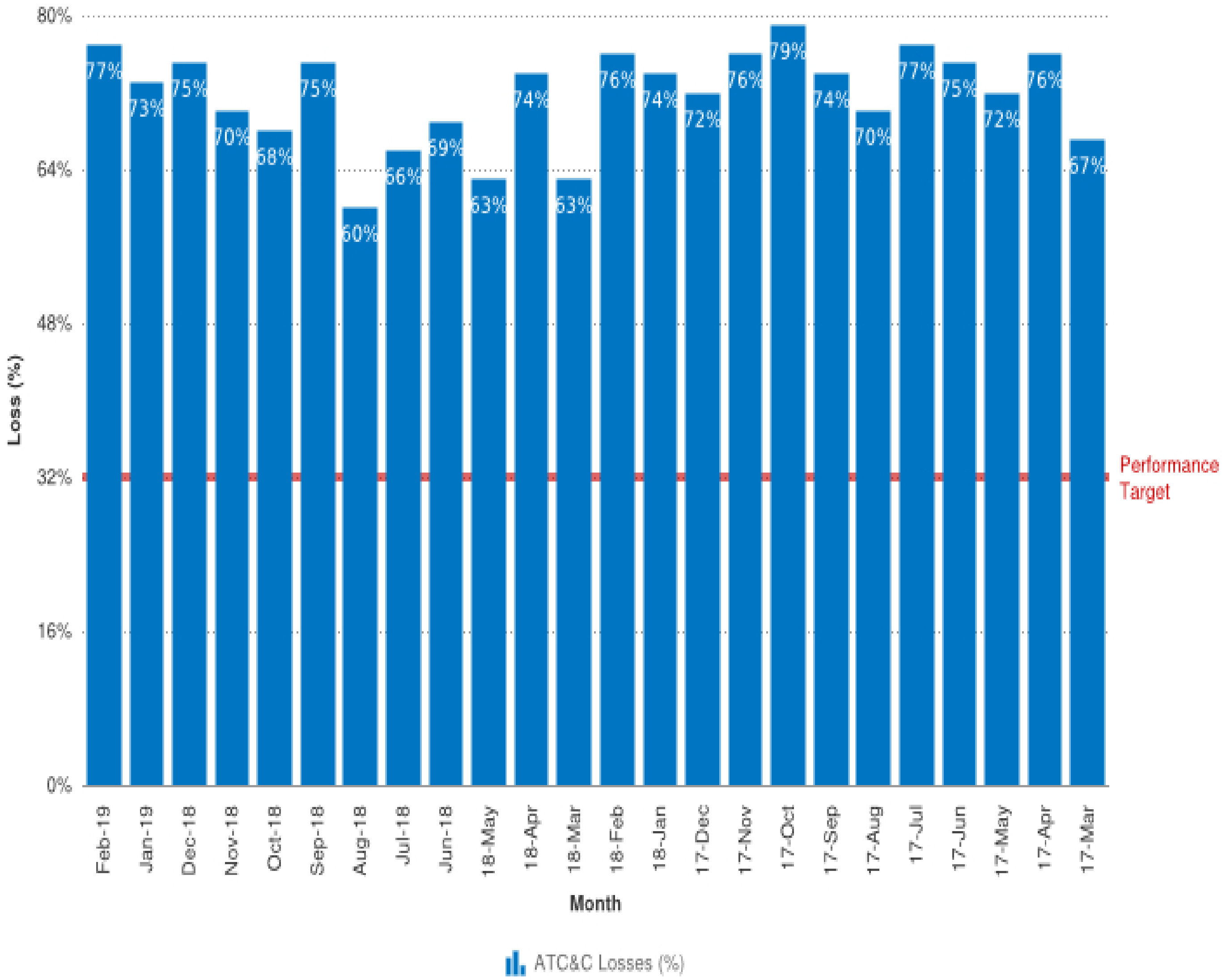

Figure 2.24. Kaduna DISCO Aggregate Technical, Commercial and Collection losses

Source: NERC, 2019.

Aggregate Technical, Commercial and Collection losses

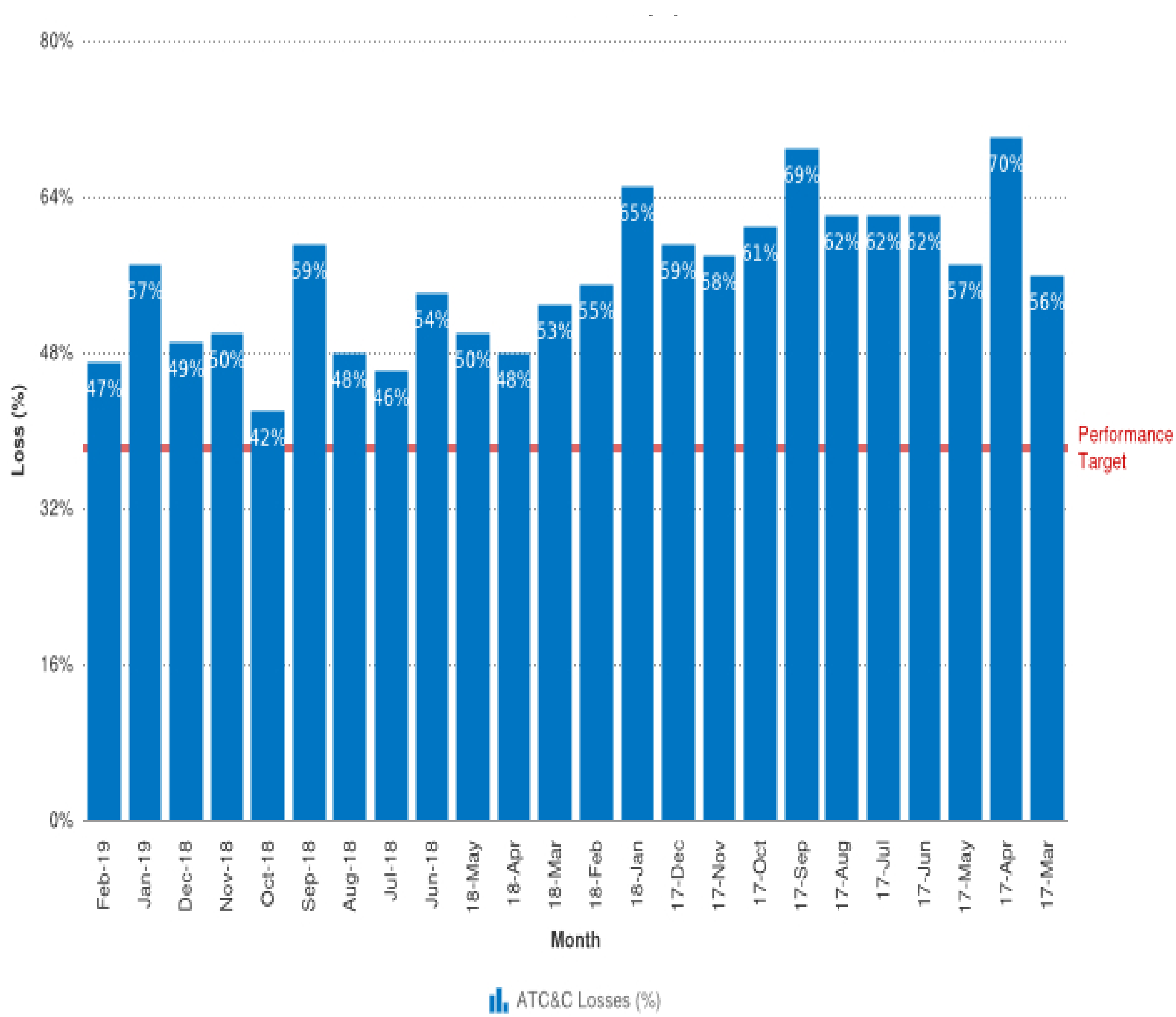

Figure 2.25. Kano DISCO Aggregate Technical, Commercial and Collection losses

Source: NERC, 2019.

Aggregate Technical, Commercial and Collection losses

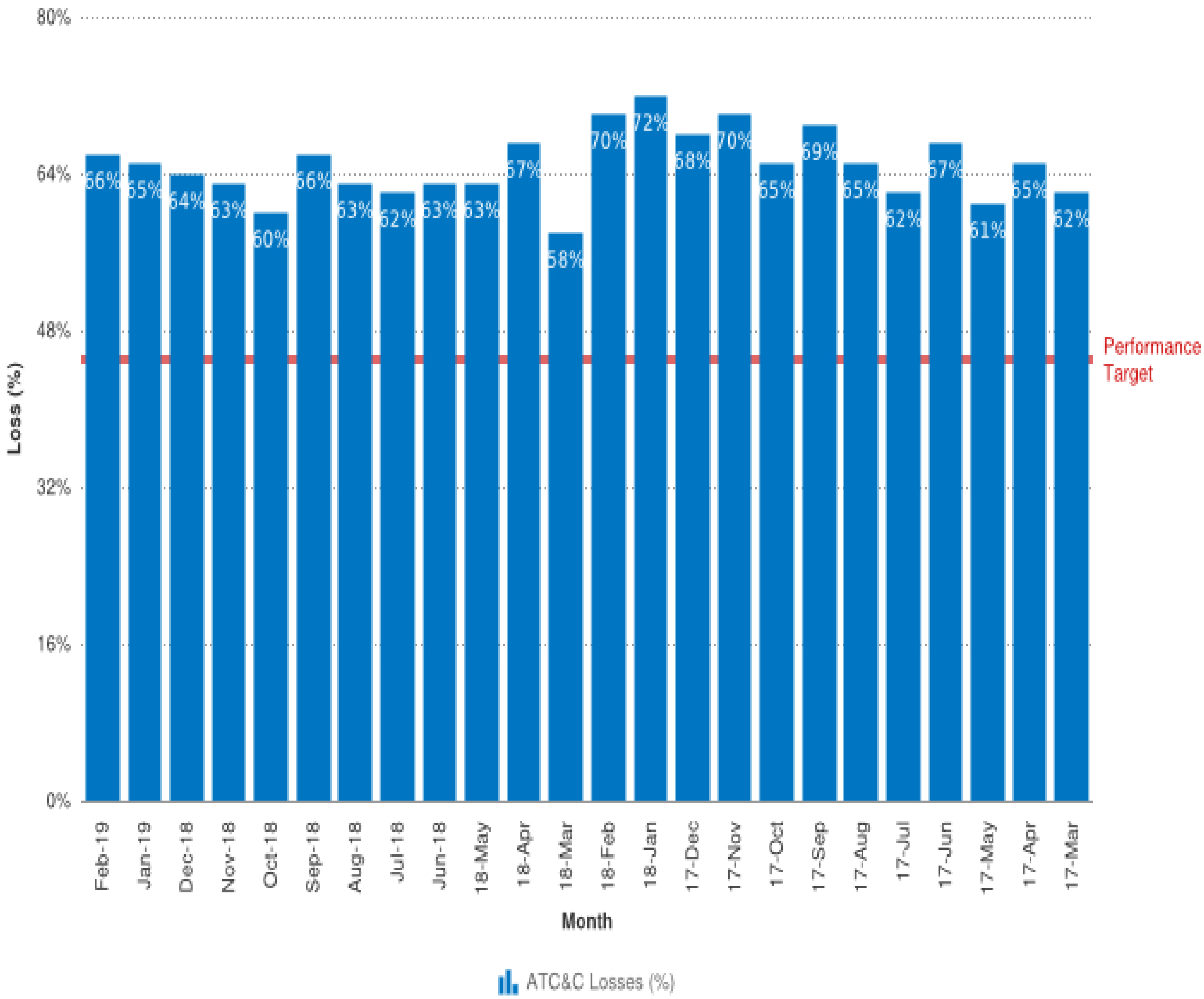

Figure 2.26. Port Harcourt DISCO Aggregate Technical, Commercial and Collection losses

Source: NERC, 2019.

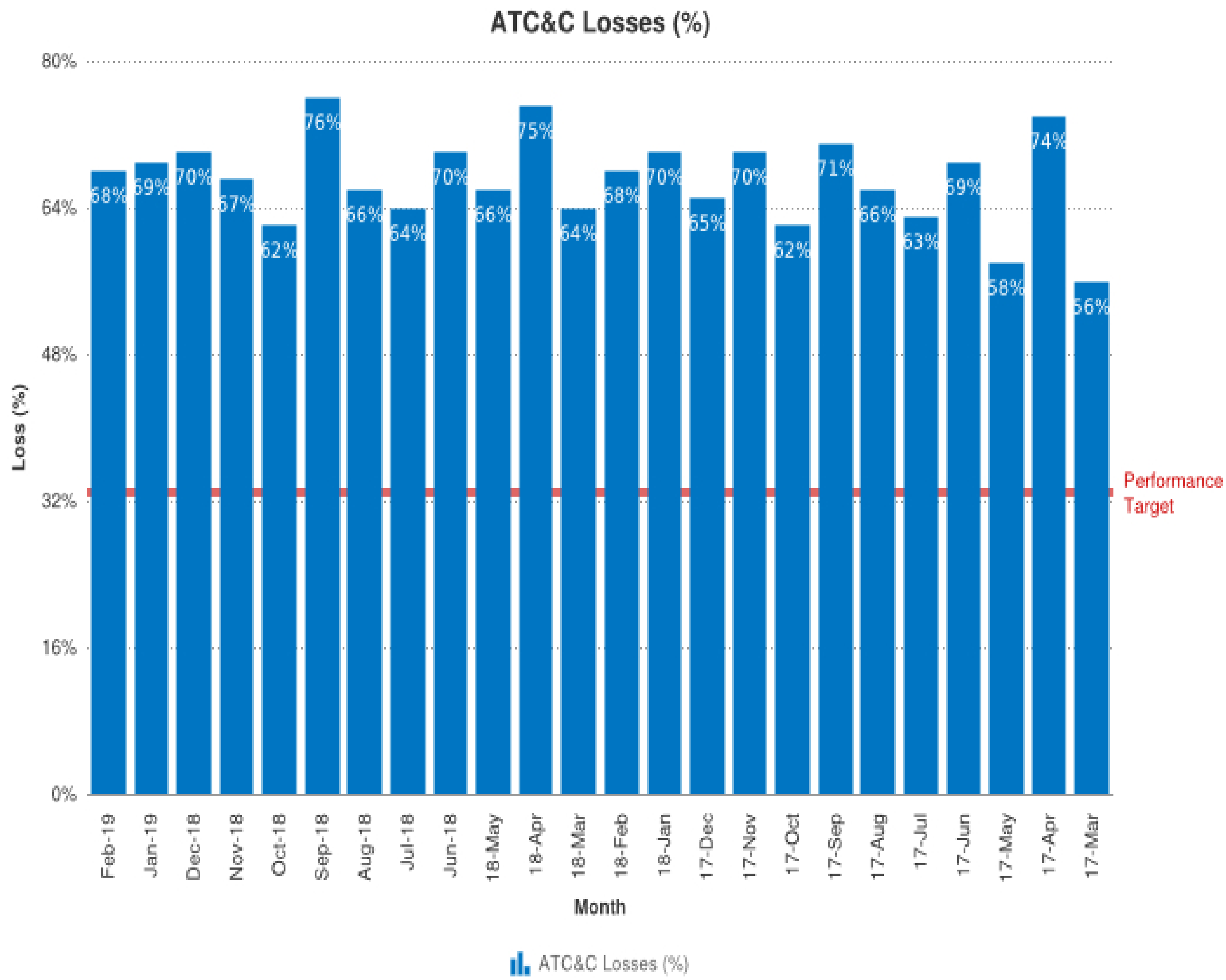

Figure 2.27. Yola DISCO Aggregate Technical, Commercial and Collection losses

Source: NERC, 2019.

From Figure 2.16, there is substantial decline in network (transmission and distribution) losses in as much as network losses began to drop significantly under PHCN, sector unbundling and privatisation have sustained the drive towards global standards in network losses. However, data from the World Bank depict that transmission and distribution network losses in Nigeria are among the largest in the world as network losses are in double digits in Nigeria compared to single digit in other countries. The high level of losses is credenceto the technical inefficiency in the sector. Figure 2.17 to 2.27 depict the ATC and C losses in the eleven operational DISCOs with an average of over 40%. As observed in the above figures, the level of the aggregate technical, commercial and collection losses in most of the DISCOs are high and they are still unable to meet their high-performance target. The only noticeable exception is Eko DISCO with a performance target of less than 20% and they have recorded some achievements in meeting or going below their performance benchmark target as observed in Figure 2.19[11]. Huge investment is required on the DISCOs network to reduce the persistent ATC and C losses.

2.4 Electricity Tariff

Under-pricing of electricity service in Nigeria have been identified as one of the main reasons for the inadequate and unreliable electricity supply across the country (NERC, 2013). This is mostly traced to the power sector's inability to generate enough revenue to maintain and upgrade the existing systems. The electricity industry has been unable to generate sufficient revenue to compensate its operating cost let alone its considerable capital expenditure demands (NERC, 2013). The Transmission Company of Nigeria also suggest that inappropriate pricing contributed in complicating the poorfinancial and operational performance of the supply industry.

An essential part of thegovernment's reform programmeon electricity is tariff increase. Electricity tariffs in Nigeria prior to the introduction of the MYTO, was not reviewed frequently and below the cost of electricity supply because the pricing failed to take into consideration the commercial viability of the power sector. According to Kaitafi (2011), the government total

[11]Eko DISCO have been the best performing distribution company since privatisation with lower ATC and C losses compared to other distribution companies.

control over the electricity industryhad negative effect on electricity tariff. The tariff has been below the cost of electricity supply.

The average electricity tariff prior to 2002 was N4.50 per kilowatt-hour. The tariff was increased to an average cost of N6 per kilowatt-hour of electricity in 2002. In 2008, when NERC initiated the MYTO methodology, the agency made a first attempt to design an effective cost recovery plan/policy. This new tariff order was assumed to ensure cost recovery in the short run (NERC, 2012). In 2008 after the introduction of the first MYTO, electricity tariff was increased to an average cost of N11.20 per kilowatt-hour. This increase which was about 50% higher than the previous tariff was still considered as one of the lowest in the world (Kaitafi, 2011). The tariff was way below the cost of electricity paid in most West African countries.MYTO had a major review in 2012 and the electricity tariff increased by more than 50% again to an average cost of N23.89 per kilowatt-hour(NERC, 2012).

Efficient electricity pricing contributes enormously to optimalperformance of the power sector because it guarantees that tariff is cost reflective (Foster and Briceño-Garmendia, 2008). In order to guarantee long term sustainability in the electricity sector, full costs recovery associated with electricity service must be implemented and achieved.

Most Nigerians are aggravated with the frequent increase tariff by the electricity providers because it does not reflect the quality of electricity supplied. Electricity supply is unreliable, and epileptic and many times, cause irreparable damages to household appliances. Also, the DISCOs do not respond speedily to electrical faults or technical issues even when several complaints have been sent by electricity customers. In fact, there is general poor quality of service regulations. Most Nigerians claim that there was better quality electricity supply in the early 90's when electricity tariffs were moderate and low compared to the present situation. In Table 2.7 below, the average price of electricity between the year 2010 and 2017 when it was last reviewed for all the tariff subclass is presented. Figure 2.28 gives a pictorial description of Nigerian Electricity Tariff from 1970-2019.

It is noteworthy to point out that one striking observation in Table 2.7 and Figure 2.28 is the continuous electricity tariff increase which has not convincingly reflected on the quality of electricity service delivery to end users.

Table 2.7. Average Electricity Price in Nigeria (2010-2017)

AVERAGE ENERGY CHARGES, N / kWh							
	2010	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Subclass	**Energy Charges, N / kWh**						
R1	1.8	4.00	4.00	4.00	4.00	4.00	4.00
R2	5.9	11.87	12.58	14.73	15.46	16.12	29.32
R3	8.9	33.41	33.73	34.49	35.29	36.13	42.41
R4	12.5	30.80	31.46	32.93	34.48	36.08	42.79
C1	9.4	16.77	17.35	18.12	18.94	19.71	35.22
C2	12.3	21.93	22.39	23.22	24.10	24.99	42.24
C3	12.3	35.87	36.03	37.17	38.36	39.61	39.94
D1	9.8	15.72	16.36	17.43	18.46	19.34	36.63
D2	12.9	24.74	25.47	26.55	27.68	28.85	42.97
D3	12.9	22.38	23.06	23.77	24.51	25.28	44.20
A1	8.6	11.69	12.07	12.65	13.18	13.68	34.51
A2	8.6	14.59	15.11	15.80	16.37	16.97	36.80
A3	8.6	19.77	20.65	21.76	22.81	23.90	40.30
L1	6.8	13.14	13.95	14.70	15.47	16.18	31.72

Source: NERC MYTO & Author Compilation, 2018

R1 – R4: Residential customers

C1 – C3: Commercial customers

D1 – D3: Industrial customers

A1 – A3: Special customers

L1: Street Lighting

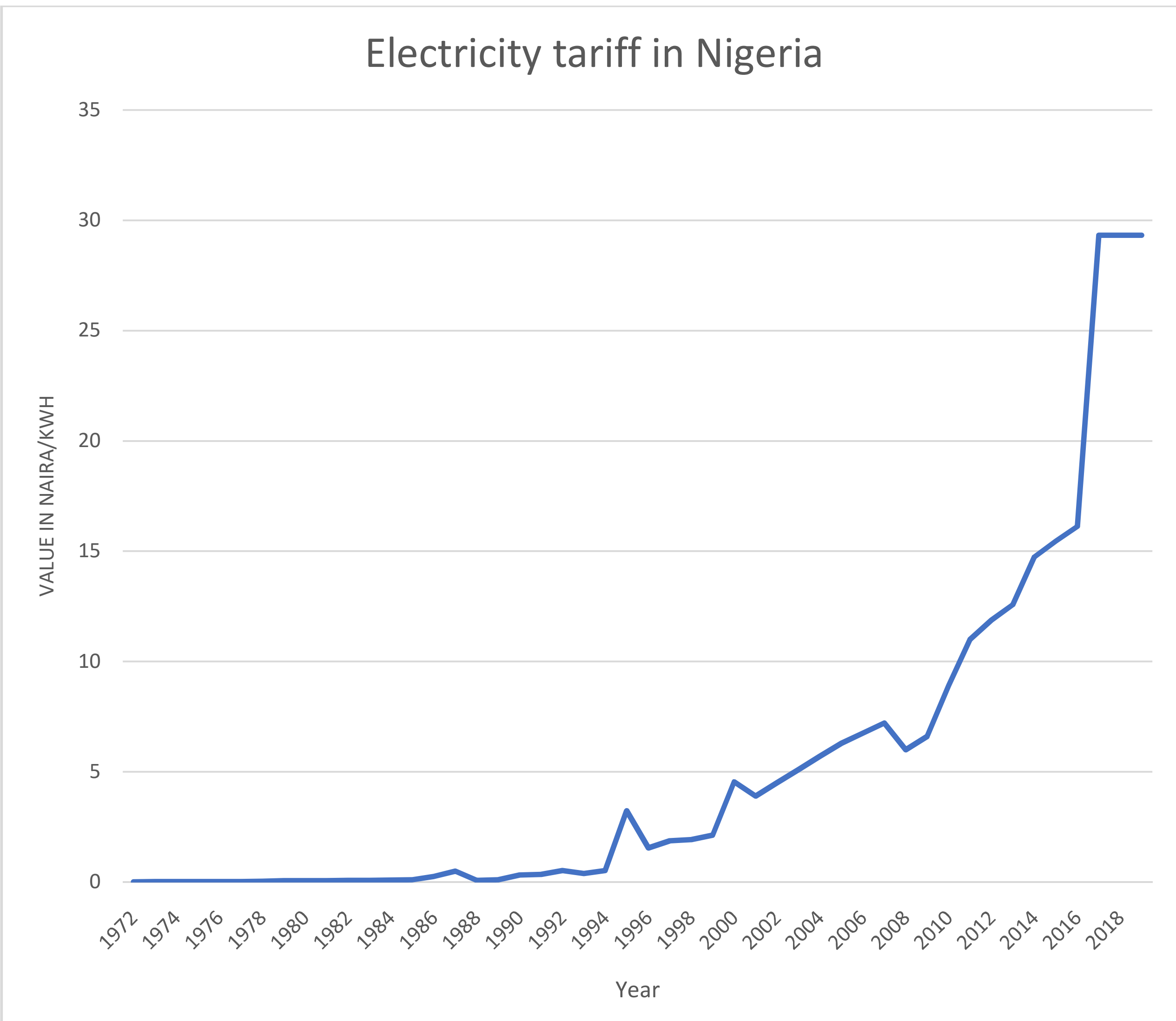

Figure 2.28. Electricity Tariff in Nigeria (1970-2019)

Source: Author Compilation, 2019.

2.5 Quality of Electricity Supply

The utility customers derive from electricity supplied is an important issuein ensuring that the developments and privatisation reforms in the electricity sector continues.

Quality of electricity supply is more than just the availability of the power. Quality of supply has three dimensions, namely: continuity or reliability of supply, voltage quality, and commercial quality.

2.5.1 Continuity of Supply

Continuity of supply is estimated by the number and duration of supply interruptions within a given period of time.This is sometimes referred to as the reliability of supply. It is analogous to the availability of electricity supply (Seršen and Voršič, 2008). This dimension of quality of electricity supply is the most significant for customers since electricity is essentialto accomplish a lot of task. The fewer and the shorter in duration of the occurrence of blackouts or outages, the better the quality ofpower supply from the customers or end users'perspective.

Electricity distribution companies in many European countries are subjected to quality regulation and are penalized if continuity supply standards are defaulted in any way (Fernandes, Candela, and Gómez, 2012). This quality dimension of electricity service is the most critical for customers due to the factthat the availability of electricity is very crucial for the nature of lifestyle in our environment today. Thus, this quality aspect of electricity is usually the main focus of most researches related to electricity quality (Twerefou, 2014; Oseni, 2017)and an important issue in the agenda of energy regulator.

2.5.2 Voltage Quality

Voltage quality incorporates every technical aspect of the distributed electricity excluding power outages(Seršen and Voršič, 2008). It is simply referred to as the usability or usefulness of power supply when there are no power interruptions. In situations when the voltage quality is very poor, diverse problems may emanate in the use of electrical appliances and electrical processes. This quality dimension is typically more intricate to regulate because it comprisesof many quality issues and sequentially each issue has several dimensions.

Normally, voltage quality is more complicated to regulate because itcomprises of many quality issueswhich in turn has several dimensions.The usualmethodin regulating voltage quality is through the means of setting up mandatory values for compliance.

2.5.3 Commercial Quality

This is considered very importantbecauseit involves the directactivities or business dealings involvingthe electricity companies (either Distribution Companies or Generation Companies, or both) and the end users (customers).It encompasses both supply and electricity retail, as well asnumerousmodes of contacts between the electricity companies and customers(Seršen and Voršič, 2008). This dimension of quality electricity supply is very relevant because the end users are highly involved and it affects their level of utility derived. It is basically like the customer service the Distribution companies render to their customers.

This quality aspect of electricity relates to the timely provision of services, the timely repair of faults, call center performance and complaint handling, and may include the following: number of calls unanswered, average waiting time before a call is attended to, percentage of calls abandoned, appointment punctuality, number of complaints received and resolved by category, resolution time by complaint category, billing and metering queries, time taken for new connections; and time taken to repair street lights, transformers or resolve any electrical fault.

This is an important part of electricity that NERC and NEMSA (Nigerian Electricity Management Services Agency) are meant to enforce especially on the Distribution companies for better service performance to the electricity customers. It is well known that the poor, epileptic and unreliable electricity supply has led to the damage of many household appliances, hesitation from the customers to pay electricity bills and even electricity theft.

The use of personal generators as alternative source of power supply in Nigeria is still a temporary solution to the power supply issue until the electricity providers deliver quality electricity supply to the end users(IseOlorunkanmi, 2014).

2.6 Policy Development

2.6.1 Power Sector Reforms

The Federal Government of Nigeria adopted an integrated approach of restructuring the power sector and privatising of business units unbundled from NEPA (Oyeneye, 2014). In 2001, the reforms of the power sector commenced with the adoption of the National Electric Power Policy (NEPP) which paved way to theofficial liberalisation of the Nigerian power sector through the Electric Power Sector Reform (EPSR) Act in 2005. The EPSR Act provided a legal and regulatory framework for the electricity sector.

The reforms under the EPSR Act were to be implemented in successive phases, but has since suffered setbacks. For instance, in as much as the regulators (NERC) gave licenses to private investors to build independent power plants, the tariffs charged were low and made it very difficult to recoup the investment and operational cost. Hence, this situationdeterred new generating capacity investments, and impeded essential upgrades to the transmission and distribution networks.

The law remodeled the entire energy landscape of the country along the value chain with different players for generation, transmission, distribution and commercialization. The law is consideredthe most important legislation in thehistory of the electricity sector.

In an effort to promote renewable energy for electricity generation, the Act mandated NERC to create a leveled playing field in the electricity market through the Feed-in tariff policy mechanism[12]. It ensured that all electricity generated from various energy sources is fed into the national grid, and delivered to the consumers. The Feed-in tariff accelerated investment in renewable energy technologies by offering long-term contracts to renewable energy producers, typically based on the cost of generation from each technology.

2.6.2 The Roadmap to Power Sector Reform

The Presidential Action Committee on Power (PACP) established in 2010, by the President of Nigeriawasobligatedwith driving forward the EPSRprogramme for adequate and reliable electricity. The implementation and monitoring arm of the PACP was the Presidential Task Force on Power (PTFP). PTFP designed the Roadmap to Power Sector Reform in 2010 which was intended to mimic the methodologies applied in the successful reform of the telecommunication industry.

[12]Nigerian Electricity Regulatory Commission, 2015. In 2015, pursuant to its regulatory mandates, NERC established a feed-in tariff for renewable energy-based power generation in Nigeria. https://www.nerc.gov.ng/index.php/home/operators/renewable-energy

In as much as notable progress was achieved in the implementation of the 2010 Roadmap, however, there were issues such as delays in timeline and missed targets due to government bureaucracy.

It also became apparent that some of the assumptions in the 2010 roadmap were more like a mirage and had been too optimistic. The Roadmap Revision 1 review process was basicallycarried out to resolve cases of slipped projections in the 2010 Roadmap.

PTFP released a revised roadmap with new set of realistic assumptions in 2013. For instance, the year 2020 electricity generation target was changed from 40GW to 20GW. This 2013 roadmap is currently the operating manual used for the power sector.

Table 2.8 below shows the PTFP installed generation capacity projections (MW) for Nigeria.

Table 2.8. Installed Generation Capacity Projections (MW) for Nigeria

GENCOS	2013	2014	2015	2016	2017	2018	2019	2020
Successor Thermal	2525	2815	3591	3591	3591	3591	3591	3591
Successor Hydro	1270	1300	1520	1610	1610	1960	3610	4910
NIPP	2909	4259	4771	4771	4771	4771	4771	4771
IPP – A (Existing non-IOC)	429	529	529	529	529	529	529	529
IPP – B (Identified IPP Generation Projects coming on stream)	361	361	455	2870	7246	8970	8970	8970
IOC	1130	1130	1130	2155	3380	3380	3380	3380
Others (Micro Hydro, Renewables and Coal)	40	60	110	110	110	110	110	2110
Annual Addition		1790	1652	3530	5601	2074	1650	3300
Total Annual Capacity	8664	10454	12106	15636	21237	23311	24961	28261

Source: PTFP Roadmap to Power Sector Reform – Revision 1, 2013

2.7 Institutional Developments

2.7.1 Federal Ministry of Power

This ministry is the administrative arm of the government that handles policy formulation and provides general guidelines to other agencies involved in the power sector.

The core function of this Ministry is to develop and facilitate the implementation of policies for the provision of adequate and reliable power supply in the country. In carrying out its functions, it is guided by the provisions of the Roadmap for Power Sector Reform 2010, the Transformation Agenda on Power of the Federal Government and the 2005 EPSR Act.

2.7.2 Nigerian Electricity Regulatory Commission (NERC)

NERC was established by the EPSR Act, 2005. The Commission is an independent regulatory agency obligated to monitor and regulate the electricity sector of Nigeria.

The industry regulator was formed by section 31 of the EPSR Act2005 and is responsible for creating an efficient structure for the market. As the regulator it also manages the relationship between the different parties in the sector. The major objectives of the commission as specified by the Act are:

i. To ensure that consumers experience adequate supply of electricity.
ii. To ensure the safety, reliability and quality of service in the production and delivery of electricity to consumers.
iii. Promoting and facilitating consumer connections to distribution systems across the country by maximizing access to electricity services.
iv. To protect the welfare of consumers by ensuring that the electricity tariff charged by service providers (licensees) are fair to the consumers and sufficient enough to finance the efficient operations of the electricity service providers as well as allow reasonable earnings.
v. To ensure that regulation is fair and balanced for consumers, investors, licensees and other stakeholders.
vi. To setup, bolster and maintain efficient market structures and industry as well as ensure the optimal utilization of resources for the provision of electricity services.

vii. To present quarterly reports to the President and National Assembly on its activities.

Also, the Act empowers the commission to carry out some functions as specified in section 32, which include licensing of persons engaged in generation, transmission, system operation, distribution and trading of electricity as specified by sub-section 2d.

The construction, ownership or operation of generating facilities requires a license from NERC, issued according to the ESPR Act, this is only exempted by captive generation[13]. NERC has the power to issue licenses as obligated by the Act, and the term for the license is clearly specified for a maximum of ten years andfor a renewable, further term of five years. An environmental impact assessment report of the feasibility study of the generatorfrom the Federal Environmental Protection Agency is required by the regulator while applying for a license.

Furthermore, as part of the functions of the commission as specified by the EPSR Act of 2005, section 76(1) of the ESPRA of 2005 empowers the commission to regulate tariff for generation, transmission, distribution and system operation while sub-section 2 of 76, empowers the commission to regulate this tariff according to a set methodology.

In line with the obligations of the regulator, the regulatory commission, NERC has recorded some significant achievements. Some of these notable achievements include the development of the MYTO, electricity industry codes and standards as well as market rules. The electricity network and capacity were also expanded through the issuances of licenses to eligible investors for electricity generation and distribution.

In addition, NERChas ensured that market transactions are rule based with the guidance of the EPSR Act to foster an attractive and stable electricity market in Nigeria. This is made possible by NERC consultation of all stakeholders involved to guarantee accountability, fairness and transparency which are critical to the Commission as an independent regulator.

2.7.3 Nigerian Electricity Management Services Agency (NEMSA)

NEMSAformerly known as the Electricity Management Services Limited (EMSL), is one of the successor companies established by the Federal Government in line with the provision of Part 1,

[13]The EPSR Act defines captive generation as production of no more than 1MW with a distributive capacity of no more than 100kW for exclusive use of the generator.

Section 8 of the EPSR Act 2005, the Supplementary Regulation number 46/47 (B499 452) of the Federal Government Official Gazette No. 374 0f 2010 and the NEMSA Act No.6 of 2015.

NEMSA was mandated to carry out the functions of enforcement of technical standards and regulations, technical inspection, testing and certification of all categories of electrical installations, electricity meters and instruments. Thus, to ensure the efficient production and delivery of safe, reliable and sustainable electricity power supply as well as guarantee safety of lives and property in the Nigerian electricity supply industry and other related matters.

In line with NEMSA objectives, the organization have commenced with regular technical monitoring and evaluation of networks and installations under the eleven (11) DISCOs. This was carried out in order to identify constraints militating against quick realization of the Federal Government's policy and efforts for sustainability of the incremental, stable and uninterrupted supply. NEMSA have recorded notable achievements in identifying high risk and technical loss points along 33KV feeder lines that pose serious threats and dangers to the operational staff and general public for immediate attention and rectification.Also, they have been assessing and evaluating causes of load rejection by the DISCOs, and thus, making recommendations for dealing with the identified challenges.

2.8 The Multi-Year Tariff Order (MYTO) Pricing Mechanism

Section 76(1) of the ESPRA of 2005 empowers NERC to regulate tariff for generation, transmission, distribution and system operation while sub section 2 of 76, empowers the commission to regulate this tariff according to a set methodology. Following from this, the commission in 2008 came out with a methodology which was said to be a cost-reflective methodology called the Multi Year Tariff Order (MYTO).

The MYTO provides a 15-years tariff path for the electricity industry (from 2008 to 2023), with limited minor reviews each year to incorporate any changes in a limited number of variables such as foreign exchange rates, inflation, actual daily generation capacity and gas prices.The minor reviews of the industry's pricing structure aredone twice in a year (usually announced on December 1standJune 1st) while the major reviews are carried out every 5 years, when all inputs are reviewed with every stakeholder involved.

The methodology used to arrive at the MYTO tariff path is known as the building block approach. This approach combines the positive attributes of rate of regulation and price caps. It is a regulation that is known as the incentive-based regulation. The incentives are based on performance thereby encouraging investors to continuously improve their services.

To determine the approach, 3 standard building blocks were used:

i. Allowed return on capital used to achieve a fair rate of return on assets invested
ii. Allowed return on capital used for recovering the capital over the useful life of assets (depreciation)
iii. Efficient operating costs and overheads.

Inputs to the methodology are initial capital valuation and future capital expenditure, operating costs, quantity sold, costs and efficiency improvements.

Prices in MYTO are to be regulated at the beginning but will be expected to reduce over time as competition increases in the market and electricity supply increases to meet requirement. The regulation of the prices will be as follows:

i. Generation will be subject to vesting contracts, with set prices to be received by the generators who do not hold a Power Purchase Agreement (PPA). When the industry matures, generation prices will not be regulated.
ii. Transmission will remain a monopoly and will be subject to tariff regulation.
iii. Distribution also will be treated as a monopoly and its price regulated.

Figure 2.29 below shows a block diagram of how the end users’ tariff is set using the MYTO.

INPUTS TO THE TARIFF

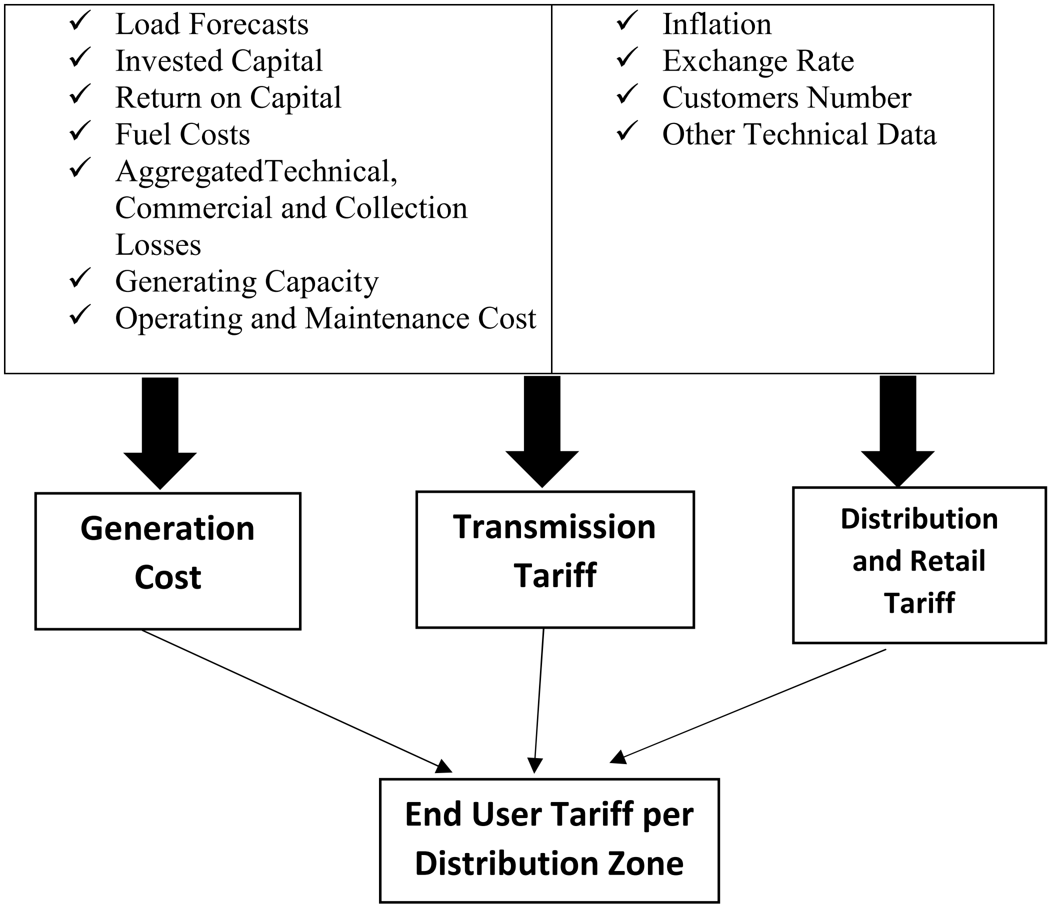

Figure 2.29. Multi-Year Order Tariff Methodology

Source: Nigerian Electricity Regulatory Commission, 2012

From Figure 2.29 above, the total wholesale contract price is calculated for each year as a capacity and an energy charge. The capacity charge comprises of the cost of capital, fixed operation and maintenance cost and two-third (2/3) of tax cost. On the other hand, the energy charge comprises ofthe variable operation and maintenance cost, transmission loss cost, fuel cost and a third (1/3) of tax cost.

The capacity and energy charge are included in the wholesale contract and is the basis for payments to the eligible generators.This wholesale contract price added with the transmission and distribution prices with other charges are used in deriving the end-user tariff which is by the customers. The electricity tariff is made up of all the cost incurred by the all the segments of the electricity supply industry which is divided by the total energy delivered or supplied to the consumers.

The average tariff of electricity over the years has always been a subject of debate as investors see them as unacceptable and cannot attract investment. When checked across all classes of customers, the average tariff of electricity has remained constant over the years at N6.31/KWh or $0.42/kWh till 2008. This tariff has been said to be insufficient to meet operating cost talk less of encouraging investment and plant upgrade.

The Multi Year Tariff Order became effective on July 2008. NERC determined tariff for supply was ₦6.00 per kWh, with the idea that the Federal government will provide subsidy. This basic assumption was that the tariff will gradually reach a cost reflective level by 2011 and this was based on the customer distribution and also the MYTO 1 assumption was based on the fact that generating capacity will increase over the years which will necessitate a decrease in estimated average tariff over the years.

In order to increase the capacity available in the sector, new investments in generation and loss reduction were conceptualized. Also, NERC proposed a gradual introduction of cost reflective tariffs such that tariffs gradually increase to cost reflectivity across 3 years, with no tariff increase in the 12 months of the period until July 2009. The tariff levels were expected to increase to N10/KWh by 2012.

The Government of Nigeria approved the implementation of MYTO and agreed to provide a huge sum of N177.95 billion over the3-years period to finance the Electricity Equalization Fund. The subsidy levels and tariffs were based upon a cost-plus analysis.

In June 2012, a new tariff structure was introduced because it was discovered that some key assumptions that curbed the MYTO 2008 versionwere notfeasible and consequently not met and some other assumptions did not give a proper reflection of the actual operating attributes. Hence, the tariff schedule was not cost-reflective, which was not favorable to new investors.

It was assumed that Nigeria would have attained a generating capacity of 16,000MW of electricity by 2011 with expectations that the revenue requirement of the electricity industry would have been met.The MYTO I assumptions was subsequently subjected to a major review.

In May 2014, NERC announced thattariffs would increase from June that same year following a minor review of tariffs. The reason cited for the review was that there was more than 5% change in some of the 4 variables assessed in the minor reviews and these variables included; inflation rate, actual daily generation capacity, foreign exchange rate and gas prices. Thisminor review gave birth to the MYTO 2.1 which is currently used to determine the tariff for each customer class. The current prices are based on the generating capacity of between 3000 to 5000MW, and this form the basis for determining the tariff pending any further major or minor review. A major review was recently done in July 2019 which will result in a cost reflective tariff due to a lot of changes in the variables involved but it will be fully implemented in 2020.

Since the inception of the MYTO methodology as the framework for determining electricity tariffs in line with the provisions of the EPSR Act 2005, the financial model have ensured that prices charged by DISCOs are fair to customers and are sufficient to allow licensees recover the efficient cost of their business activities whilst earning a reasonable return on the capital invested in the business. NERC will continue to use MYTO though it will be reviewed and evaluated regularly to ensure its integrity and consistency whilst being utilised.

2.9 Theoretical Review of Literature

This section discusses the related theories relevant to the study.

2.9.1 Electricity Demand and Pricing Models

Electricity demand has been modelled after the classic demand theory which posits that the demand for any good or services is a function of the price of the good, prices of substitute and complimentary goods and the consumer's income. The literature on electricity demand has shown that there are some basic factors that affect electricity demand and they include; price of electricity, prices of alternative sources of energy and the real income of consumers (Dutta and Mitra, 2017).

However, other studies have revealed that there are other factors which also influence the demand for electricity. They include; prices of household appliances, temperature, real GDP per capita, industry efficiency, demographic features, population, weather conditions, consumer usage patterns, technology and the nature and stock of electrical appliances (Narayan and Smyth, 2005; Foley,Gallachóir,Hur, Baldick, and McKeogh, 2010).

2.9.2 Individual Choice Theory

Theories of individual choice behaviour conceptualize choice as a function of thecharacteristics of the decision maker, of the set of available resource alternatives and their attributes,and a decision rule. Given a fixed set of alternatives and their attributes, individual choice iscommonly defined in two steps;first, the individual assesses the utility of each alternative and, second, the individual makes a choice based on the decision rule of utility maximization. The concept of utility therefore "assumes commensurability of attributes(Ben-AkivaandLerman, 1985).

Empirical studiesshow that individuals facing an identical choice situation do not always select the samealternative (Thurstone, 1927). Moreover, when repeating the same choiceexperiment,respondents do not always choose the same alternative. Probabilistic choice theory has therefore been proposed as more appropriate approximation of individualchoice processes than deterministic choice theory. Luce and Suppes (1965) distinguish two probabilistic choice mechanisms:Constant utility and random utility.

2.9.2.1 Constant Utility Theory

Individual utility models consist of two steps: first, assessing the preference or utilityof each alternative and, second, choosing the alternative with the highest preference or utility.

Constant utility theory states that the second of these steps should not be regarded asdeterministic, and that choice is a probabilistic function of preferences or utilities (Luce, 1959). For instance, if a decision maker faces three alternatives a, b,and c and attributes to these options the (cardinal) utilities Ua = 70, Ub = 60, and Uc =50.Suppose that this decision maker faces the same choice situation very often, deterministic choice theory would predict that the decision maker chooses alternative ‘a’ in allrepetitions of the choice experiment. Probabilistic choice theory predicts that thedecision maker chooses ‘a’ more often (or, at least as often) as ‘b’ and ‘b’ more often (or, as leastas often) as ‘c’.

2.9.2.2 Random Utility Theory

The random utility theory assumes that the decision makers will always select the alternative with the highest satisfaction or utility. This theory was pioneered by Thurstone in his research on food preferences in the 1920s and later developed by Lancaster (1966) and McFadden (1974).

The probabilistic element of individualchoice lies in the first step of assessing utilities. Probabilistic choice theory in its randomutility form implies that the individuals’ reports of their preferences or utilities is not alwaysthe same under identical conditions, owing to measurement error or to random variation in theassessment of preference/utility by individuals (however, these two situations are formallyindistinguishable). Utilities are not known with certainty to the analyst and aretreated as random variables. Random utility models are commonly used to model the choice among a set of alternatives and have been applied in most studies on consumer preferences and willingness to pay for improved services (Oseni, 2017; Twerefou, 2014; Needelman and Mary, 1995; Abdullah and Mariel, 2010). Thus, this study on households’ willingness to pay for improved quality of electricity supply was anchored on the random utility theory.

2.9.3 Valuation Methodologies on Willingness to Pay

Basically, there are two theoretical approaches developed to estimate individuals’ willingness to pay (WTP) to ensure the sustainability of market goods or publicly funded goods and services such as electricity supply; revealed preference and stated preference.

2.9.3.1 Revealed Preference

The revealed preference approach measures the WTP for a service using actual expenditure data on marketed goods related to the service of interest. This approach infers outage costs based on observed consumer's behaviour. Thus, this principle suggests that the cost of power interruptions may be deduced by the actions taken by individuals in mitigating or reducing losses caused by unreliable electricity supply.

The investment in backup generators and inverters as alternative sources of power supply for instance, show how much households are willing to pay for a higher level of supply security than is currently provided by the network. The aforementioned investment is then used to estimate the cost of power interruptions or outages to the consumers. This approach has rarely been explored in the estimation of the cost of unreliability to households compared to its extensive use in the valuation of the cost of reliability to business ventures (Pasha, Ghaus, and Malik, 1989;Matsukawa, and Fujii, 1994; Serra and Fierro, 1997; Beenstock, Goldin, and Haitovsky, 1997; Adenikinju, 2003;Phaneuf, Kling and Herriges, 1998;Oseni and Pollitt, 2013).

2.9.3.2 Stated Preference Approach

This valuation method is also known as the Expressed Willingness to Pay. This approach relies on survey-based methods and hypothetical scenarios to estimate the consumer's WTP for an improvement in a good or service such as electricity supply.

It is also not always possible to attributeindividual's WTP for a good by observing the costs of their actions taken to avert suffering damages as a result of the loss in the resource. In such cases, people are asked in a survey to express their WTP for a particular commodity or services after they have beenpresented with a hypothetical scenario. Inother cases, they may be asked to make tradeoffs among different alternatives available. Data generated from these surveys are used to estimate individual's WTP for the good, service or given resource (Beenstock, Goldin, and Haitovsky, 1998; Layton andMoeltner, 2005; Carson and Groves, 2007; Carlsson and Martinsson, 2008; Abdullah and Mariel, 2010; Oseni, 2017).

This class of valuation techniques, also known as stated preference approach involves directly asking peoplethe extent of value, they attach to environmental services that are not marketable, and to express or reveal their preferences towards changes in service delivery (Lareau and Rae, 1987).

Methods under this category gives the total economic value of the good or service (measuring both use and non-use values of a resource). Serra and Fierro (1997)pointedout that because these methods are not tied to behaviour, they can be used to value some goods and services that the revealed preference methods may be unable to value. The Contingent Experiment Method and the Contingent Valuation Method are valuation approaches under the stated preference class.

2.9.3.2.1 The Choice Experiment Method (CEM)

Willingness to pay (WTP) is deduced from hypothetical choices or tradeoffs that respondents make using this approach. Respondents are given an array of alternative depiction of a commodity or service and are asked to reveal or choose their preference. This is analogous to real market scenarios where the sellers present the consumers with two or more goods which possess similar characteristics but at different levels of these characteristics. The respondents are given the option to choose whether to buy one of the goods or none of them. In other words, Choice Experiments are a contingent valuation method based on random utility theory and Lancaster's characteristic theory of value which states that; the value of a good is determined by the characteristics that make up the whole (Garrod and Willis, 1999). Choice experiment therefore seeks to find the values for each of these attributes of a particular resource by presenting respondents alternative choices each made of different degrees of the various attributes (Adamowicz, Boxall, Williams, and Louviere, 1998). Respondents are required to either choose an option or maintain the status quo. The analysis of the tradeoffs assists in arriving at the willingness to pay for each attribute.

Choice experiment provides more information about the resource being valued on the whole and the decisions here projects the decisions faced by consumers in real life where they have options of varying attributes from which to choose such as the quality of electricity supply.

2.9.3.2.2 Contingent Valuation Method (CVM)

CiriacyWantrup first came out with the Contingent Valuation Method in 1947 theoretically as a means of eliciting the market value of a non-market good. However, it was first used in a study by Davis (1963) on the estimation of the recreational value of Maine Woodlands in America. Despite this method of environmental valuation being labelled the most contentious approach amongst other techniques, it has become a popular method in research on environmental valuation (Cummings, Ronald, and Laura, 1999; Hanley, Shogren, and White, 2002).

Although this method is extensively applied in the valuation of infrastructure services like transportation, however, only few literatures emphasize on the valuation of electricity service improvement using the CVM approach (Rehn, 2003; Farhar, 1999; Carlsson and Martinsson, 2006; Wiser, 2003;Layton and Moeltner, 2005;Kateregga, 2009; Atkinson, Mourato, Szymanski, and Ozdemiroglu, 2008; Carlsson and Martisson,2007).

The contingent valuation method directly elicits from customers the values place upon any particular good or service while relying on economic theory and survey research approach(Mitchell and Carson, 1989; Carson and Hanemann, 2005).People are offered a given change in the provision of a good or service, in this case the provision of a better quality of electricity supply.

CVM measures the resource value by estimating the willingness to pay of individuals to maintain or keep the resource or the costs of compensating them for the degeneration or total loss of the resource. In effect, this method asks people to directly state or reveal their WTP for a particular good or to improve a particular service or their Willingness to Accept (WTA) to forgo a good or for degeneration in a particular service. Thus, this approach involves asking people directly the value they attach to a particular resource and/or its characteristics. Hence, the method is able to estimate the respondent's consumer surplus for the resource and therefore the maximum amount the resource is worth to the respondent. A hypothetical scenario is used in this method which specify and describe the characteristics of a particular resource and its effects. Individuals (respondents) are required in a designed survey to state how much their household are willing to pay for a certain resource, good or service or how much compensation they are willing to accept if the particular resource deteriorates or totally getslost. This technique is called Contingent Valuation because individuals are required to state their WTP based on a specific hypothetical scenario or assumption and description of a particular resource. The total value of the resource is estimated by taking the average of the individuals' (respondents) values and applying an extrapolation technique on it across the survey area or population. This is an open-ended contingent valuation format.

It has been argued, however, that respondents often find it difficult to assign an appropriate value to the resource on their own. This often leads to a wide range of responses in a survey. In contrast to the open-ended format is the close-ended format of contingent valuation. This is a discrete or dichotomous choice question where respondents are presented with a value and are asked to either respond 'yes' if they would pay that amount or 'no' if otherwise. This typically reflects the choice consumers face in an actual market for a commodity where the good has a price and they either buy the commodity at the going price (yes) or they don't (no).

Other elicitation techniques exist. However, the elicitation technique chosen is dependent on the type of resource that is being valued and the attribute of the sample. Among the common elicitation techniques include:

i. **The Bidding Game Technique:** The technique was first used by Davis in 1963. This elicitation technique involves taking the respondents through a sequence of bids until a negative response comes up and a threshold established. There is a starting bid given by the interviewer to which the respondent either agrees to pay (or accept) or disagrees. The interviewer consistently increases the bid till the respondent answers 'no' to it or keeps consistently decreases the bid till the respondent answers 'yes' to it. The latest bid to be accepted represents the respondent's maximum WTP or minimum WTA. There is a starting point bias in this technique. The situation whereby the starting bid suggested by the interviewer has the potential to ultimately influence the respondent's final bid is what is termed as a starting point bias.

ii. **The Payment Card Technique:** This technique was developed by Carson and Mitchell (1981 and 1984 respectively) as an alternative to the bidding game. This format asks respondents to choose from a range of values which best suits their maximum WTP. This approach doesn't provide a single starting point and thus eliminates the starting point bias as found in the bidding game. However, biases may arise as a result of the ranges used on the cards.

iii. **The Discrete Choice Technique:** The discrete or dichotomous choice techniqueisalso known as the referendum format or take-it-or-leave-it format (Bishop &Heberlein, 1979). This approach asks the respondent to either agree or disagree to an amount stated by the interviewer. The amounts given are varied across the sample. This is what most consumers face in actual markets and hence, are familiar with this system. This is also called the single bounded dichotomous choice. This method makes the respondents' task easier similar to the bidding game but this excludes the iterative process component of the bidding game. The setback with this method is that more observations are required for the same degree of statistical exactness in a sample estimate.

iv. **Single and Double Bounded Voting Game:** This approach is also referred to as Discrete Choice with a Follow-Up approach.It requires respondents to answer 'yes' or 'no' to an amount regarding their WTA for a particular resource. A 'yes' response draws out a follow up question with a higher amount while a 'no' response attracts a follow up question with a lower amount this time round. This approach though gives the survey process significant gain in efficiency, but still has the limitations observed under the discrete choice technique. After all, this is just the same as the discrete choice; only with follow up questions. Additionally, the follow up questions gives this format some semblance with the bidding game and thus suffers from the limitations of the bidding game especially the starting point bias.

Some of the biases that are likely to confront the use of CVM as a valuation technique include:

i. **Starting Point Bias:** The starting point bias results when the starting bid given by the interviewer goes to ultimately influence the final response given by the respondent. This bias is best minimized by varying the starting bid among the sample. This way, the interviewer is able to investigate the influence of the starting bids on the final WTP.

ii. **Strategic Bias:** This bias emanates when respondents intentionally understate their WTP or downplayor understate their WTA. Sometimes also, WTP may be overstated especially if the respondents are aware that they will not be asked to pay for the resource but their responses are merely being used to get a value for the resource after which the government will provide the good. Respondents are likely to overstate their WTP if they want the good provided or may understate it if they do not want the resource provided. A discrete choice format where 'yes' or 'no' responses are required for differing amounts within the sample may minimize this bias.

iii. **Hypothetical Bias:** Hypothetical bias results from a poor understanding of the hypothetical scenario created from which WTP questions are asked. If respondents misunderstand the scenario or the scenario is misrepresented by the interviewer, it will lead to responses that do not match the hypothetical scenario hence biases. This can be minimized by well explaining the hypothetical scenario and avoiding any ambiguity whatsoever. Hypothetical bias may also arise because people may respond differently to decisions drawn from assumptions compared to how they make actual decisions.

iv. **Interview and Compliance Bias:** Interview bias arises from the conduct of interviewers that tend to influence the responses given by the respondents in a survey. Compliance bias arises when respondents tries to give answers that they think may gratify or please the interviewer. These biases can be minimized by training interviewers well to adhere to the principles of conducting an effective survey.

v. **Non response Bias:** Non response bias results from the fact that some sample members do not respond and yet they have values for the resource which may be different from those given by respondents. This has the tendency to bias the overall value placed on the resource.

vi. **Information Bias:** Information bias usually occurs because respondents may be asked to value thecharacteristics of a resource for which they have little or no knowledge of. This means that the information that they are given to the respondents will have substantial influence on their responses.

However, despite the likely biases that may arise when the CVM is employed, there are effective ways by which to reduce or eliminate them in some cases as have been discussed. This makes it less costly to use the CVM since the potential biases may be dealt with as opposed to the earlier valuation methods discussed whose biases may be difficult to overcome.

A major advantage that the contingent valuation method has over other methods of valuation is its ability to estimate and measure the total economic value (use and non-use values) of a particular resource (Johannesson, Liljas, and Johansson, 1998). This is due to the fact that it allows respondents to consider both the use values and non-use values of a resource to them before making any decision on the maximum amount they are willing to pay for the resource or willing to accept for the decline of that particular resource. CVM is also the most widely used because it is widely applicable as Hanley et al. (2002) posited. According to Pearce and Turner (1990), the CVM is the only acknowledged technique for finding the value of many non-market benefits especially their non-use values.

Compared to other methods especially revealed preference methods, the CVM has an advantage. It is flexible enough to allow for the creation of hypothetical market scenario. These hypothetical scenarios may go beyond observed market behaviour and thus helps to measure existence values that are not related to the consumption of other goods.

These are the reasons why the CVM is the valuation method employed in this research.

2.9.4 Willingness to Pay (WTP) and Willingness to Accept (WTA)

There are two Hicksian measures of utility change developed by Hicks (1941) which can be applied in studying the value attributed to a resource, good or service in a contingent valuation survey. They are; compensating variation and equivalent variation.

Compensating Variation is the change in income that would 'compensate' for a change in price of a resource. It is the maximum amount that an individual would give up for a good or service to keep his utility constant.

Equivalent Variation is the change in income that will be 'equivalent' to a proposed change in price of a resource. It is the minimum amount that an individual would be willing to accept to forgo a resource, good or service or lose some part of the resource.

Table 2.9 below is a detailed cross table of Hicksian measures of utility change:

WTP and WTA may provide different values for the same commodity change. WTP for a resource is often lower than WTA compensation to forego the same resourceand it is often difficult to measure WTA accurately in contingent valuation (Bishop et al, 1983).

Due to this, researchers have often times always focused on WTP in assessing the value of a resource.

Table 2.9.Hicksian Monetary Measures for the Effects of a Price Change

Price Change	Compensating Variation	Equivalent Variation
Price rise	Willingness to accept compensation for the change occurring	Willingness to pay for the change not occurring
Price fall	Willingness to pay for the change occurring	Willingness to accept compensation for the change not occurring

Source: Perman, McGilvary, and Common, 2003.

2.9.5 Incorporating Quality of Supply in Electricity Pricing

Inadequate and unreliable electricity services to consumers is at the core of the Nigerian electricity supply dilemma. This issue is linked to the inefficient nature of the electricity network infrastructure and the electricity tariff level charged consumers, which in turn further impacts the financing capability of the industry to fund the investment required to meet the huge shortfall in supply (Iwayemi, 2008). The poor electricity narrative in Nigeria evident in the persistently inadequate and unreliable electricity services to consumers despite numerous reforms further confirms the economically inefficient ways resource allocation problems in the industry are handled.A crucial concern is electricity tariff not providing appropriate signals to electricity economic agents (sellers and buyers) as suggested by economic analysis. Electricity tariff has not been allowed to play its role of incentivizing investors and suppliers along the value chain to invest in and supply adequate and reliable electricity services to consumers profitablyand also induce consumers to use electricity efficiently.The need to emphasize economic efficiency along the value chain cannot be overemphasizedin reforming the reform process in the industry to move to a new trajectory characterized by adequate and reliable electricity supply to consumers. Tariff to consumers should reflect the real cost of supply to the consumer (Passey, Haghdadi, Bruce, andMacgill, 2017). One of the main reasons why load shedding and quality of supply have defied solutions for almost 40 years is because successive effort has neglected the role of cost-reflective tariff in eliminating unreliability of electricity service to consumers.

Figure 2.30 depict the role of pricing in the elimination of capacity shortage that underpins load shedding and power outages. When demand rises sharply and exceeds available capacity, load shedding and unreliable supply will loom due to shortage of available capacity along the value chain to meet demand as shown in Figure 2.30. Thus, when demand exceeds supply, the market will no longer be in equilibrium and power outages and load shedding occurs. No market-clearing price exists to balance supply and demand. Capacity addition or expansion to bridge the demand-supply gap is required to deal with this situation. To prevent load shedding, investors must be incentivized to invest in supply adequacy and reliability by setting the price at P2. This will result in the required capacity addition to close the supply-demand gap GH that will eliminate supply interruptions due to load shedding arising from inadequate capacity. Pricing at value of lost load measured by the willingness of consumers to pay to avert power outages provides an efficient solution to load shedding and poor quality of supply (Iwayemi, 2018)[14]. Consumers WTP for uninterrupted and good quality electricity supply is an important issue because it incentivized and guarantees the investors investment returns (Oseni, 2017).

[14]Value of lost load is the average value of the MWh lost by customers during an outage.

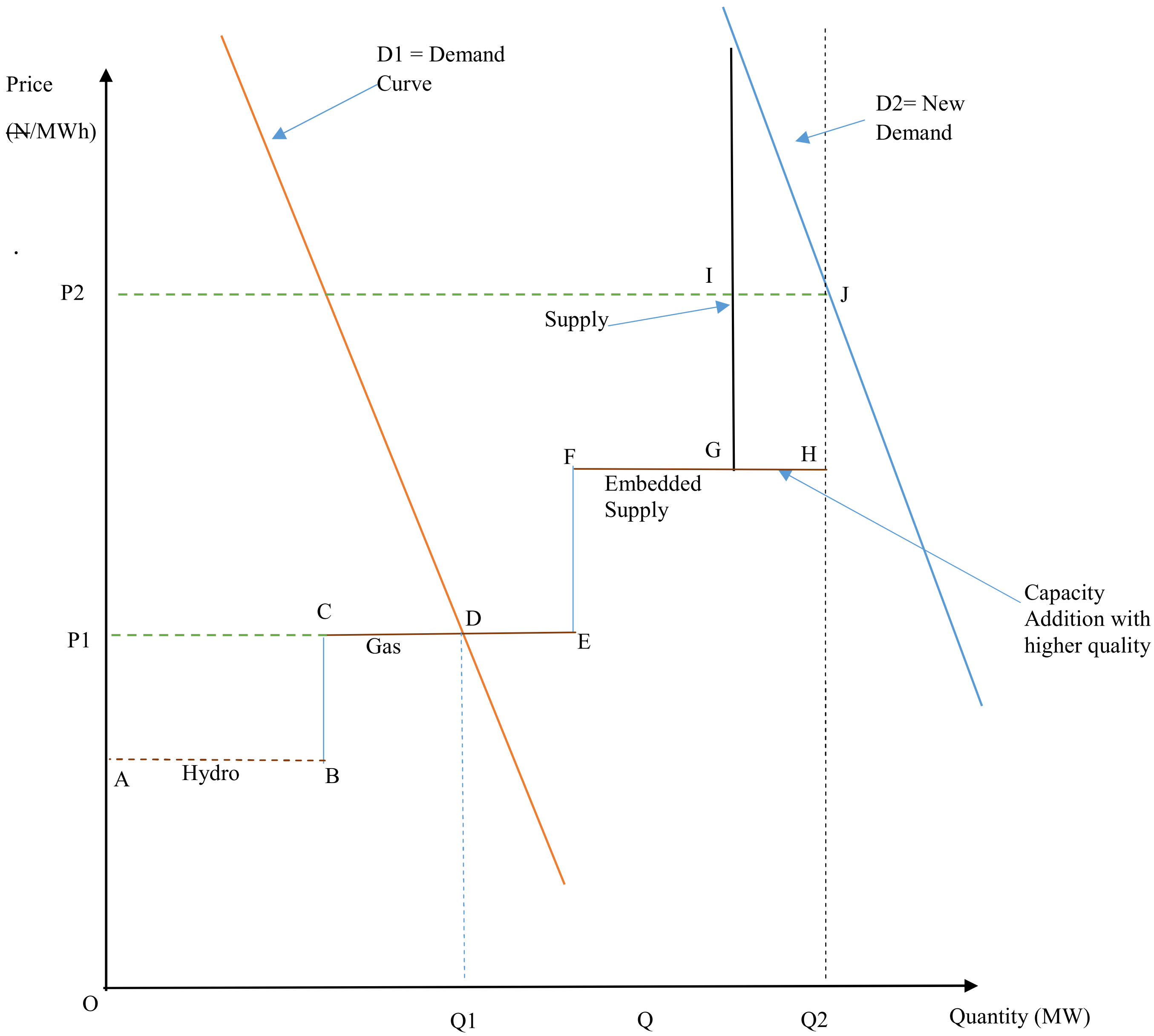

Figure 2.30. Putting Quality of supply in Electricity Pricing

Source: Iwayemi, 2018 [15]

[15]Adopted from Iwayemi (2018) paper "Reforming the Nigerian Electric Power Industry - The Challenge to Economic Theory"; Putting reliability (quality of supply) in electricity pricing.

2.10 Review of Empirical Literature

This section highlights the relevant empirical literature related to this study in line with the objectives.

2.10.1 Welfare Effect of Quality Electricity Supply

Salmon and Tanguy (2016) conducted a study on Nigerian households to investigate how electrification affects labour supply decisions in Nigeria. A survey method and an instrumental variable strategy analysis were employed in the study. The results of the study revealed that quality electricity supply or reliable electrification increases the working time of household especially the men, hence, improving their living standards.

Tagliapietra et al (2020) conducted a study in Nigeria to provide a better understanding on the impact of good electrification on outcomes of the labour market. The study employed the propensity score matching, probit and biprobit estimation techniques. Results from the study affirmed that reliable electrification have relevant impact on labour market outcomes. The results further revealed that there is a significant increase on employment rate and labour market participation with the improvement of electricity supply.

Oseni (2012) carried out a study on Nigerian households to examine their access to improved electricity service and consumption pattern. The study revealed that the current state of electricity supply is very poor despite the abundant natural resources in Nigeria. One obvious inference from the study is that access to adequate and good quality of electricity supply is crucial to sustainable economic development of the country, hence, improving the welfare and standard of living of its citizens.

Bhattacharyya (2013) carried out a research in some selected countries in Sub-Saharan Africa. The study employed a survey method for its analysis. Results from the study revealed that the Sub-Saharan Africa region lags behind significantly in terms of adequate and reliable electricity and this negatively affects the standard of living and welfare of households within the region. The study further inferred that weak governance, poor organizational structure as well as weak investments have contributed in creating these weak outcomes.

2.10.2 Estimates and Drivers of Willingness to Pay for Improved Quality of Electricity Supply

Carlsson and Martinson (2004) carried out a study on households in Sweden to investigate their WTP to avoid power outages using the Discrete Choice Experiment method. The result observed was that households were willing to pay more to avoid any power outage the longer the duration of the outage. Another significant result identified in the study was whether outages were planned or unplanned. By planned outages, households are notified in advance about an impending power outage; unplanned outages referring to the opposite. Specifically, the authors reported that in cases of planned outages, the Swedish households were willing to pay 6.30 SEK (Swedish Krona) to avoid an hour outage and 189.25 SEK to avoid awhole day outage. In the case of unplanned outages, the sampled households were willing to pay 9.39 SEK to avoid a one (1) hour outage and 223.01 SEK to avoid a whole day outage.

Oseni (2017) carried out a study on households in Osun and Lagos State, Nigeria to investigate the extent to which self-generation might affect household's WTP for reliable electricity service. A survey method, interval data model, and a regression analysis were employed in the study. He observed that owning a backup generator tended to increase households' willingness to pay. Specifically, the author reported that an increase in N1 (naira) in self-generation's fuel cost every hour is associated with a WTP of N5.22 more in the monthly electricity bill.Households' WTP for improved reliability was between N24.47/kWh to N26.1/kWh of electricity which was less than the marginal costs of reliability from self-generation within the price range of N44.04/kWh and N66.88/kWh.

Also, Babawaleand Awosanya(2014) examined the WTP for improved electricity supply in Lagos Metropolis, using two medium-income public residential estates. The study employed the contingent method, conjoint analysis, multivariate analysis and the 'payback period' analysis. The results showed that WTP for improved electricity services in the Millennium Estate is affected by household size, household income, number of days households use their generators within a week, and the cost of running generator. One obvious inference from the study is that sustainable electricity supply to the housing estates under reference through private sector participation is presently not feasible

Twerefou (2014) conducted a study on households' WTP for improved electricity supply in Ghana. The Contingent Valuation Methodwas employed in his analysis.Result from thestudy showed thatGhanaian households were willing to pay on the average a sum of ¢0.2734 (Ghanaian cedis) per kilowatt-hour of electricity which was about a 50% increase on what they were paying. The study revealed that factors that determine household's willingness to pay for uninterrupted power supply weregender, householdincome, size of the household and the level of education of the household head.

Abdullah and Mariel (2010) carried out a study on the WTP to avert power interruptionsamong rural households who had access to electricity in Kisumu District, Kenya. The choice experiment valuation was employed in the study and a mixed logit estimation technique was used to determineseveral socioeconomic and demographic factors that influenced WTP. The study reported that some households in the surveyed district are willing to pay above their monthly electricity bills to improve electricity supply while others are not prepared to pay any more money above the monthly bills they paid at the time. It was further revealed that the decision of a household to belong to either of the categories depends on factors such as employment status, age, duration oftime a household has been living in the district under consideration, family size, ownership of a bank account or otherwise among others.

Also, Kateregga (2009) employed the CVM to determine the cost incurred by consumers on power outages in three Ugandan suburbs. Open ended questions were asked to 200 households in each suburb alongside payment cards. The Tobit model was used to analyse the effects of socioeconomic factors on households' responses. The results of the study revealed that only a few households were willing to pay significant amounts to avoid the inconveniences that come with the outages despite the cost they incur during these outages. It was also revealed that the factors that influenced households' WTP were electricity as the major source of cooking fuel, household income, and substitution costs.

Ozbafli and Jenkins (2015) examined households' WTP for an improved electricity service in North Cyprus and theCVM was employed as the estimation technique for 350 households. The probit model was also employed and they observed that households were willing to incur 13.5% increase in their monthly electricity bills to avoid outages. A Cost Benefit Analysis was further employed to analyze the economic benefits of improved reliability of the electricity service yearly.

Pepermans (2011) conducted a study on Belgian households to determine the value of uninterrupted electricity supply. The study revealed that electricity supply is very reliable in Belgium and consequently, power interruptions are not the norm of the study area. Using the choice experiment approach, it was established that on average most household types will be willing to accept as much as €30.00 - €50.00 to have just one additional power outage per year. Additionally, the study estimated that the average household's willingness to accept a minute increase in the duration of a power outage was in the region of €0.30 - €0.60 per minute.

Morrison and Nalder (2009) conducted a study on willingness of businesses to pay for improved quality of electricity supply across different business type and locations in Australia. The Choice modelling with random parameters logits model was employed as the estimation techniques. Their results showed that rural/regional business were willing to pay more than businesses located in the metropolises. Also, the manufacturing businesses were also willing to pay more than the service businesses for improved quality supply. However, the Choice Experiment method used in their study limits the respondents' choice range on the exact amount they might be willing to pay or accept.

2.10.3 Gaps in the Literature

Regarding placing monetary values on the costs of erratic power supply, both Carlsson and Martinson (2004) and Pepermans (2011) agree that their respondents were willing to give up significant amounts to avoid power outages or willing to accept significant amounts for the occurrence of power outages. Both studies have as a strong determining factor, the duration of the outage. The findings of these two studies conducted in Sweden and Belgium interestingly deviate slightly from those conducted in African countries (Uganda, Nigeria and Kenya). In terms of WTP in the context of the developed countries, households have high WTP to avoid the costs they face when electricity supply is cut. A high value is placed on constant flow of electricity by residents of the more developed economies.

In terms of the most significant determinant, income was a key factor in influencing WTP within the African context whereas within the context of the more advanced economies, the major issue was on the duration of the outage rather than income (Kateregga, 2009; Abdullah and Mariel, 2010). This may be due to the fact that in the more developed economies, having continuous supply of electricity is deemed an absolute necessity; not at all an option irrespective of the income or social status of a person. Therefore, WTP for improved electricity in developing countries is most likely to be highly dependent on the income levels of the people as Kateregga (2009) and Abdullah and Mariel (2010) rightly inferred.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the theoretical framework applied in this study, data types and sources, sample design and related issues as well as analysis method employed.

3.2 Theoretical Framework

The underlying economic theory adopted in this study is the random utility theory pioneered by Thurstone in his research on food preferences in the 1920s and later developed by Lancaster (1966) and McFadden (1974). This study assumes a Random Utility Model (RUM) in which utility provided to individual *i*by good *j,* U_{ij} is a function of observed attributes of the individual and of the good being consumed as well as a function of an unobserved stochastic error term e_{ij}. The indirect utility function associated with this utility function may be written as:

$$U_{ij} = U_i (Y_j, V_j, e_{ij}) \dots\dots\dots\dots (3.1)$$

Where Y_j is the disposable income for household j, V_j is the vector of observed attributes of the household and their choices, and e_{ij} is the unobserved error term of the indirect utility function.
A proposed payment Y_i* is introduced which changes the attributes of the resource such as the quality of the resource (in this case, the improved quality of electricity supply). The consumer will agree to the payment proposed if only the utility derived from the improved state is greater than the utility derived from the status quo.
Symbolically, if

$$U_{ij} (Y_j – Y_i^*, V_j, e_{ij}) > U_{ij} (Y_j, V_j, e_{ij}) \dots\dots\dots\dots (3.2)$$

Where Y_i * is the particular amount the household is willing to pay for the proposed upgrade or improvement in the resource. The probability that a respondent will answer yes is an indication that he prefers the proposed improvement. Therefore, for the jth respondent, the probability that he answers ‘Yes’ is given by:

$$Pr (Yes) = U_{1j} (Y_j – Y_i^*, V_j, e_{ij}) > U_{0j} (Y_j, V_j, e_{ij}) \dots\dots\dots (3.3)$$

Where U_{1j} is his new utility level and U_{0j} is his former utility level.

A common formulation of the RUM is the Additive Random Utility Model (ARUM) (Cameron and Trivedi, 2005). The ARUM assumes that the utility function is additively separable into deterministic and stochastic preferences.

Thus, equation 3.1 may be written as:

$$U_{ij}= U_i (Y_j, V_j) + e_{ij} \dots\dots\dots\dots\dots\dots\dots\dots (3.4)$$

The probability statement that a respondent answers ‘Yes’ to a proposed bid therefore becomes:

$$Pr (Yes) = U_{1j} (Y_j - Y_i^*, V_j) + e_{1j} > U_{0j} (Y_j, V_j) + e_{0j} \dots\dots\dots\dots (3.5)$$

Now let WTP_i be the maximum amount a household is willing to pay for improvement in quality electricity supply. WTP_i is assumed to be a function of the household’s socioeconomic attributes and the characteristics of the electricity supply. Also, since utility in the RUM is dependent on the deterministic and random components, the change in utility associated with an improvement in quality electricity supply will equal the change in the deterministic and random components. In other words, without loss of generality, WTP can be written as:

$$WTP_i= \beta_i V'_i + e_i \dots\dots\dots\dots\dots\dots (3.6)$$

Where, β_i = vector of estimated parameters,

V_i = vector of the household's socioeconomic attributes and the characteristics of electricity supply and

e_i = the error term which captures all other factors that affect households' WTP which have not been included in the model.

The error term is assumed to follow a standard normal distribution with a mean value of zero and variance value of one. On the basis of this framework, this study estimates the following equation:

$$WTP_i = \beta_1 HSZ_i + \beta_2 HY_i + \beta_3 EDL + \beta_4 REL_i + \beta_5 CRR_i + \beta_6 CAP_i + \beta_7 MO_i + \varepsilon_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(3.7)$$

Where:

WTP = Maximum Willingness to Pay; HSZ = Household Size;

HY = Household Monthly Income EDL = Highest Educational Level Attained by Respondent

REL= Reliability/Continuity of Current Supply;

CRR = Cost incurred repairing or replacing damaged appliances;

CAP = Cost of alternative power supply. MO = Number of outages in a month.

WTP_i is unobserved, however, we would know the ranges within which WTP_i falls from the responses. Let P_1, P_2,…, P_J be the j prices which partition the range of WTP space into J+1 categories and be a categorical variable such that:

$$WTP_i = \begin{cases} 1 \text{ if } WTP_i^* \leq P_1 \\ 2 \text{ if } P_1 < WTP_i^* \leq P_2 \\ : \\ J+1 \text{ if } P_J < WTP_i^* \end{cases} \quad \ldots\ldots\ldots\ldots\ldots (3.8)$$

If j=1, 2,…, J+1, then the WTP_i^* = J if

$$\left.\begin{aligned} & P_{J-1} < WTP_i^* \leq P_J \\ & \equiv P_{J-1} < \beta V'_i + e_i \leq P_J \\ & \equiv P_{J-1} - \beta V'_i < e_i \leq P_J - \beta V'_i \end{aligned}\right\} \quad \ldots\ldots(3.9)$$

Although WTP_i^* is unobserved, we can determine the exact category of WTP households belong to since they would indicate the amount that they would be willing to pay for improved quality of electricity supply.

Thus, the probability that household *i* will choose category *j* is written as:

$$\left.\begin{aligned} Pr\ (WTP_i = j) &= Pr\ (P_{J-1} < WTP_i^* \leq P_J) \\ &= Pr\ (P_{J-1} - \beta V'_i < e_i \leq P_J - \beta V'_i) \\ &= Pr\ (\mu_{J-1} - \beta V'_i < e_i \leq \mu_J - \beta V'_i) \\ &= \phi\ (\mu_J - \beta V'_i) - \phi\ (\mu_{J-1} - \beta V'_i) \end{aligned}\right\} \quad \ldots.\ (3.10)$$

Where $\mu_J = P_J$

Given J+1 WTP categories, the probability of a household *i* choosing a category *j* (where j=1, 2,…, J+1) is given by:

$$Pr\ (WTP_i = 1) = Pr\ (WTP_i^* \leq P_1) = Pr\ (\beta V'_i + e_i \leq \mu_1) = Pr\ (e_i \leq \mu_1 - \beta V'_i) = \phi\ (\mu_1 - \beta V'_i)$$

$$Pr\ (WTP_i = 2) = Pr\ (P_1 < WTP_i^* \leq P_2) = Pr\ (e_i \leq \mu_2 - \beta V'_i) - Pr\ (e_i \leq \mu_1 - \beta V'_i)$$

$$= \phi\ (\mu_2 - \beta V'_i) - \phi\ (\mu_1 - \beta V'_i)$$

$$\vdots \qquad \vdots$$

$$Pr\ (WTP_i = J+1) = Pr\ (WTP_i^* \geq P_J) = 1 - \phi\ (\mu_J - \beta V'_i)$$

Where μ_J's are the threshold parameters which will be estimated as well as the coefficient vector β. The cumulative standard normal distribution is given by ϕ (...) (Greene, 2008).

In using models such as the ordered probit, interpreting the parameters from the regression is of little importance. According to Woodridge (2010), the response probability does not matter much because WTP is unobserved. Meaningful conclusions can be made if the marginal effects are estimated. The marginal effects show how the probability of each outcome changes as a result of changes in the regressors. The marginal effects for the categories are given by:

$$
\left.
\begin{array}{l}
\partial Pr\ (WTP_i = 1|x) / \partial x = -\phi\ (\mu_1 - \beta V'_i)\beta \\
\partial Pr\ (WTP_i = 2|x) / \partial x = [\phi\ (\mu_1 - \beta V'_i) - \phi\ (\mu_2 - \beta V'_i)]\beta \\
: \\
\partial Pr\ (WTP_i = J+1|x) / \partial x = \phi\ (\mu_J - \beta V'_i)\beta
\end{array}
\right\} \quad \ldots\ldots\ldots\ldots(3.11)
$$

3.3 Method

Thefollowing methods were employed in analyzing the data to achieve the specific objectives in this study:

i. Assess the impact of the quality of electricity supply on household welfare:

The research was a survey-based method; hence, primary data was used in the study. Data on the effect of poor quality of electricity supply on their various activities was obtained from respondents in the selected sample areas.

The method used in analyzing this data was descriptive statistics.

ii. Investigate the factors that influence consumers' willingness to pay for an improved quality of electricity supply:

Data on the social economic characteristics of households,quality of existing electricity supply and related issues were obtained from respondents in the selected sample areas in order to achieve this objective.

The method employed in analyzing this data was the ordered probit model. The model was employed as the main estimation technique to obtain the factors that influence households' willingness to pay. The ordered probit model was also preferred to other methods such as the logit, probit and linear regression model because it accounts for unequal differences between the ordinal categories in the dependent variable.

From the theoretical framework of the study, the model specification is given as:

$$WTP_i = \beta_1 HSZ_i + \beta_2 HY_i + \beta_3 EDL + \beta_4 REL_i + \beta_5 CRR_i + \beta_6 CAP_i + \beta_7 MO_i + \varepsilon_i \quad \text{.....................................(3.7)}$$

Where:

WTP = Maximum Willingness to Pay; HSZ = Household Size;

HY = Household Monthly Income EDL = Highest Educational Level Attained by Respondent

REL= Reliability/Continuity of Current Supply;

CRR = Cost incurred repairing or replacing damaged appliances;

CAP = Cost of alternative power supply. MO = Number of outages in a month.

iii. Estimate how much consumers are willing to pay for reliable and improved quality of electricity supply.

A hypothetical scenario of an improved electricity system that conforms to all the dimensions of quality electricity supply was created and data on the maximum willingness to pay for this service was obtained from respondents. The random utility theory was adopted as the economic theory.

The Contingent Valuation Method (CVM) and the Discrete Choice with a Follow-Up technique was used in this study to obtain the willingness of households to pay for an improved quality of electricity supply. The contingent valuation method was used to directly elicit from customers the values place upon the quality of electricity service. The CVM is able to estimate the respondent's consumer surplus for the resource and therefore the maximum amount the resource is worth to the respondent. The total value of the resource (in this case, the provision of a better quality of electricity supply)is estimated by taking the average of the individuals' (respondents) values and applying an extrapolation technique on it across the survey area or population.

A major advantage that the contingent valuation method has over other methods of valuation is its ability to estimate and measure the total economic value (use and non-use values) of a particular resource. Compared to other methods especially revealed preference methods, the CVM is flexible enough to allow for the creation of hypothetical market scenario. These hypothetical scenarios may go beyond observed market behaviour and thus helps to measure existence values that are not related to the consumption of other goods. This method is appropriate for this study because how much a consumer is willing to pay to avoid power outages invariably depict the cost to households of these outages.

3.4 Data and Sources

This research used primary and secondary data. Information was obtained from secondary sources such as journals, annual reports, and the publications of the Nigerian Electricity Regulatory Commission, etc. to aid in the credibility of the study.

A questionnaire was the main instrument for the data collection. A well-structured questionnaire was administered to a sample of households within the cities of Abuja, Ibadan, Port Harcourt and Lagos. The questionnaire comprised of three thematic areas.First isthe social economic characteristics of the household. Secondly, the nature of the quality of electricity supply and how it affects households' welfare. In the third section, a hypothetical scenario of an improved electricity system that conforms to all the dimensions of quality electricity supply was created. In this scenario, power supply was assumed to be reliable and of good quality. Reliability means the power supply is available every time and good quality means the power supply comes with the appropriate level of voltage. The hypothetical case ruled out power outages to a large extent. Power outages may only occur when repair works need to be carried out and even in such cases, users of electricity who will be affected would be notified ahead of the outages and the outage will not last beyond four(4) hours. Respondents were asked to state the maximum amount they were willing to pay for such an improved quality of electricity supply system.

The elicitation format that was employed in the study was the discrete choice with a follow-up approach. A first bid was proposed to each respondent. If the respondent agrees to pay that amount, a higher amount was proposed. If he agrees to that, a third amount, higher than the second was further proposed. If he declined to pay the first bid, the follow up bid proposed to the respondent was lower. After going through the follow up process, all respondents were asked to state after careful thoughts what their maximum WTP for the improved quality electricity supply would be. The amounts each respondent states here were compared to the responses from the follow up process to check for consistency. A likely bias associated with this format was the starting bid bias. To help correct for this bias, the initial bids given was varied among the sample.

3.5 Sample Design and Related Issues

In determining the sample size for the survey, the sample size determination formula was employed. The magnitude of the variables that was imputed in the sample size formula are:

i. Population size (N): The number of electricity customers (R2 subclass) was gotten from MYTO;

Abuja= 848813, Port Harcourt= 583869, Ibadan= 1558393 and Lagos (Ikeja DISCO) = 518289.

ii. Confidence Interval (e): No sample is perfect, a confidence interval of ±8% was used by the researcher.

iii. Confidence level (Z): A 95% confidence level was used. The corresponding value of the 95% confidence level in the Z-table is 1.96 from the Z-score table.

iv. Percentage (P): A percentage of 50% was used. This is often the worst-case percentage in determining the sample size needed for a given level of accuracy and to ensure that the sample size will be large enough in representing the total population.

The statistical sample size determination formula is given as:

$$\text{Sample size} = \frac{Z^2 * P(1 - P)/e^2}{1 + (Z^2 * P(1 - P)/e^2N)}$$

Where Z = 95% = 1.96, P = 50% = 0.5, e = ± 8% = 0.08,

N = {Abuja= 848813, Port Harcourt= 583869, Ibadan= 1558393 and Lagos (Ikeja DISCO) = 1067386}

Substituting the above values into the sample size equation to determine the number of respondents required, thus: Sample size = 150 for each city.

The selected areas used were Abuja Municipal Council and Bwari Local Government Area (LGA) in Abuja, Ibadan North and Ido LGA in Ibadan, Surulere and Alimosho LGA in Lagos and Obio-Akpor LGA in Port Harcourt.

778 households were administered questionnaires (a minimum of 175 in each study area), only 680 responses representing87.4% of the sampled households were used and analysed due to the

poor-quality responses from some of the respondents. Eventually, a sample size of 170 households in each study area was used in the analysis of this study.

3.6 Locational Differences and Similarities of Sample Areas

The four selected cities; Abuja, Ibadan, Lagos and Port Harcourt are amongst the major cities in Nigeria with high economic activities and inhabitants with diverse ethnicity. While Abuja is located towards the northern part of Nigeria, Ibadan and Lagos are located in the western part of Nigeria and Port Harcourt in the far southern part of Nigeria.

The selected areas used were Abuja Municipal Council and BwariLGA in Abuja, Ido and Ibadan North LGA in Ibadan, Surulere and Alimosho LGA in Lagos and Obio-Akpor LGA in Port Harcourt.

The inhabitants of these selected areas are characterized by a high number of low- and middle-income earners and a few higher income earners who pay uniform electricity tariffs in their respective cities. Figure 3.1, 3.2, 3.3 and 3.4 shows the map of the study area in Abuja, Ibadan, Lagos and Port Harcourt respectively.

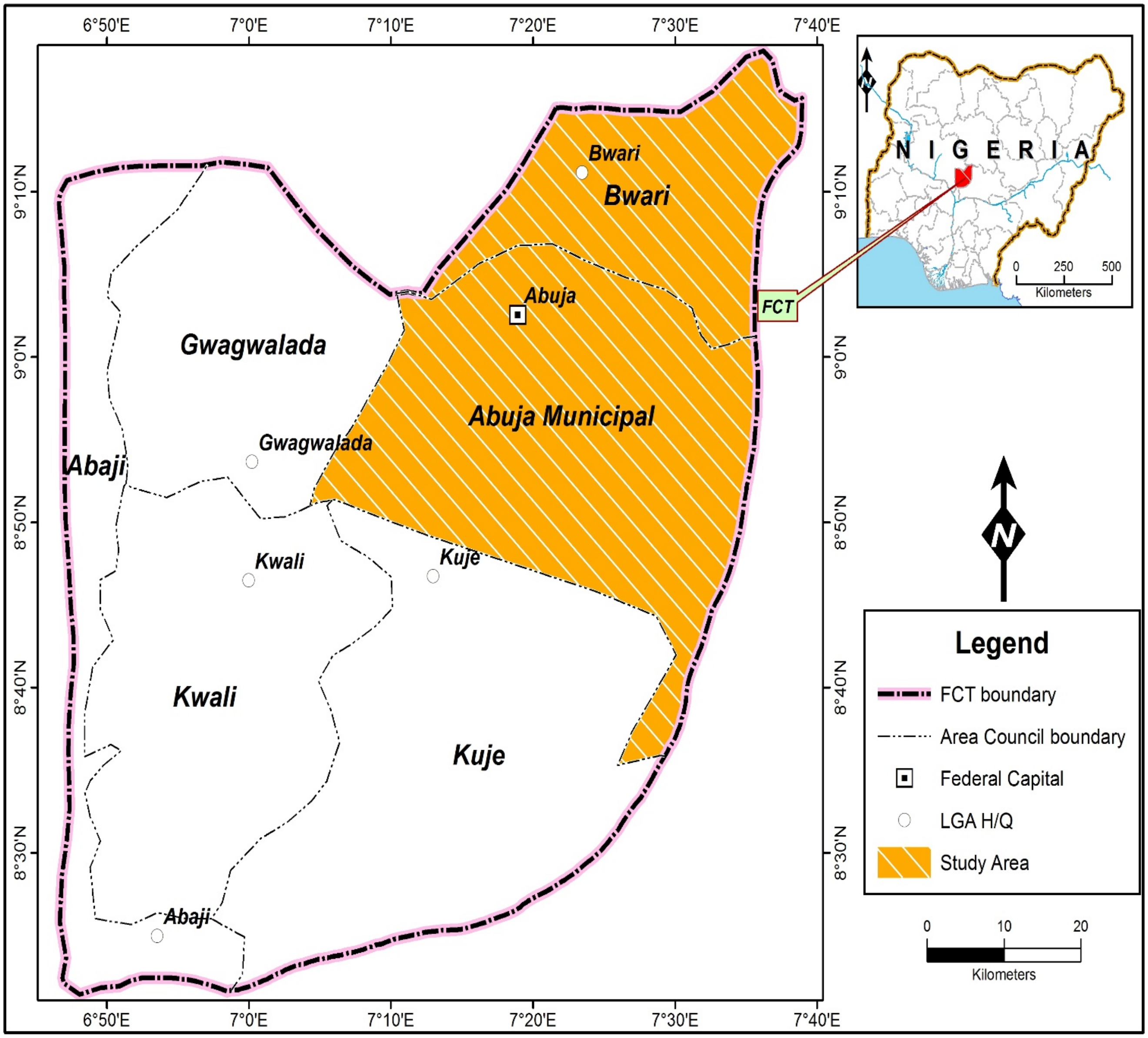

Figure 3.1. Study Area in Abuja

Source: Author's Compilation, 2018.

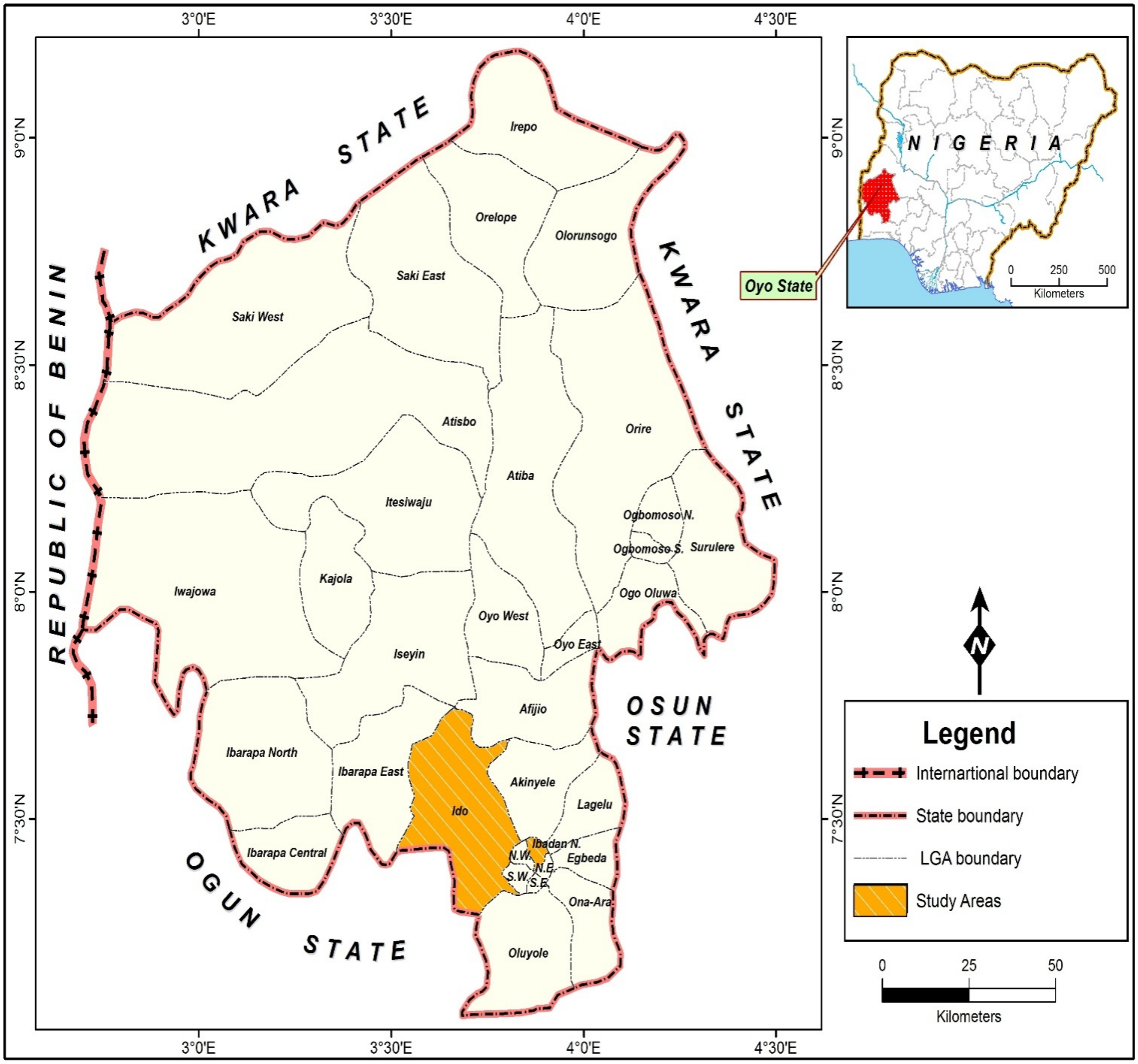

Figure 3.2. Study Area in Ibadan

Source: Author's Compilation, 2018.

Figure 3.3. Study Area in Lagos

Source: Author's Compilation, 2018.

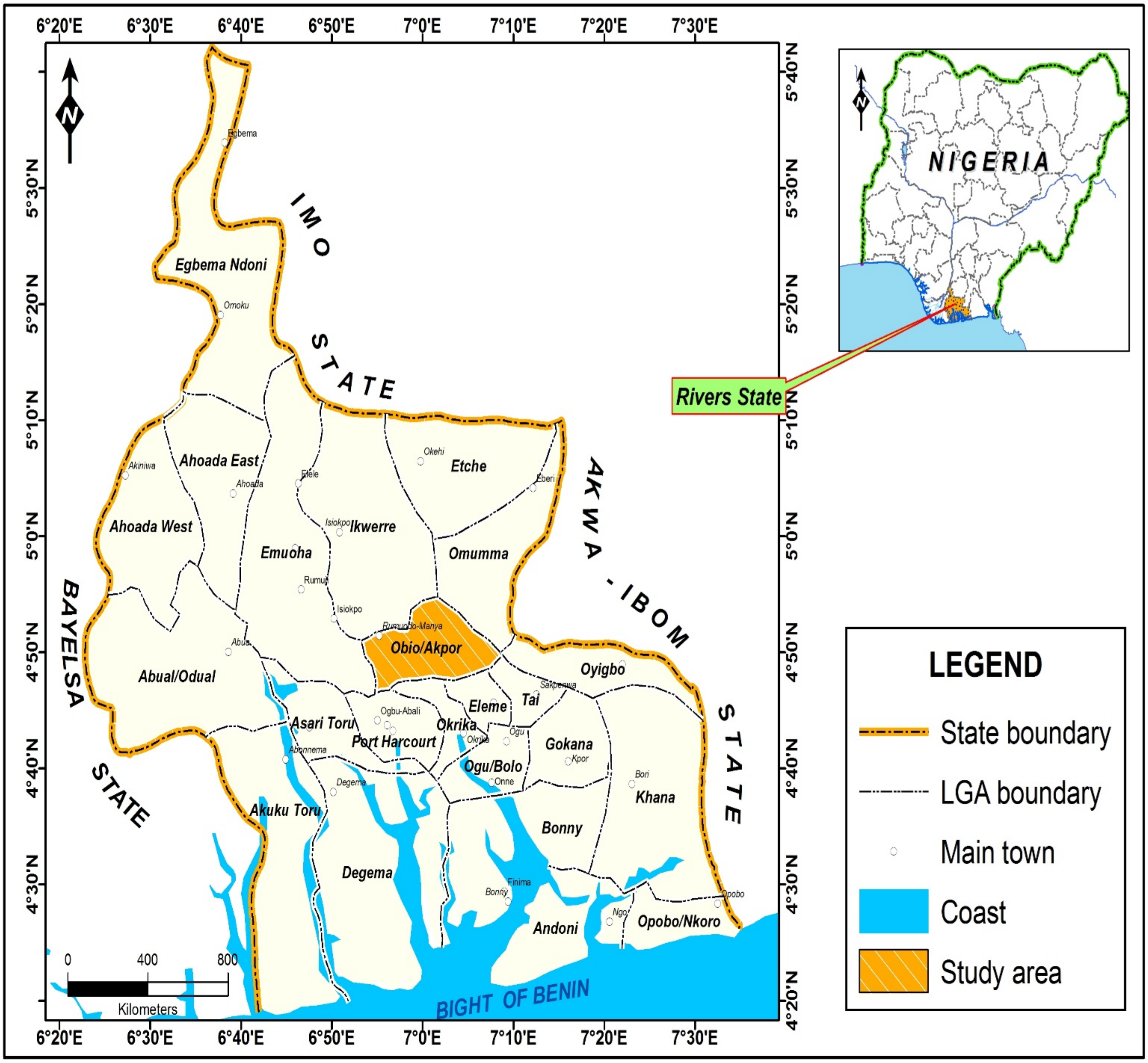

Figure 3.4. Study Area in Port Harcourt

Source: Author's Compilation, 2018.

3.7 Data Analysis and Estimation Techniques

In this study, the Contingent Valuation Method (CVM) was used to obtain the willingness of households to pay for improved quality of electricity supply. This technique was appropriate for this study because how much a consumer is willing to pay to avoid power outages invariably depict the cost to households of these outages. A survey in the study areas was conducted and household heads or their representatives was asked questions about their existing electricity supply and other socioeconomic characteristics of the respondents and their households.

The Ordered Probit Model was employed as the main estimation technique for the study. The ordered probit was preferred in this study because although households may give an amount as their WTP, it may not be their maximum WTP. Their true WTP may lie within a certain interval of the maximum value the respondent is willing to pay and the next highest value. Hence, this implies that although the outcome of the event is discrete, the multinomial logit or probit model would ignore to account for the ordinal attribute of the response variable. The ordered probit model has merits over the unordered multinomial conditional or nested logit or probit model in that while accounting for the attribute of the dependent variable, the unordered multinomial probit and logit models fail to account for the ordinal attribute of the dependent variable (Greene, 2008). Also, the linear regression model was not a suitablemethod for handling such an ordinal dependent variable in this study because the assumptions regarding the specification of the error term in the linear model will be disregarded (Maddala, 1983). The ordered probit model was also preferred to linear regression model because it accounts for unequal differences between the ordinal categories in the dependent variable (Greene, 2008). The ordered probit model is specified as follows:

$$WTP_i = \beta_i V'_i + e_i \qquad (3.12)$$

Descriptive data analysis was also employed in analyzing the collected data.

CHAPTER FOUR

ANALYSIS AND DISCUSSION OF RESULTS

4.1 Descriptive Analysis

This section is divided into the following subsections namely; Socio-Economic and Demographic Characteristics, Attributes of existing electricity supply and related issues and WTP for an improved quality of Electricity supply.

4.1.1 Socio-Economic and Demographic Characteristics

The socioeconomic and demographic data of the respondents were collected and analysed using descriptive statistics tools such as charts, frequencies and percentages.

Respondents' Position in the Family

The distribution of respondents' position in the family is depicted in Figure 4.1. Generally, in all the study areas, majority (64.0%) of the respondents are household heads while the remaining 36.0% are household members (Others) who had good knowledge about their electricity billing and payment. The study area with the highest number of household heads is Port Harcourt (80.6%) and this is followed by Abuja and Lagos with about 78.2% and 54.7% respectively. However, more than half (57.6%) of the respondents in Ibadan are household members.

Respondents' House Occupancy Status

Figure 4.2 show the house occupancy status of selected respondents in the study areas. According to the result, there are more tenants (71.2%) than landlords (28.8%) for all the cities. Particularly, in Abuja; more than two-third (67.1%) of the respondents are tenants while about 32.9% are landlords. In Ibadan, about 53.5% (more than half) of the respondents are tenants while the remaining 46.5% are landlords. Similarly, about 82.9% and 81.2% (more than three-quarter) of respondents are tenants in Lagos and Port Harcourt respectively while the remaining 17.1% and 18.8% are landlords in the two study areas.

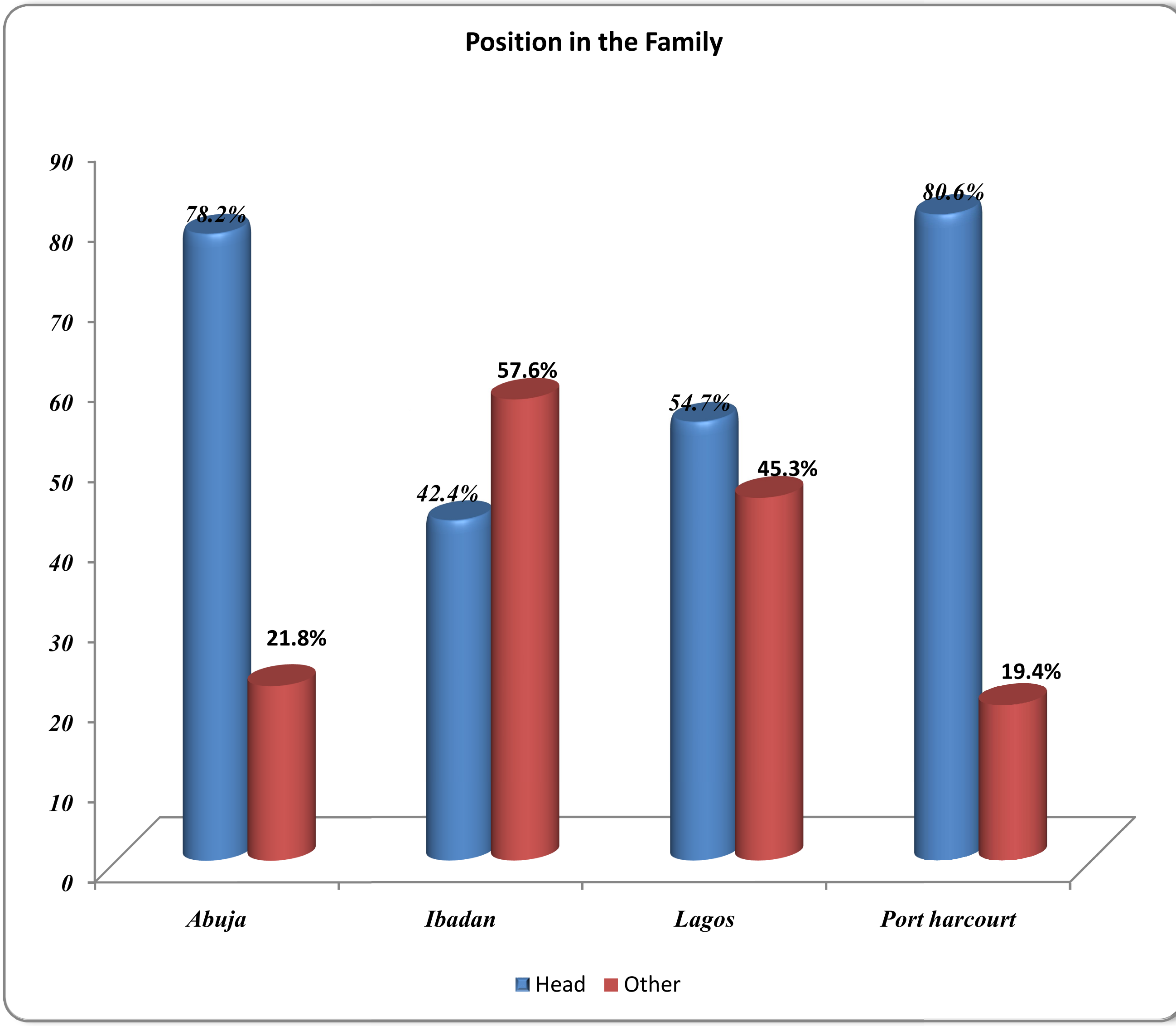

Figure 4.1. Position in the Family

Source: Author's Compilation, 2018.

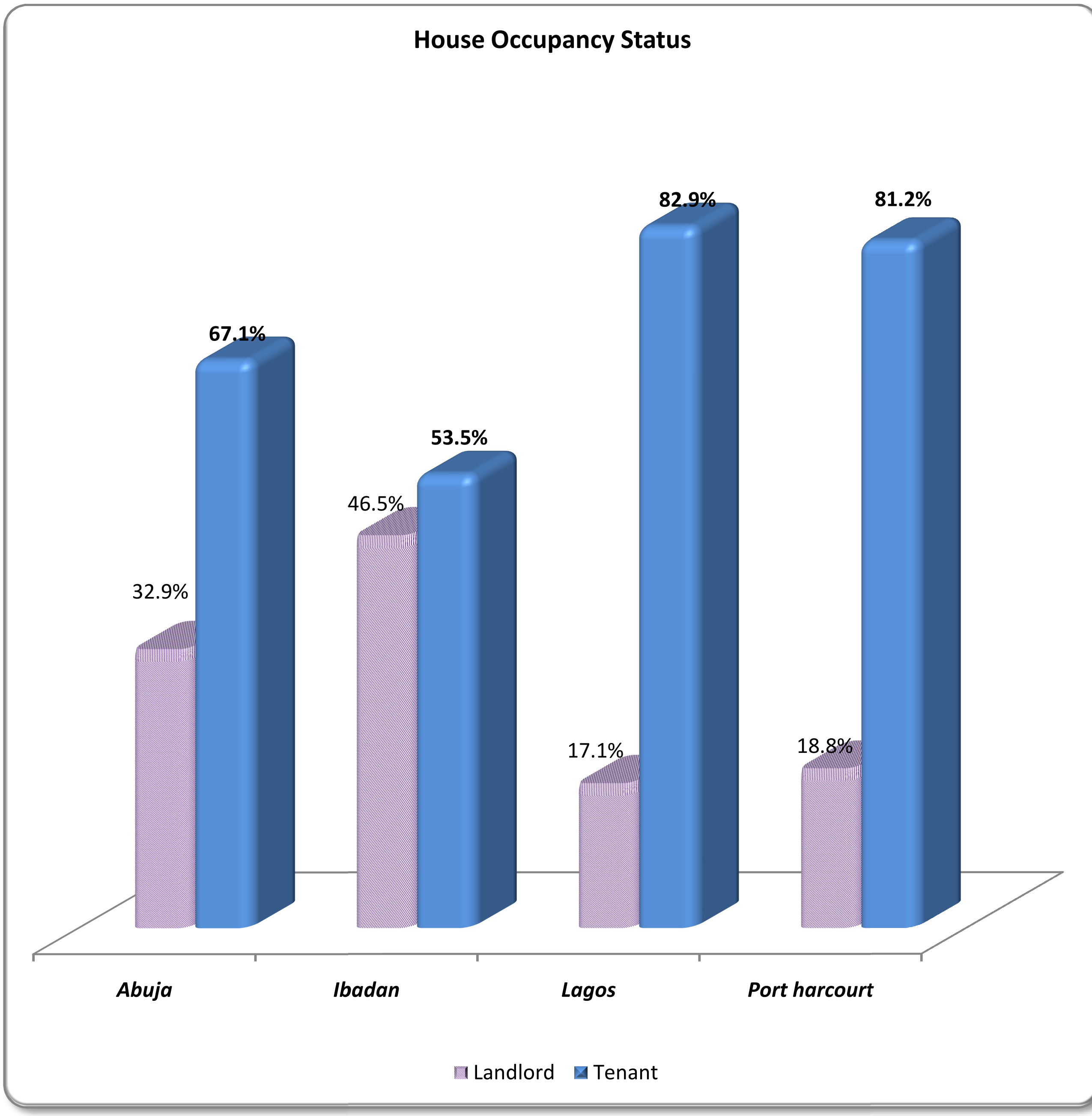

Figure 4.2. ***House Occupancy Status***

Source: Author's Compilation, 2018.

Respondents' Gender

Figure 4.3 shows the gender distribution of the respondents in the four study areas. The results show that majority of the respondents in all the areas are males except for Ibadan where female (51.8%) is more than male (48.2%). More specifically, 69.4% of the respondents in Abuja are male while the remaining 30.6% are female. In Ibadan, 48.2% of the respondents are males while 51.8% are females. For Lagos and Port Harcourt cities, about 51.8% and 70.0% respectively are male while the remaining 48.2% and 30% are female respondents.

Respondents' Age

Figure4.4 shows the age distribution of the respondents. Most respondents are in the 30-39 years age bracket with 39.1%, followed by respondents in the less than 30 years bracket with 27.6%, after which is 40-49 years which has about 22.6%, thereafter 50-59 years category with 9.0% and lastly the 60 years and above with 1.6%. Explicitly, for Abuja; 48.8% of the respondents which fall within the age group 30-39 years and this is followed by 40-49 years with 29.4%, less than 30 years with 11.2% and 10.6% in the age group 50-59 years. Nevertheless, (0.0%) is found Above 60 years.

In Ibadan 37.1% of the respondents are below 30 years. However, 35.3% are between 30-39 years, 17.1% between 40-49 years, 10.0% between 50-59years, just a respondent, and 0.6% are above 60years. In Lagos 35.9% of the respondents are below 29 years, whereas 34.1% are between 30-39 years, 19.4% between 40-49 years, 7.6% between 50-59years and 2.9% are above 60years. Most (38.2%) of the respondents in Port Harcourt are between the ages of 30-39 years. This is followed by 26.5% below 29, 24.7% between 40-49 years, 7.6% between the ages 50-59 years, and the remaining 2.9% are above 60 years.

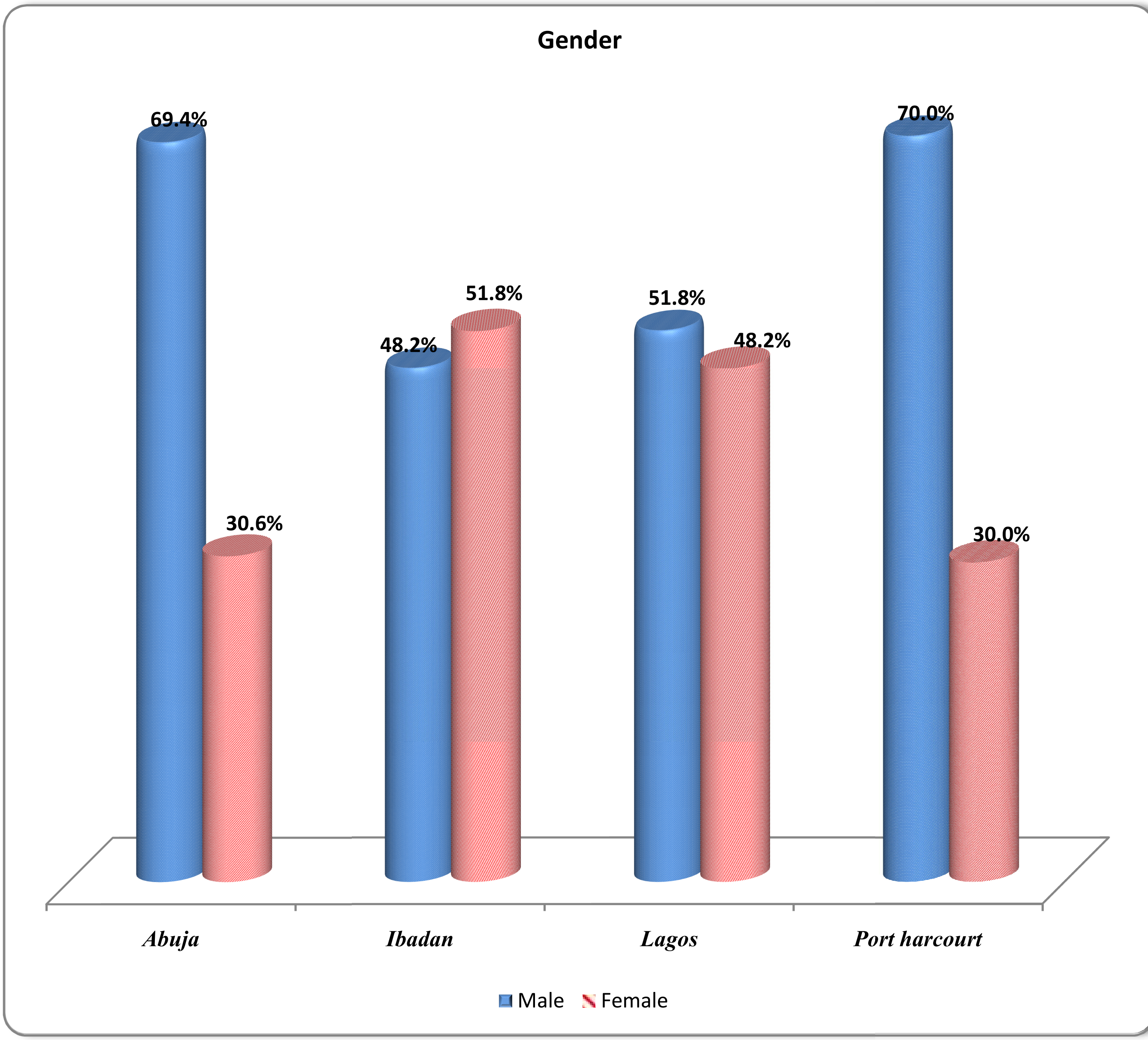

Figure 4.3. Gender

Source: Author's Compilation, 2018.

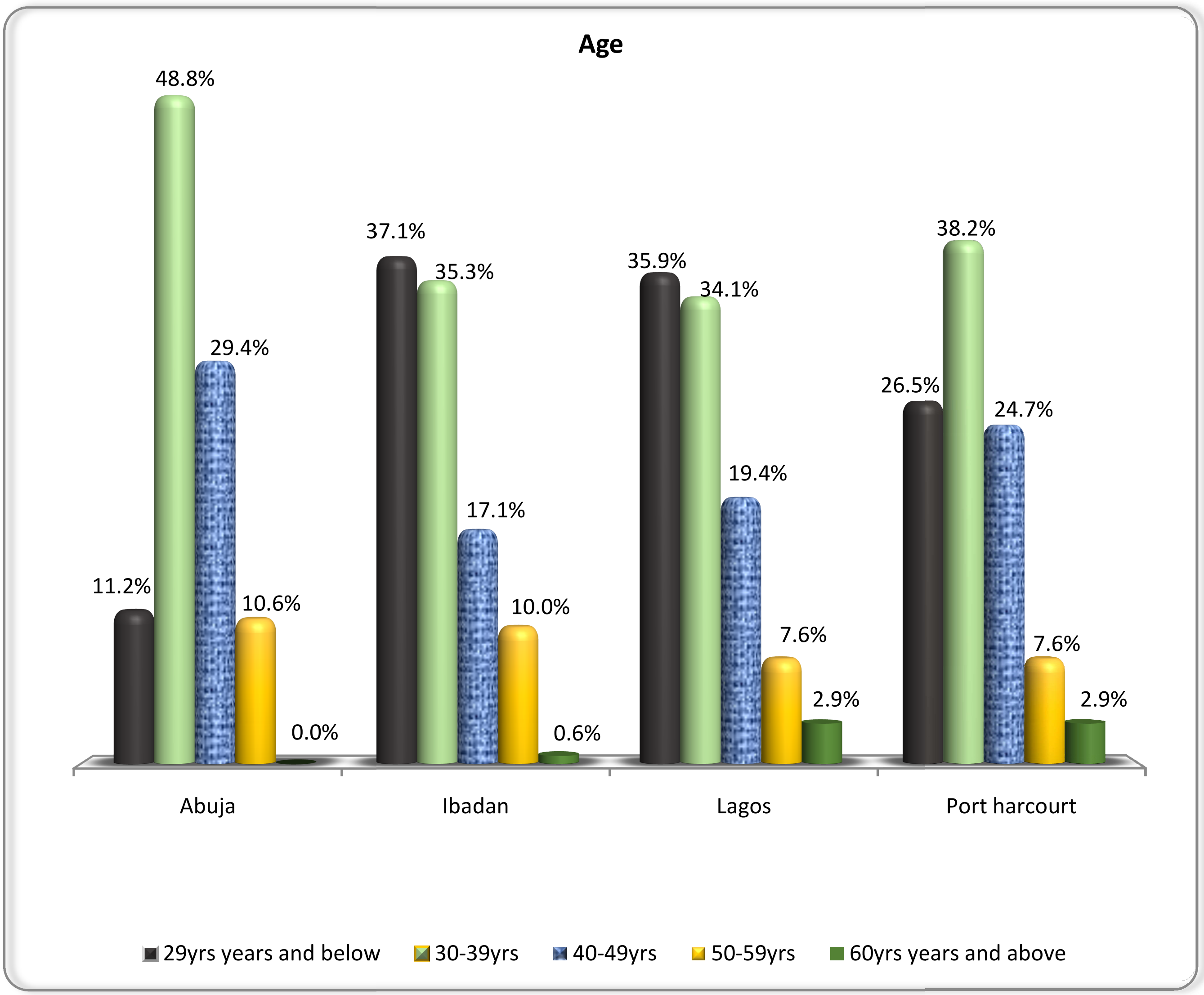

Figure 4.4. Respondents' Age

Source: Author's Compilation, 2018.

Respondents' Highest Educational Level

The distribution of respondents by their highest level of education attained is presented in Figure 4.5. About1.8% of the respondents have no formal or just have basiceducation, 31.2% have secondary and 67% have tertiary education in Abuja. In Ibadan, 11.7% of the respondents have no formal or just have basiceducation, 13% have secondary and 75.3% have tertiary education. Furthermore, 58.2% and 65.9% of the respondents have tertiary education in Lagos and Port Harcourt respectively.

Household Size

The result in Figure 4.6 shows that majority of the respondents in Abuja, Ibadan, Lagos and Port Harcourt have between 3 – 5 adults and children, with 52.4%, 61.2%, 51.8% and 47.1% respectively. On the other extreme, about 1.2%, 7.1%, 5.9% and 0.6% of the respondents have above 8 household members in Abuja, Ibadan, Lagos and Port Harcourt respectively. From estimation, the average household size is 4.3, 4.9, 5.2 and 3.2 Abuja, Ibadan, Lagos and Port Harcourt respectively.

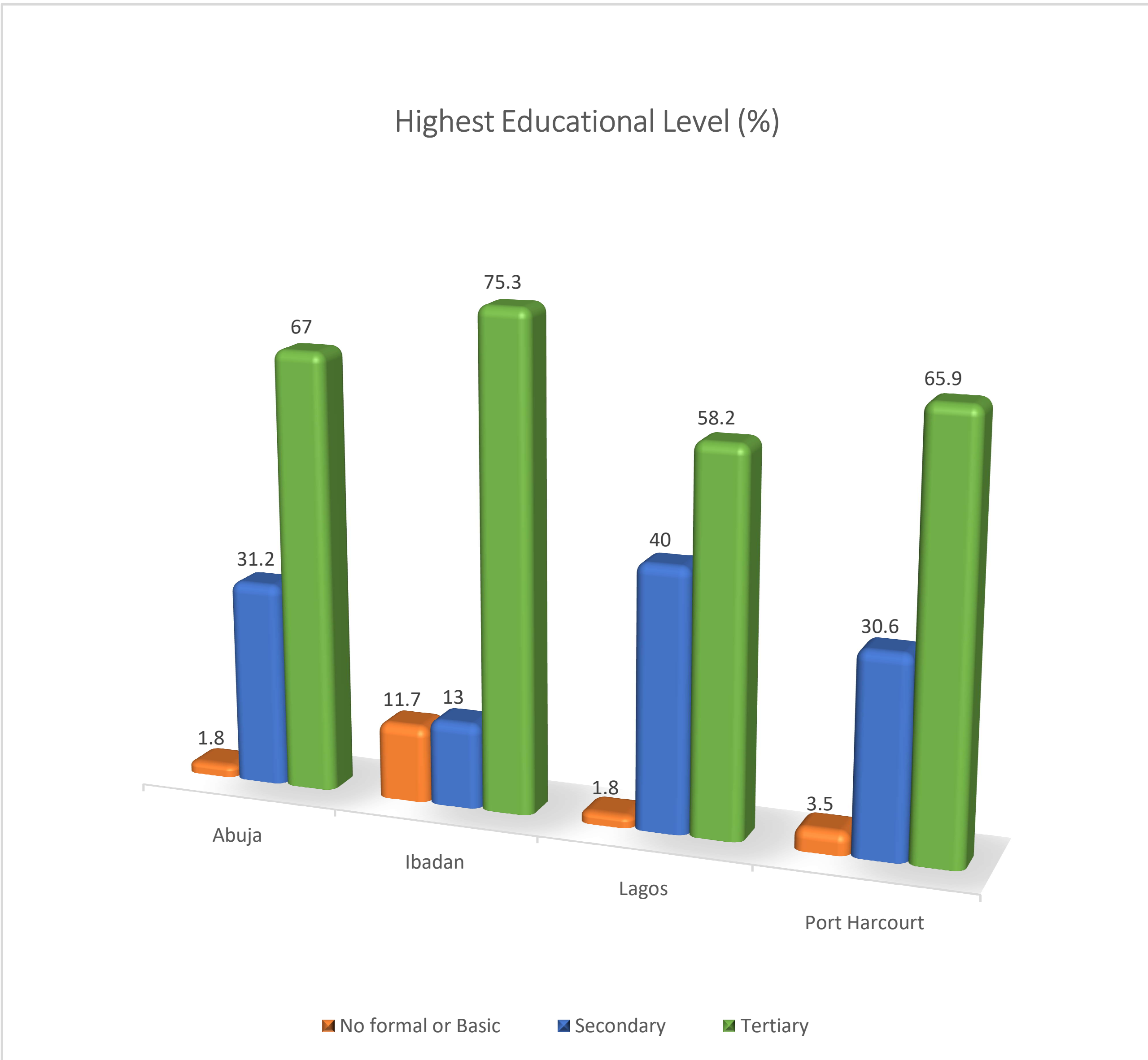

Figure 4.5. Highest Educational Level

Source: Author's Compilation, 2018.

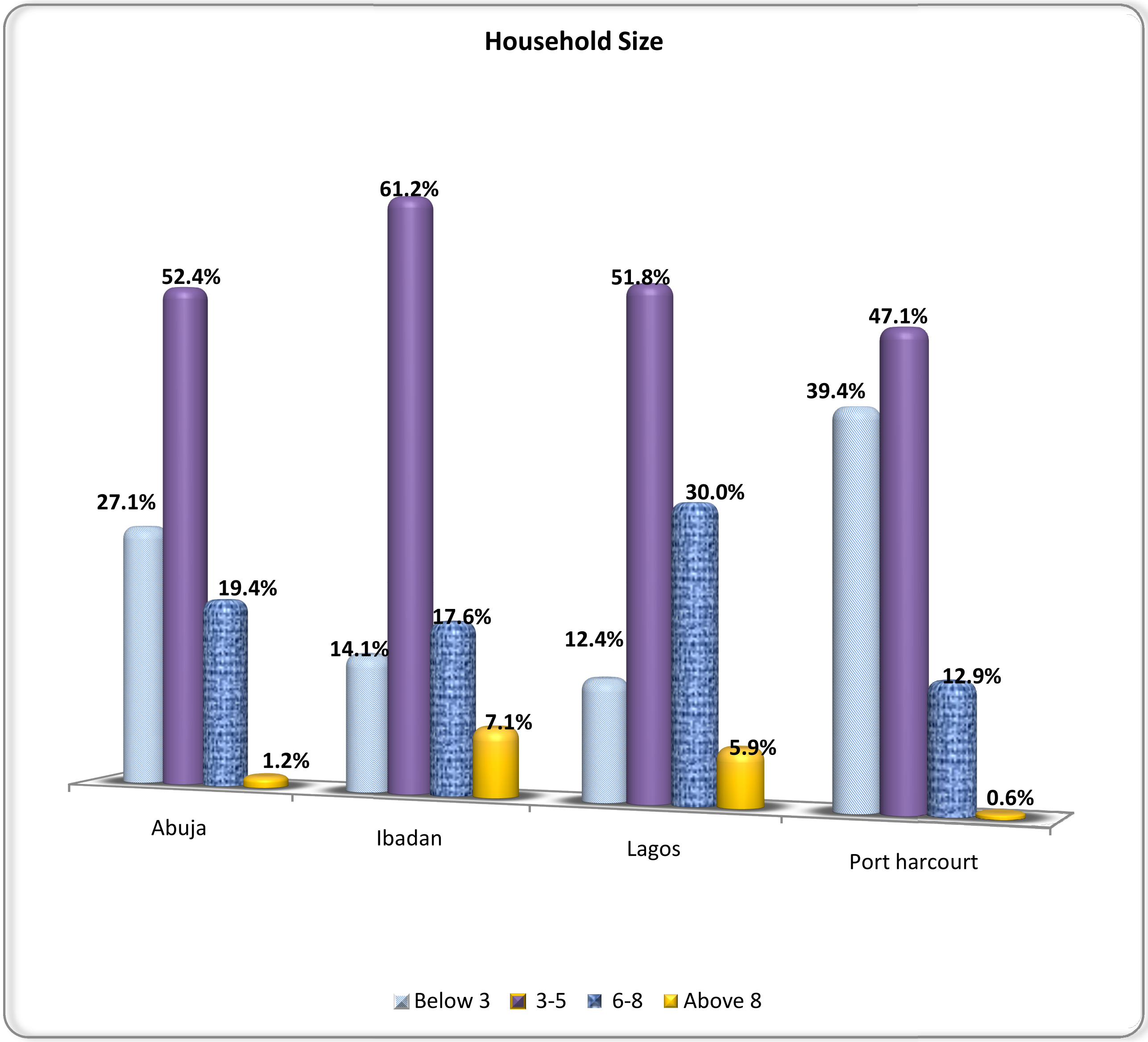

Figure 4.6. Household size

Source: Author's Compilation, 2018.

Respondents' Occupation

Figure 4.7 reveal the collective responses of the four cities (Abuja, Ibadan, Lagos, and Port Harcourt) based on their type of occupation. It can be seen that about 10.6%, 22.9%, 3.5% and 23.5% of the respondents are artisans in Abuja, Ibadan, Lagos and Port Harcourt respectively, 13.5%, 9.4%, 17.6% and 47.6% Professionals, 24.1%, 10%, 21.8% Civil servants, 45.9%, 34.7%, 33.5% and 23.5% are into business while 5.9%, 22.9%, 23.5% and 3.5% of the respondents are engaged in other type of occupation. Generally, majority of the respondents were businessmen or traders.

Respondents' Average Monthly Income

Figure 4.8 present the distribution of respondents' average monthly income in the study areas. In the selected areas in Abuja, 23.5% earn between N100,000 and N200,000 and 10.6% earn between N200,000 and N500,000. In Ibadan and Lagos, majority of the respondents earn between N51,000 and N100,000. In Port Harcourt 28.2%of the respondents earn between N200,000 and N500,000.

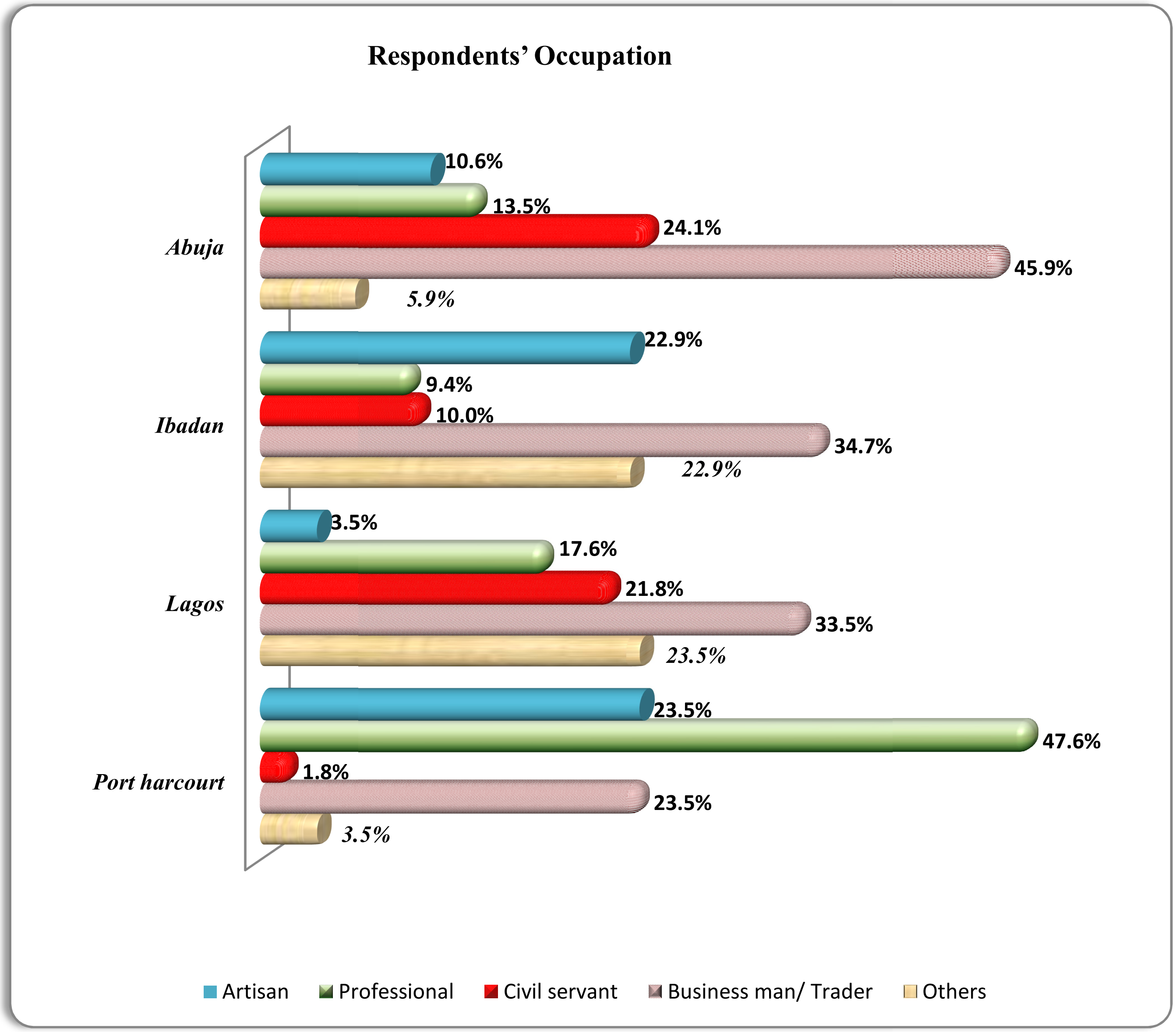

Table 4.7. Respondents' Occupation

Source: Author's Compilation, 2018.

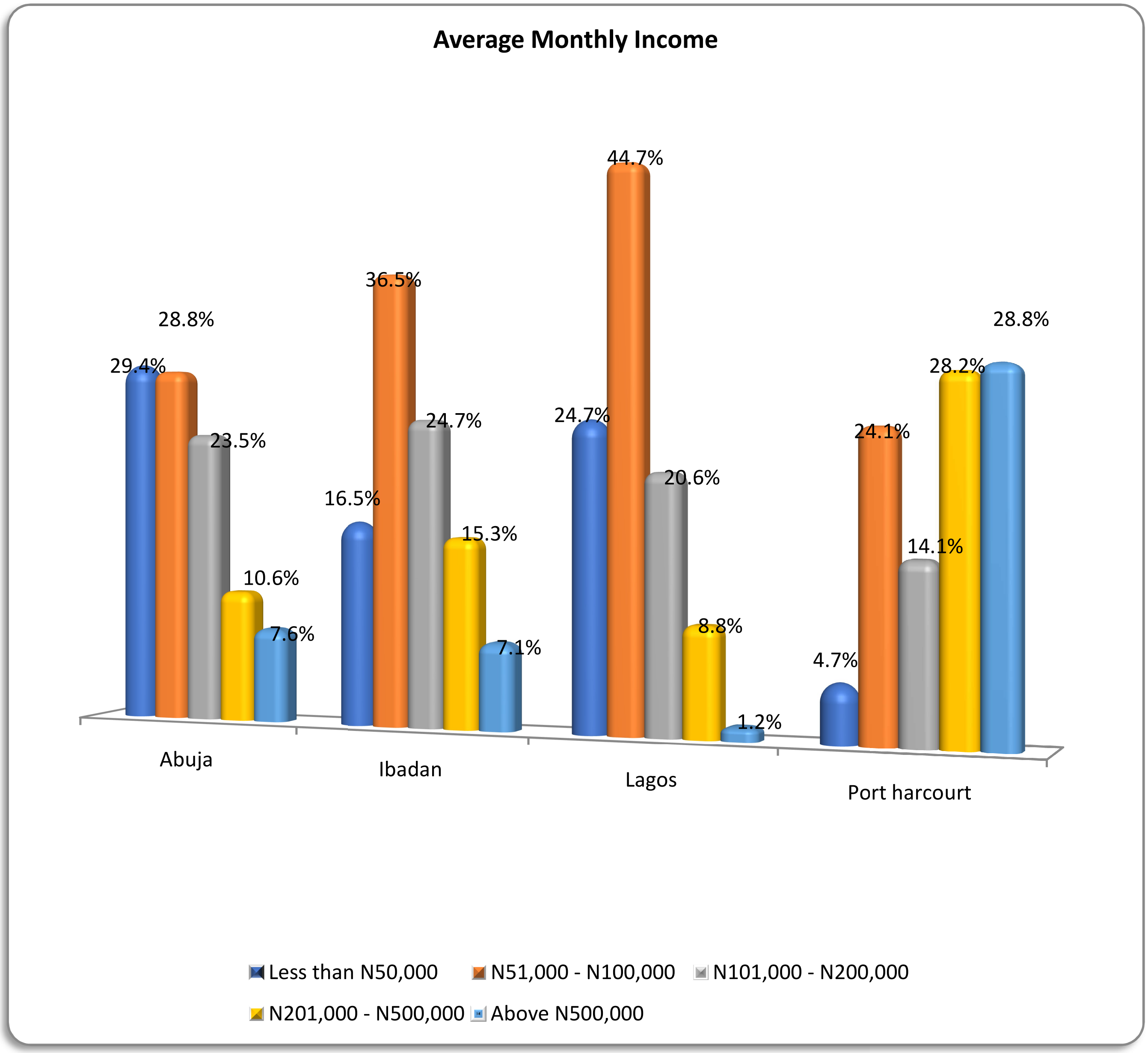

Figure 4.8. Average Monthly Income

Source: Author's Compilation, 2018.

Appendix A shows the socioeconomic and demographic attributes of the respondents summarized in a table.

4.1.2 Quality of Existing Electricity Supply and Related Issues

In this subsection, the information collected on quality of existing electricity supply and related issues were analysed.

Major Concerns in the Neighborhood

Table 4.1 reveals that most respondents in Abuja (96%), Ibadan (86.5%), Lagos (79.4%) and Port Harcourt (50%) have their worries on electricity. Overall, majority (77.9%) of the 680 respondents indicated that electricity is a major concern, followed by crime (4.3%), waste/pollution (3.5%) and Road network (3.4%). On the other end, about 0.6% of the respondents indicated Transportation.

Other Source of Power

It is shown in Table 4.2 below that the majority (94.7%) of the respondents use generator as the alternative source of power. This is followed by 28% that use inverters. On the other hand, fewer (1.2%) numbers of respondents uses solar energy as source of power.

Table 4.1. Major Concerns in the Neighborhood

		Abuja	Ibadan	Lagos	Port Harcourt	Total
Major Concerns in the Neighborhood (%)	Electricity	96	86.5	79.4	50	77.9
	Water	0.6	1.2	6.5	0.6	2.2
	Waste/pollution	1.8	1.8	6.5	4.1	3.5
	Transportation	0.6	0	1.8	0	0.6
	Road network	1.2	6.4	4.0	1.8	3.4
	Crime	0	1.8	0.6	14.7	4.3
	Others	0	2.3	1.2	28.8	8.1

Source: Author's Computation; underlying data from Field Survey, 2018

Table 4.2. Other Source of Power

		Abuja	Ibadan	Lagos	Port Harcourt	Total
Other Source of Power (%)	Generator	97.6	91.7	85.9	94.7	94.7
	Solar energy	1.8	1.2	1.8	0	1.2
	Inverters	0.6	7.1	3.5	5.3	4.1

Source: Author's Computation; underlying data from Field Survey, 2018

Days of Power Interruption or Blackout in a Month

Figure4.9 shows the distribution of days of power interruptions in month as indicated by the respondents in the selected areas. In Abuja, the majority (33.5%) of the respondents experienced blackout for more than 20 days in a month.In Ibadan, the number of days of outages experienced in a month is usually between 6 – 10 days as indicated by 41.8% of the respondents. In Lagos, 31.2% of the respondents' experiences blackout below 6 days in a month and 49.4% in Port Harcourt claim the experience outages above 20 days in a month.

Duration of power outage in hours on days when there is Power Interruption

Figure 4.10 presents the duration of power outage in hours on days when there is power interruption. Going by the result below, about 36.5%, 37.6% and 40.6% of respondents in Abuja Lagos, Port Harcourt respectively experience power outage up to 6 hours, likewise 51.2% in Ibadan fall within the range of 6 to 10 hours of power outage. 7.1% and 10.6% also experience power outage above 20 hours in Lagos and Port Harcourt.

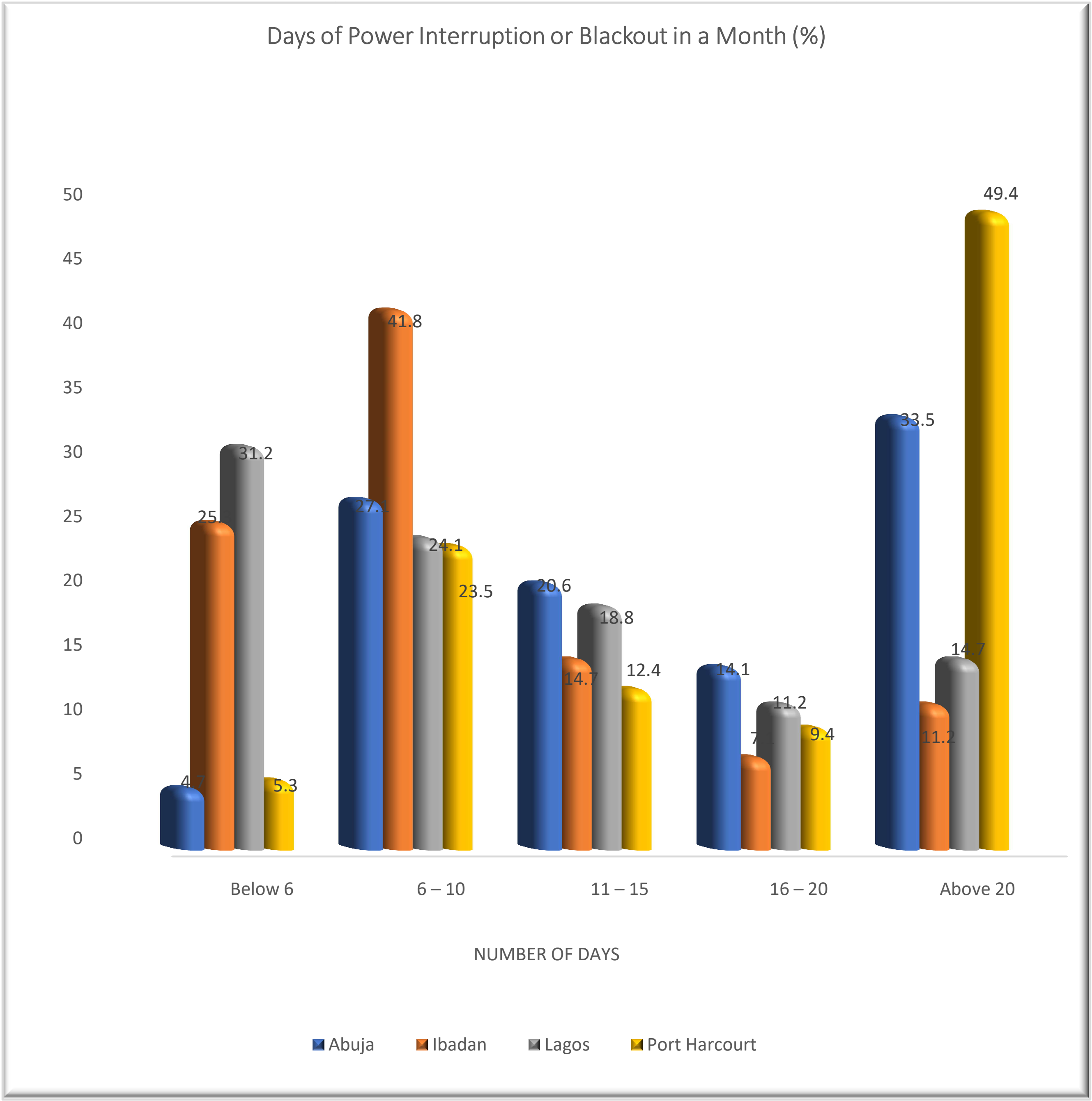

Figure 4.9. Days of Power Interruption or Blackout in a Month.

Source: Author's Compilation, 2018.

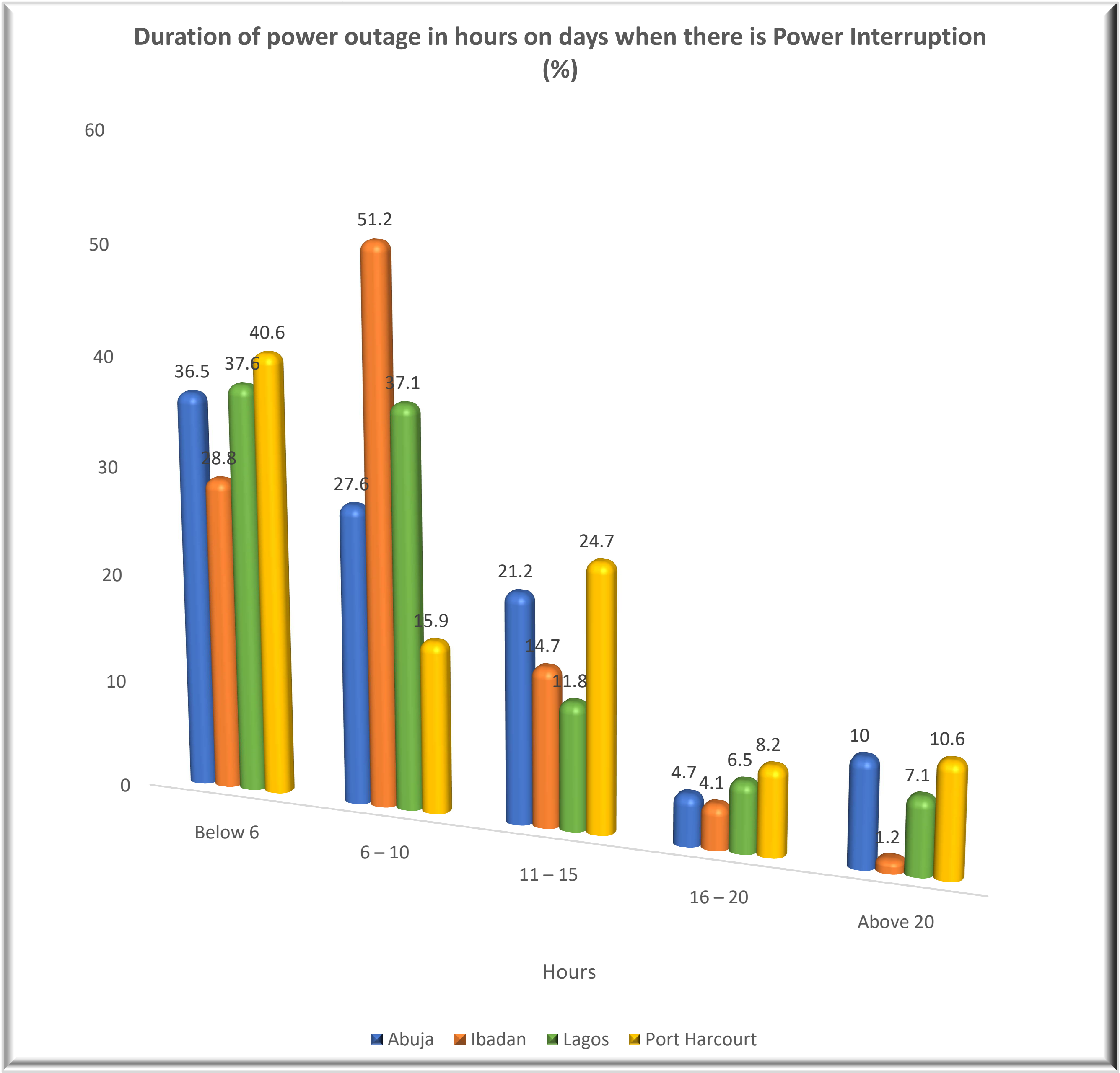

Figure 4.10. Duration of power outage in hours on days when there is Power Interruption

Source: Author's Compilation, 2018.

Level of Satisfaction on Current State of Electricity

Result shows in Table 4.3 that in all locations, a huge percentage of the respondents in the study areas are not satisfied with the current state of electricity supplied. The table further reveals the reasons of the respondents not being satisfied. 67%, 88.2%, 46.7 and 100% reported that the frequency of service is poor in Abuja, Ibadan, Lagos and Port Harcourt respectively. It can be deduced that the frequency of service of power supply has been a major challenge in all the study locations. This is followed by others comprising of voltage quality issues, poor technical response to faults, etc. with 33% of Abuja and 11.8% of Ibadan respondents affirming these issues.

Table 4.3. Level of Satisfaction on Current State of Electricity

		Abuja	Ibadan	Lagos	Port Harcourt	Total
Current State of Electricity Supply and Level of Satisfaction (%)	Not satisfied at all	69.4	64.7	75.8	57.6	67
	Reasonably	27.1	33.5	21.2	42.4	31
	Very satisfied	3.5	1.8	3	0	2
Reasons for not Satisfied Responses (%)	Frequency of service	67	88.2	46.7	100	73.1
	Others	33	11.8	53.3	0	26.9

Source: Author's Computation; underlying data from Field Survey, 2018

Electricity Consumption

Figure4.11 shows respondents' idea on the number of kilowatt-hours of electricity consumed every month. Result revealed that 40% of Lagos respondents consumes between 100-200kWh every month, 38.8% and 26.5% of respondents use about 100-200kWh in Ibadan and Port Harcourt respectively. Only about 4.1% and 3.5% of Abuja and Port Harcourt households respectively use above 400kWh every month. Also, only about 30%, 6.5%, 13% and 16.5% consumes less than 51kWh every month. These results depict the extent of poor electricity service delivery to the households in the different locations every month from their respective Electricity distribution companies. It further buttresses the reason for the high dependency on alternative sources of power; usually backup generators.

Amount Spent on Electricity Monthly

Figure 4.12 below shows the average amount spent on electricity monthly. It is apparent in the figure below that 33.5%, 45.3%, 35.3% and 51.8% of the respondents spend between N2,000-N5,000 monthly on electricity from their respective DISCOs in Abuja, Ibadan, Lagos and Port Harcourt. About 21.8%, 0.6%, 24.1% and 8.2% of the respondents in Abuja, Ibadan, Lagos and Port Harcourt respectively spend between N10,000-N20,000 on electricity. On the extreme, 32.9% of the respondents spend less than N2,000 on electricity in Ibadan and only 6.5% of the respondents in Lagos spend above N20,000 on electricity.

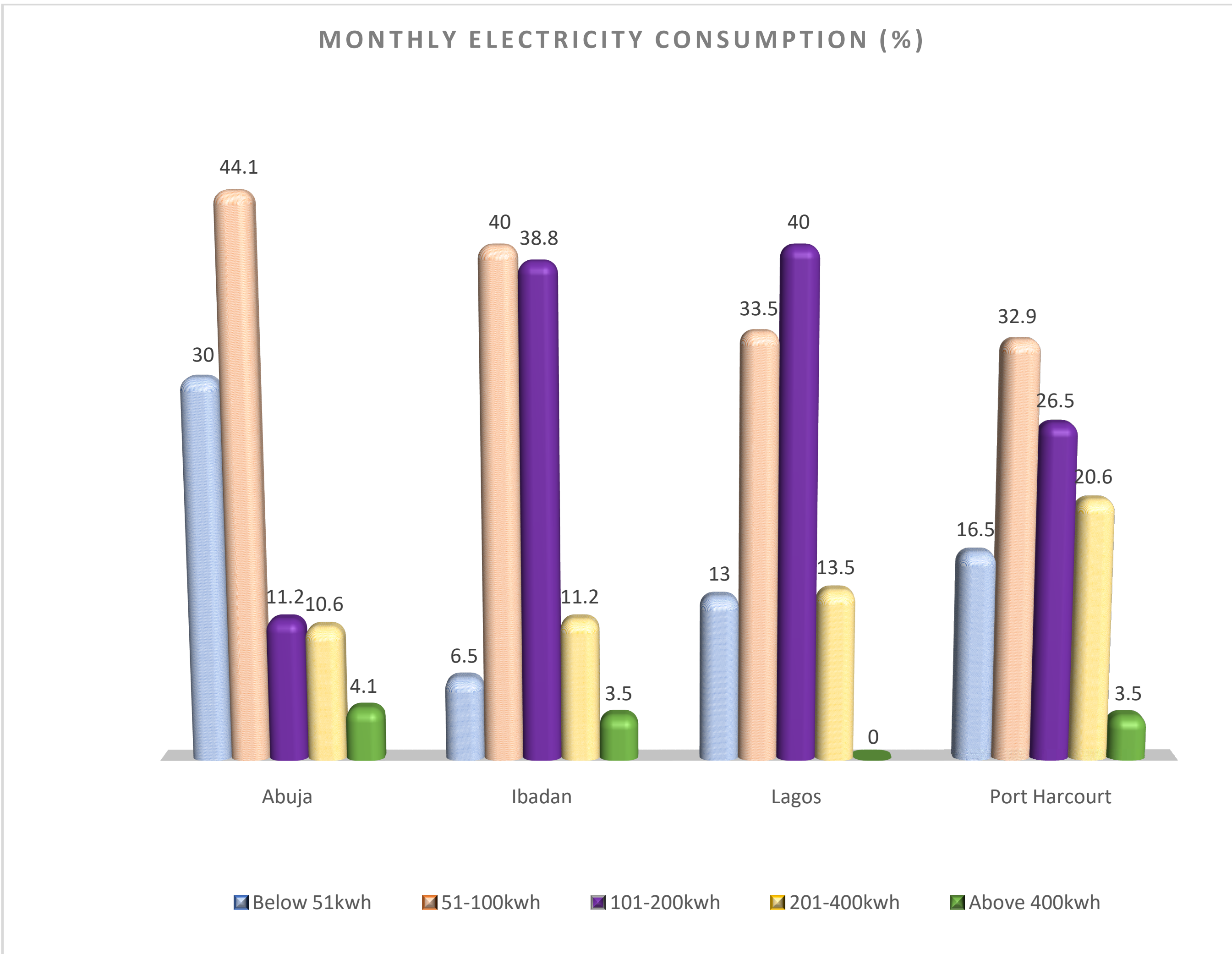

Figure 4.11. Monthly Electricity Consumption

Source: Author's Compilation, 2018.

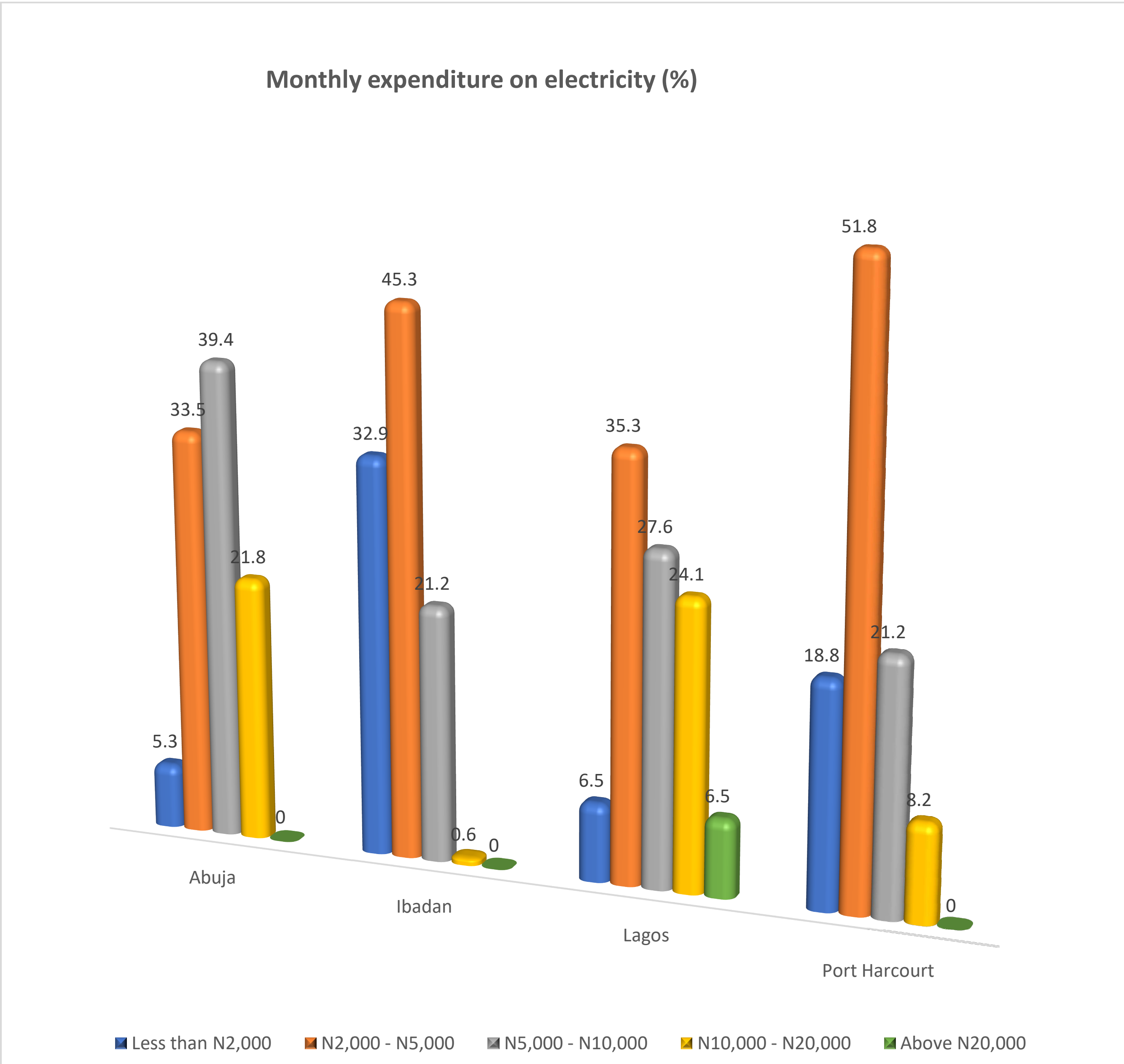

Figure 4.12. Monthly Expenditure on Electricity

Source: Author's Compilation, 2018.

Amount Spent on Alternative Source of Power during Power Outages in a month

Figure 4.13 shows the average amount spent on alternative source of power. It is evident in the table below that about 32.4%, 32.9%, 45.9% and 15.3% of the respondents in Abuja, Ibadan, Lagos and Port Harcourt respectively reports that they spend between N5,000-N10,000 on alternative power supply during outages in a month usually backup generator. Also, about 9.4%, 7.1%, 15.9% and 16.5% of the respondents claim to spend between the range of N10,000-N20,000 every month on alternative source of power. Only about 4.7% of the respondents in Port Harcourt spend above N20,000 monthly on alternative power source during outages.

Household works dependence on the Availability of Power Supply

As presented in Figure 4.14, majority of households' work in Abuja (64.7%) are not dependent on the availability of electricity while 41.2% and 67.6% of the respondents in Lagos, and Port Harcourt are partially dependent on the availability of electricity. Also, about 33.6% of respondents' households' work are highly dependent on electricity in Ibadan.

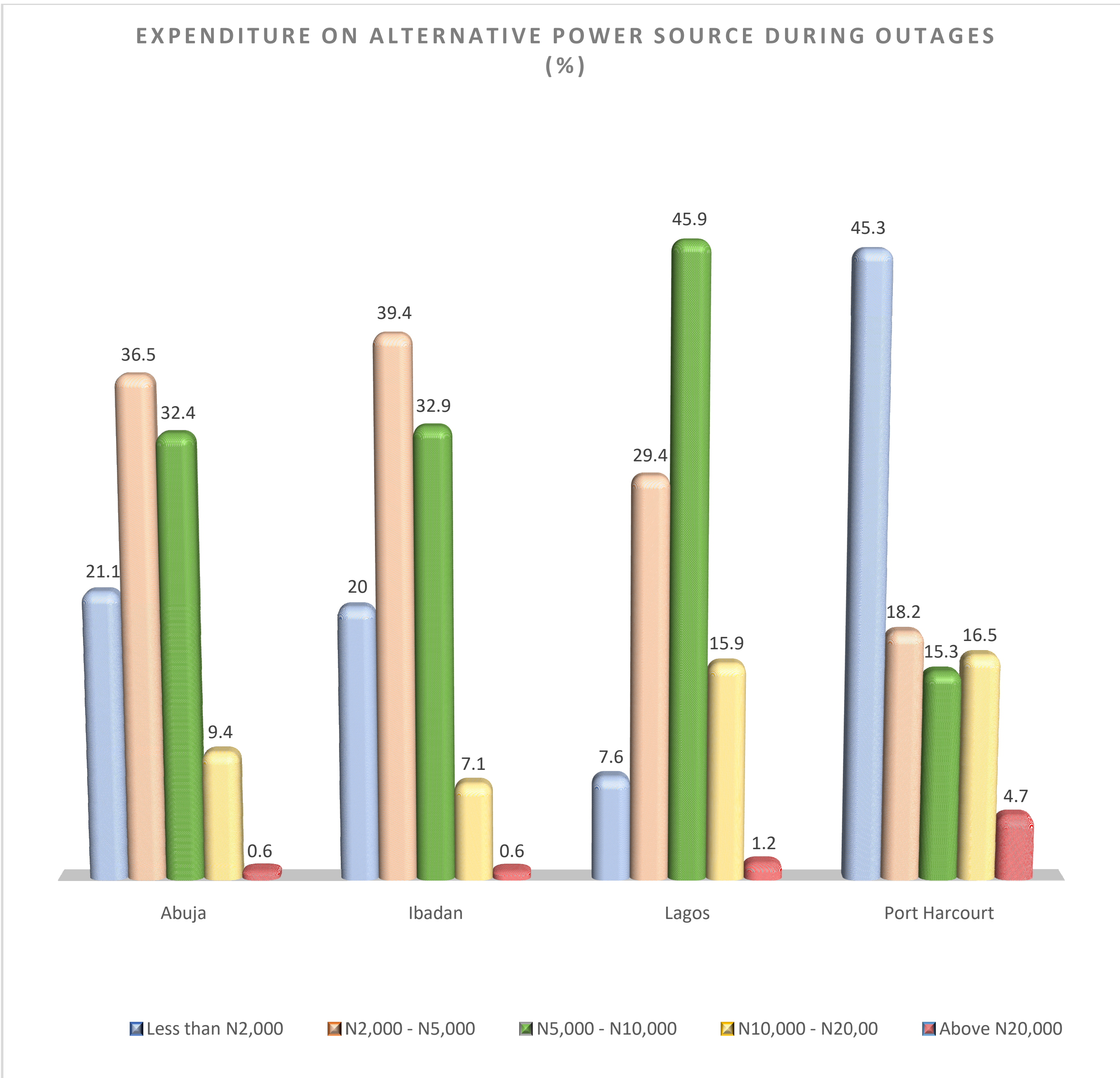

Figure 4.13. Monthly Expenditure on Alternative Power source during Outages

Source: Author's Compilation, 2018.

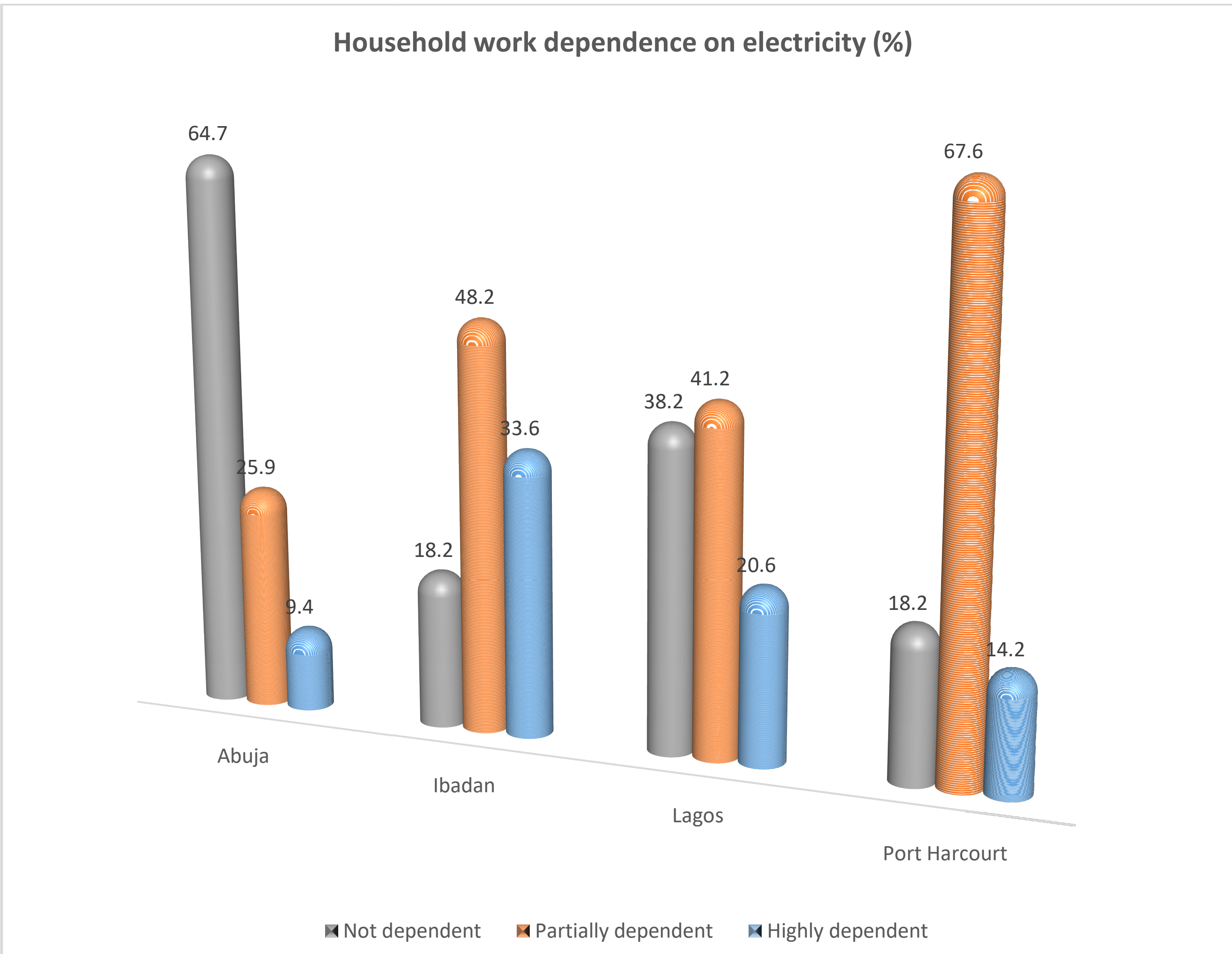

Figure 4.14. Household Work dependence on Electricity

Source: Author's Compilation, 2018.

Amount lost or spent in repairing or replacing the Appliances in the last one year

Figure4.15 presents respondents average expenditure spent on repairs and replacement of appliances as a result of power instability. In Abuja, the majority of about 35.3% of the respondents spent the amount range of N5,000 – N10,000 in repairing or replacing appliances in the last one year, while on the minimum, (1.8%). 38.2% of households in Ibadan spent within the range of N10,000 – N20,000 and 13.5% spent above N20,000. In Lagos also, the maximum of 44.7% of the respondents spent within the range of N10,000 – N20,000 and minimal percentage of 1.2% below N2,000. Finally, in Port Harcourt, about 42.9% of the respondents spentabove N20,000 in repairing or replacing appliances affected by poor quality of electricity supply in the last one year.

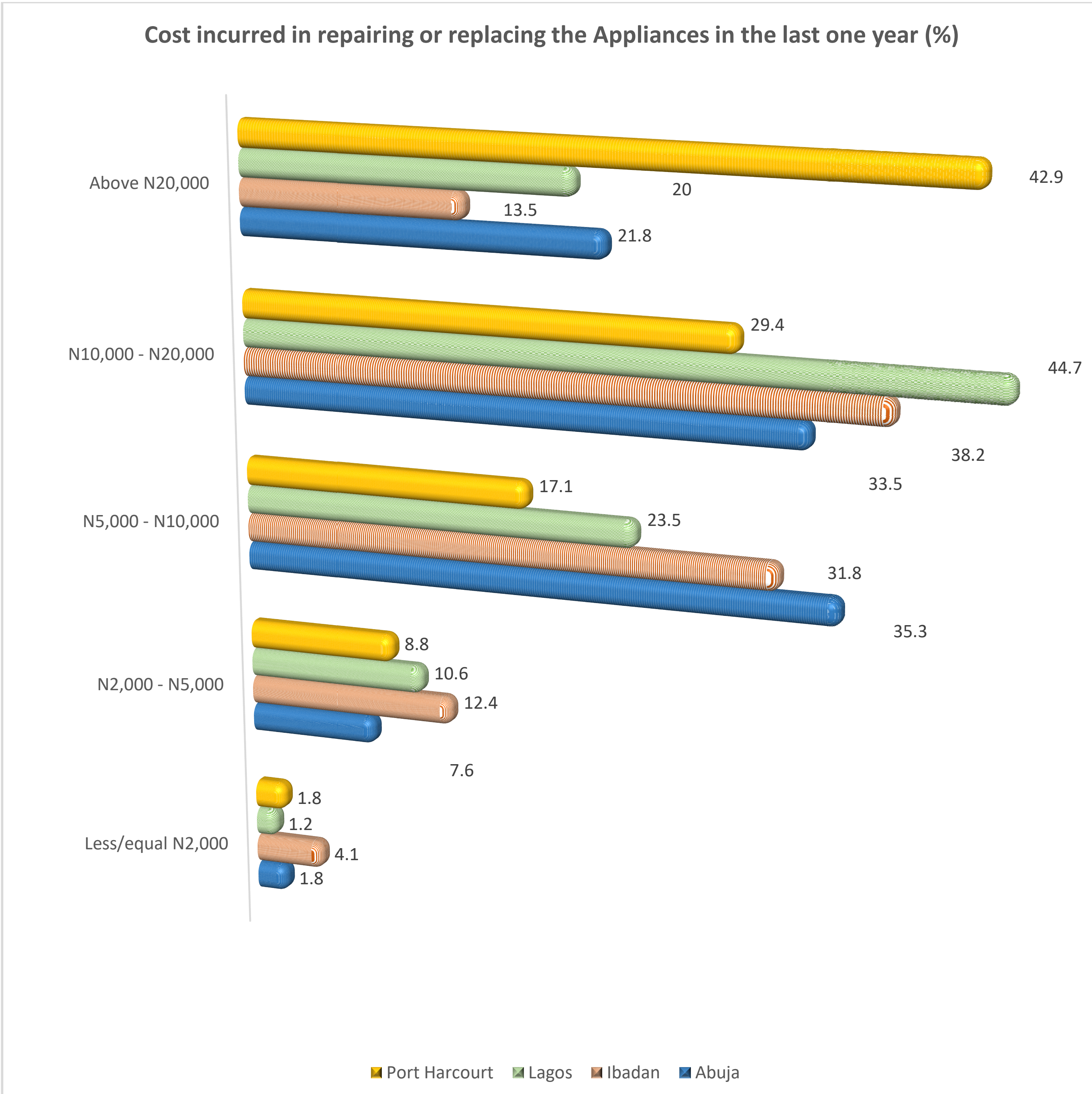

Figure 4.15. Cost Incurred in Repairing or Replacing the Appliances in the last One Year

Source: Author's Compilation, 2018.

Respondents' Perceptions on the Quality Dimensions of Electricity

Table 4.4 shows the perceptions of households on reliability of electricity, voltage stability and the commercial quality of electricity supplied which include all transactions and various form of contacts between the electricity companies and customers.

From Table 4.4, on average, about8.2% of the respondents reported that they experienced reliable power supply while the remaining 91.8% reported that their electricity supply was unreliable. More than 44% of the respondents in Abuja, Ibadan and Lagos reported that the customer service and response time of the electricity companies to complaints or rectifying technical faults was poor. Also, only a few reported being given prior notification before outages and that appropriate measures have been taken by the authorities involved in solving the electricity problems.

Table 4.4. Households' Perceptions on the Quality Dimensions of Electricity

		Abuja	Ibadan	Lagos	Port Harcourt	Total
Reliability of Electricity Supply (%)	Not reliable	36.5	52.4	51.8	37.1	44.4
	Moderately reliable	26.5	32.9	24.7	44.7	32.2
	Reliable	15.3	11.2	16.5	17.6	15.1
	Very reliable	15.9	2.4	5.3	0.6	6
	Excellent	5.9	1.2	1.8	0	2.2
Voltage Quality of Electricity Supply (%)	Very poor	10.6	0.6	5.3	7.1	5.9
	Poor	24.7	7.6	40	12.9	21.3
	Good	34.1	35.3	37.1	41.2	36.9
	Very good	30.6	44.7	14.1	31.2	30.1
	Excellent	0	11.8	3.5	7.6	5.7
Commercial quality of electricity supply (%)	Very poor	29.4	7.6	15.9	28.2	20.3
	Poor	44.1	58.8	60.6	35.9	49.9
	Good	14.1	29.4	17.6	33.5	23.7
	Very good	11.8	4.1	4.7	2.4	5.7
	Excellent	0.6	0	1.2	0	0.4

Source: Author's Computation; underlying data from Field Survey, 2018

Prior notification before an outage (planned/unplanned)

In view of the responses below, Figure 4.16 elucidates individual awareness or notification before power outage. Nevertheless, more than 80% of all the households in Abuja, Ibadan, Lagos and Port Harcourt all reported that they don't receive any prior notification before an outage. Only in Abuja, that about 15.9% of the respondents claim they receive notifications mostly on planned outages in cases of maintenance.

Respondents' perception on Appropriate Authorities solving power problems

Figure 4.17 elucidates households' perception on the efforts of the appropriate authorities in resolving the consistent power issues. Over 70% of all the households in Abuja, Ibadan, Lagos and Port Harcourt all reported that the appropriate authorities haven't done enough in closing the power deficiency gap.

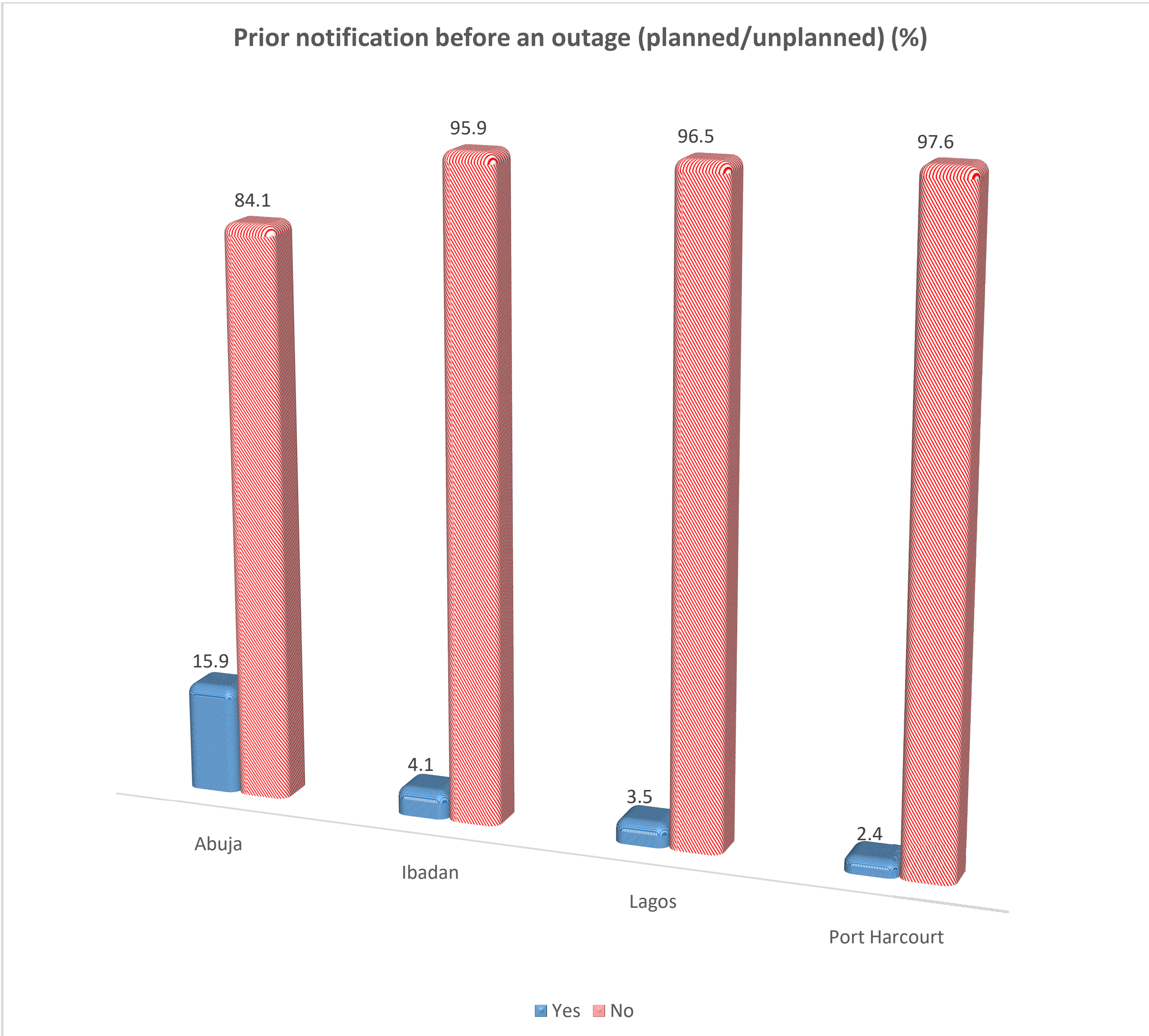

Figure 4.16. Prior Notification before an Outage (Planned/Unplanned)

Source: Author's Compilation, 2018.

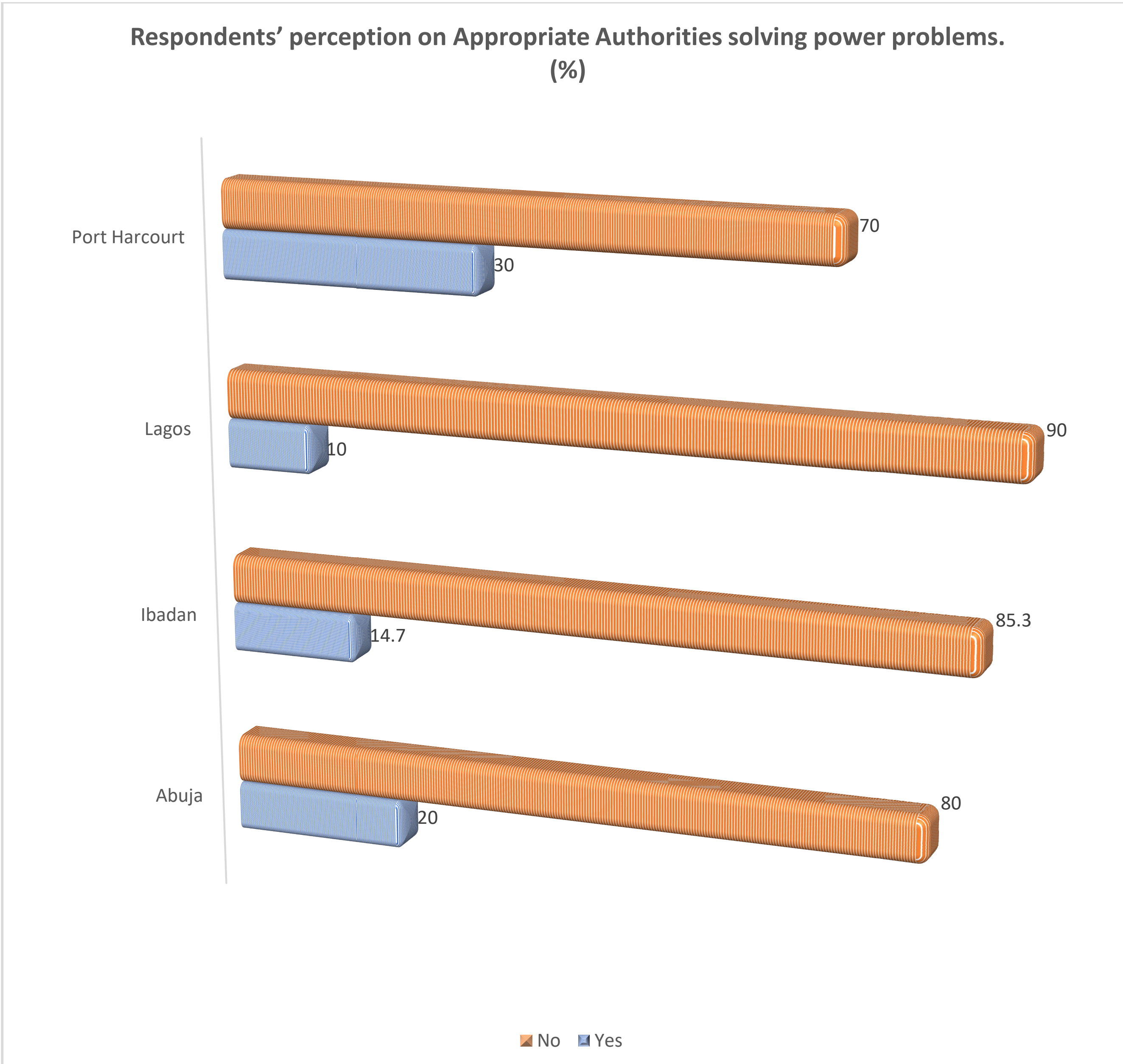

Figure 4.17. Households' Perception on Appropriate Authorities Solving Power Problems

Source: Author's Compilation, 2018.

Other data on attributes of existing electricity supply and other related issues are shown in Appendix 2.

4.2 Impact of Quality of Power Supply on Household Welfare

Figure 4.18, 4.19, 4.20 and 4.21 belowshow the effects of poor quality of electricity supply on households' activities which is a measure of their welfare in the four metropolises.

Figure 4.18 shows that about 73.5% of household in Abuja electrical appliances are affected by poor quality of electricity supply. Over 50% also agree that the poor power supply affect their ability to work from home, do their domestic activities such as laundry and even give them a sense of insecurity especially at night because of fear of accidents and crime.

Figure 4.19 revealed that more than 80% of household in Ibadan electrical appliances are affected by poor quality of electricity supply. Over 60% of the respondents also affirmed to the fact that the poor power supply affects their ability to work from home, do their domestic activities such as laundry and even give them a sense of insecurity especially at night because of fear of accidents and crime.

From figure 4.20, the results revealed that more than 70% of household in Lagos electrical appliances are affected by the poor quality of electricity supply. Over 50% of the respondents also affirmed to the fact that the poor power supply cause them discomfort and affect their ability to work from home, do their domestic activities such as laundry and give them a feeling of insecurity especially at night because of fear of accidents and crime.

In figure 4.21 below, the results elucidate that more than 80% of household in Port Harcourt electrical appliances are affected by the poor quality of electricity supply. Over 50% of the respondents also affirmed to the fact that the poor power supply cause them discomfort, prevents their domestic activities such as laundry and give them a feeling of insecurity especially at night because of fear of accidents and crime. More than 40% claim that the unstable power supply affects their ability to work from home.

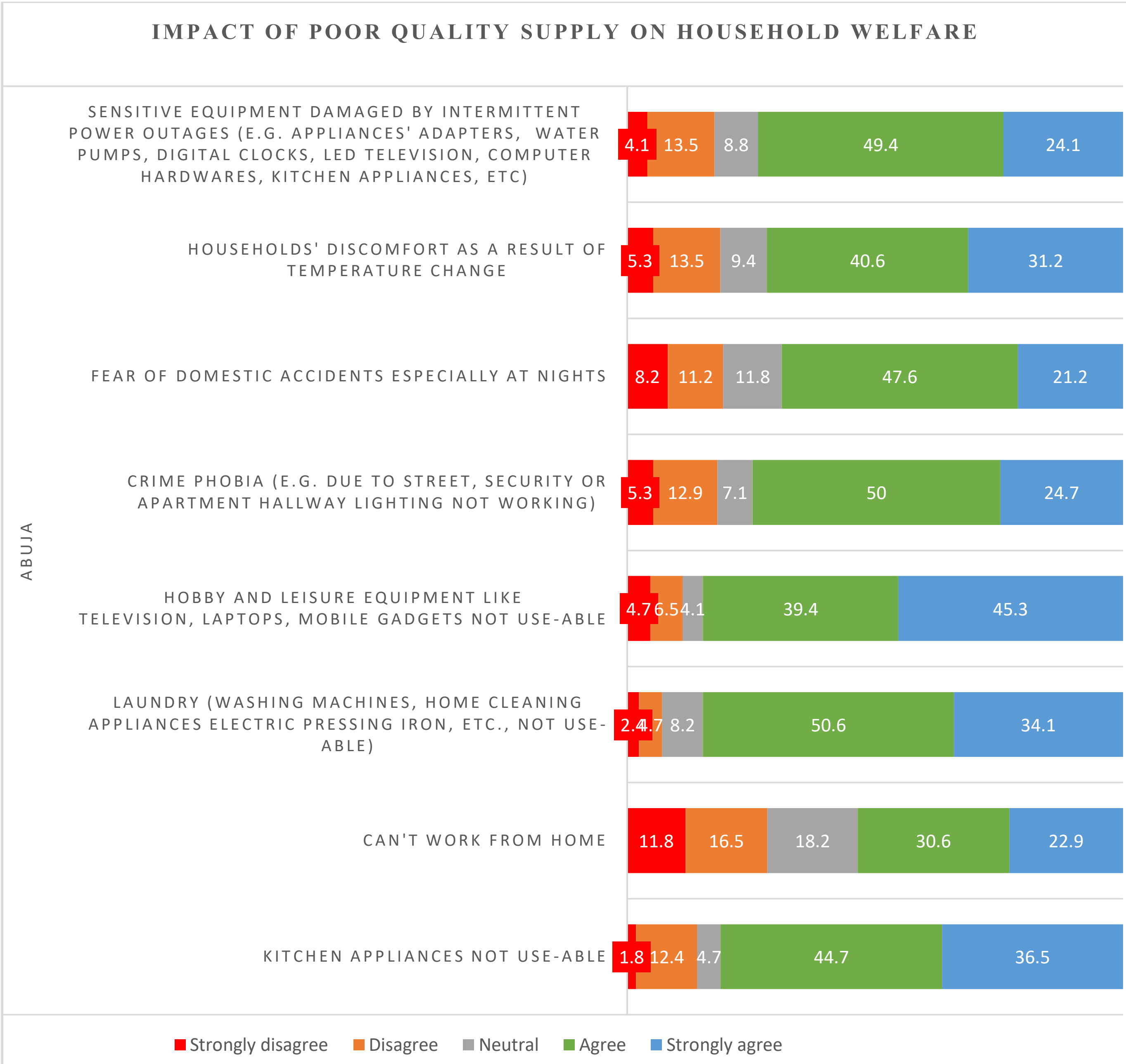

Figure 4.18. Impact of Poor Electricity Supply on Household Activities in Abuja.

Source: Author's Compilation, 2018.

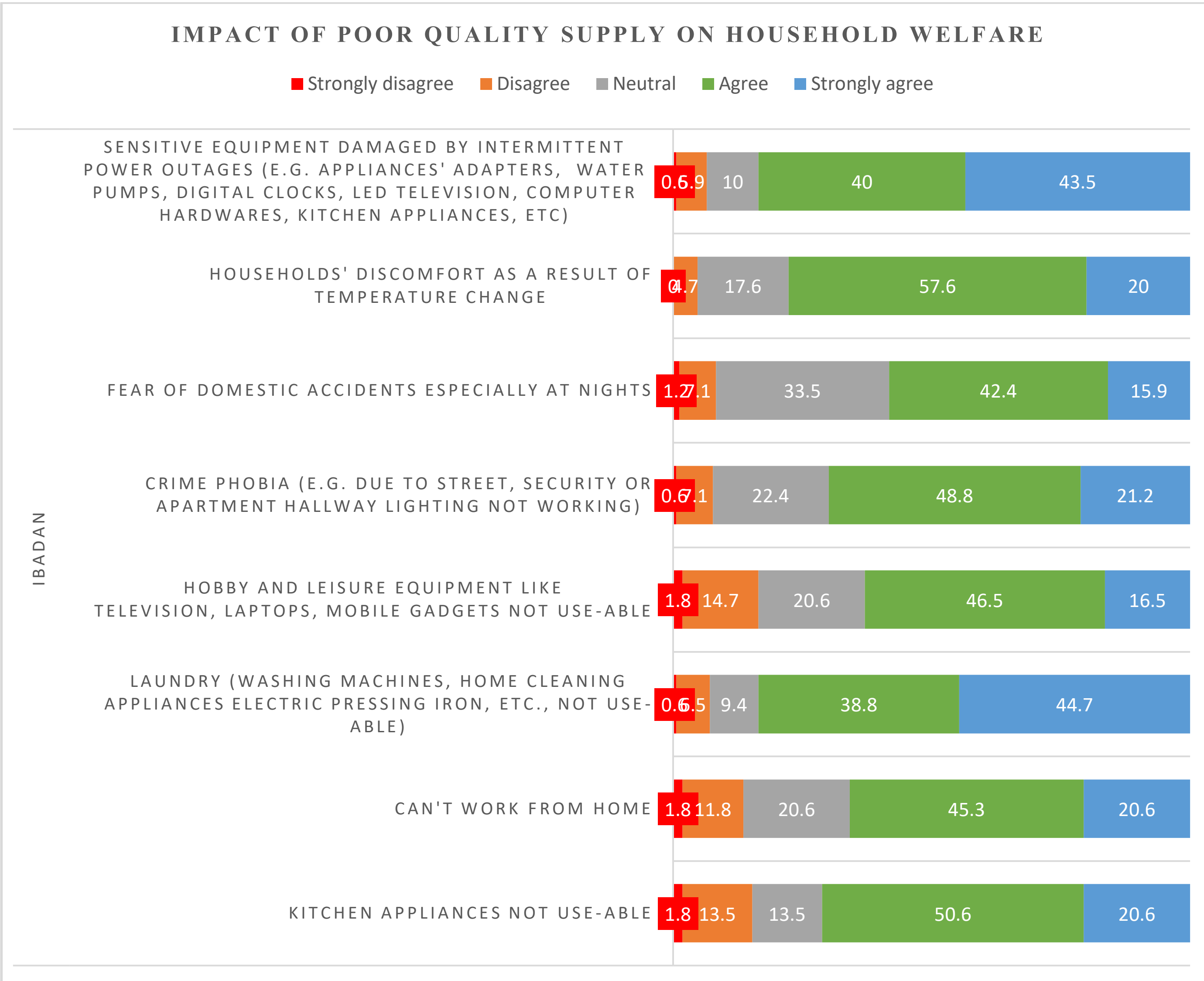

Figure 4.19. Impact of Poor Electricity Supply on Household Activities in Ibadan.

Source: Author's Compilation, 2018.

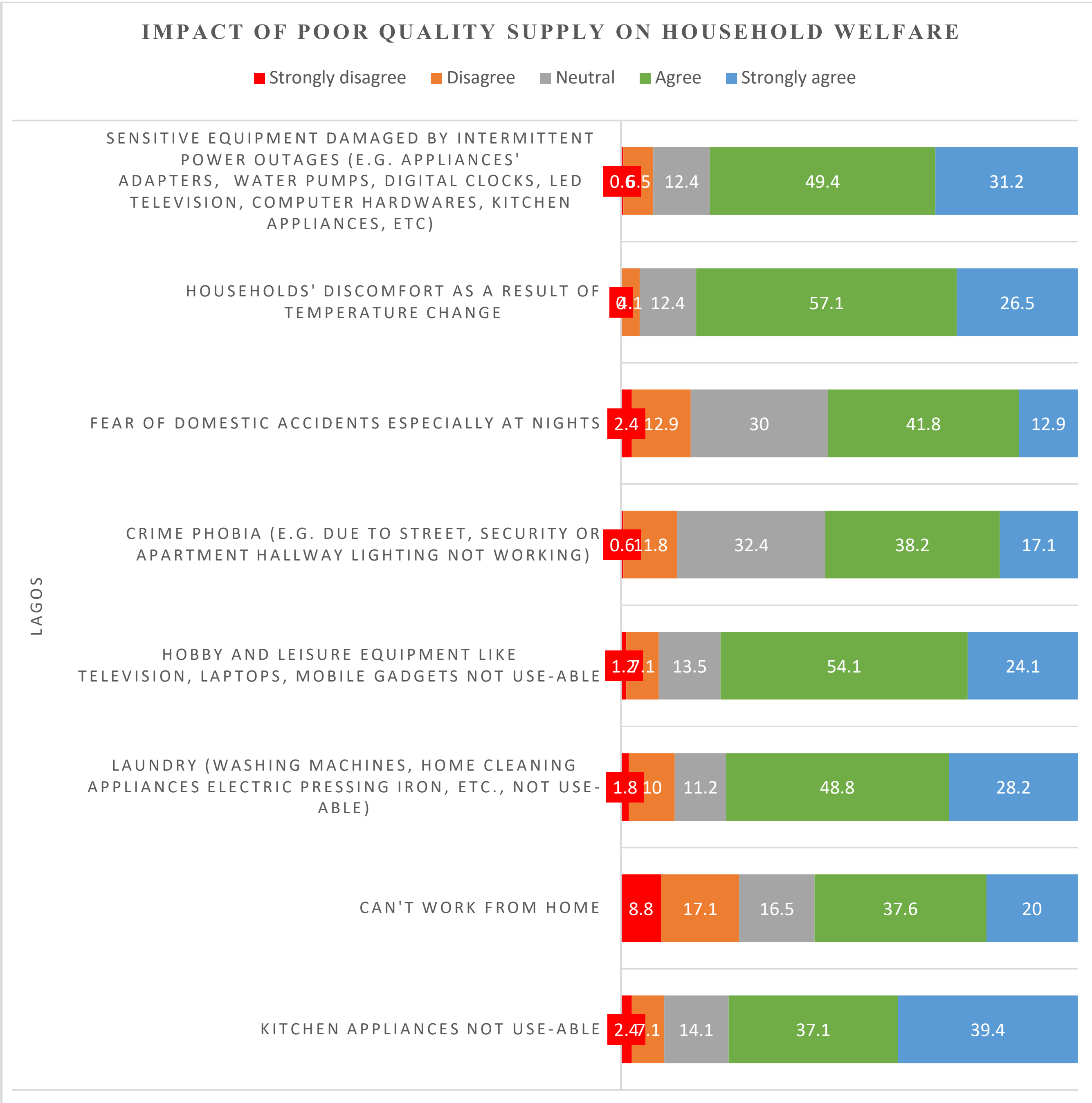

Figure 4.20. Impact of Poor Electricity Supply on Household Activities in Lagos.

Source: Author's Compilation, 2018.

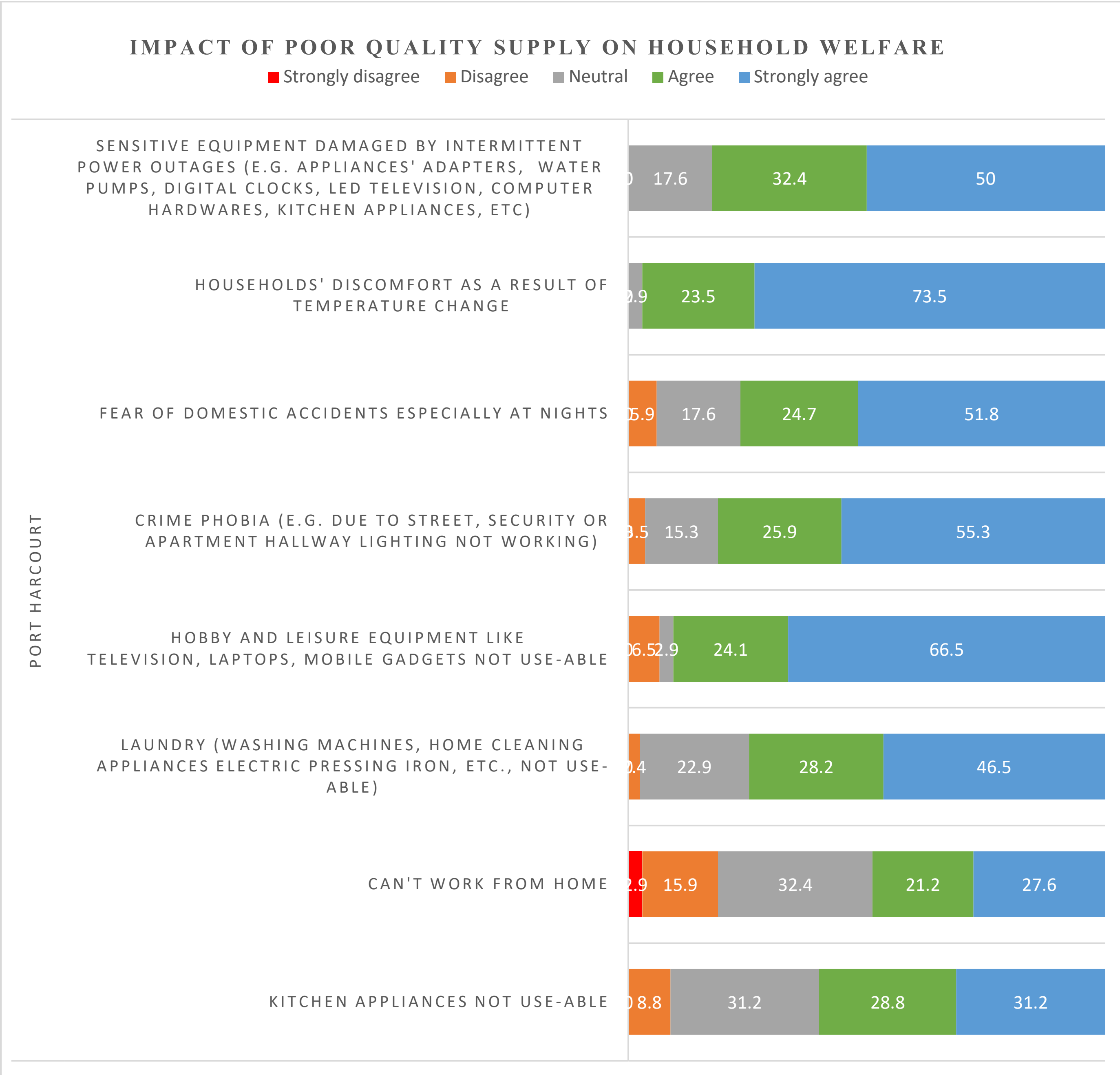

Figure 4.21. Impact of Poor Electricity Supply on Household Activities in Port Harcourt.

Source: Author's Compilation, 2018.

4.3 Drivers of Willingness to Pay for Improved Electricity Supply: Ordered Probit Regression Analysis

The Ordered Probit regression results based on the model specified in the preceding section are presented in this section. The model investigates the factors that influence consumers' WTP to pay for quality electricity supply in the study area. In the model, the outcome variable is willingness to pay (WTP) (coded 1, 2, 3; 1 being N25 – N40 and 3 being Above N55). Also, the variables used as predictors are Household Size, Monthly Outages (which are continuous variables),Household Monthly Income, Highest Educational Level, Reliability of Current Supply, Cost incurred in damage of appliances and Cost of Alternative Power Supply (which are categorical variables). However, it should be stated that 'n-1' (n being the number of categories) dummies were created for each of the categorical variables in the model. The reference category for Household Monthly Income is Below N51,000, Highest Educational Level; no formal education, Reliability of Current Supply; Excellent, Cost of Damage;Below N2,000.00 and Cost of Alternative Supply is Below N2,000. The models were estimated separately for each of the enumerated cities and full sample for easy comparison.

4.3.1 Ordered Probit Result

The result of the estimated model to investigate the determinants that influence consumers' WTP for improved quality of electricity supply in the study area is presented in Table 4.5. As noted earlier, the results are estimated using Ordered Probit regression approach, since the outcome variable (WTP) is an ordered categorical variable. The result shows the regression coefficients, their standard errors, and the associated p-values (in form of *).

Table 4.5. Ordered Probit Results (Z-scores)

VARIABLES	(1) FCT	(2) Ibadan	(3) Lagos	(4) Port Harcourt	(5) Full Sample
Household Size	-0.015(0.078)	-0.065(0.048)	-0.058(0.057)	-0.023(0.073)	-0.048(0.026)
Household Monthly Income (Ref. Cat.: Below N50000)					
N50000 - N100000	0.878(0.637)	-0.244(0.381)	-0.168(0.284)	1.000(0.677)	0.241(0.164)
N100000 - N200000	1.778***(0.665)	-0.253(0.451)	-0.487(0.352)	0.277(0.736)	0.334*(0.187)
N200000 – N500000	1.487*(0.762)	0.178(0.551)	0.026(0.539)	0.334(0.755)	0.272(0.224)
Above N500000	0.284(0.934)	0.743(0.607)	-4.804(530.26)	0.896(0.81)	0.701***(0.25)
Highest Educational Level (Ref. Cat.: No Formal Education)					
Primary	-0.771(1074.872)	-3.698(308.574)	-12.709(873.018)	5.727(126.966)	0.473(0.423)
Secondary	2.281(893.726)	-0.227(0.598)	-7.944(406.266)	-0.298(0.415)	0.008(0.249)
Tertiary	2.264(893.726)	-0.156(0.52)	-7.836(406.266)	-0.131(0.393)	-0.06(0.241)
Reliability of Current Supply (Ref. Cat.: Excellent)					
Very Reliable	0.303(0.563)	-1.345(561.785)	0.078(0.824)	0.307(0.258)	0.331*(0.178)
Reliable	-1.324**(0.67)	3.931(435.378)	-0.918(0.745)	-1.287***(0.389)	-0.254(0.191)
Moderately Reliable	-0.082(0.623)	3.603(435.378)	-0.829(0.76)	-1.397***(0.441)	-0.19(0.21)
Not Reliable	-0.859(0.554)	3.495(435.378)	-0.711(0.708)	-0.415(0.33)	-0.078(0.179)
Cost of Damage (Ref. Cat.: Below2000)					
N2000 - N5000	0.432(48.616)	-0.051(0.557)	4.232(491.852)	0.022(0.805)	0.01(0.373)
N5000 - N10000	0.499(48.616)	0.155(0.538)	5.351(491.852)	0.238(0.805)	0.431(0.354)
N10000 - N20000	0.391(48.616)	0.16(0.548)	5.27(491.852)	-0.297(0.81)	0.108(0.356)
Above N20000	0.361(48.616)	0.491(0.601)	5.381(491.852)	0.209(0.822)	0.423(0.366)
Cost of Alternative Power Supply (Ref. Cat.: Below2000)					
N2000 - N5000	0.256(0.663)	0.648(0.447)	0.53(0.608)	-0.316(0.309)	0.025(0.161)
N5000 - N10000	-0.159(0.706)	1.574***(0.488)	1.047*(0.582)	0.292(0.342)	0.431**(0.17)
N10000 - N20000	0.274(0.798)	2.252***(0.67)	1.454**(0.649)	0.436(0.394)	0.67***(0.216)
Above N20000	-0.386(89.373)	7.778(528.792)	-10.418(585.515)	1.106*(0.597)	0.927**(0.425)
Number of Outage	0.004(0.018)	-0.022(0.019)	0.006(0.015)	-0.088***(0.019)	-0.021***(0.007)
Constant cut1	8.112	4.739	-2.105	-2.582	4.409
Constant cut2	8.900	6.110	-1.526	-1.892	5.032
Observations	**170**	**170**	**170**	**170**	**680**
Pseudo R-squared	**0.325**	**0.239**	**0.322**	**0.218**	**0.142**
LR-chi2	**75.73**	**57.75**	**75.19**	**77.19**	**170.90**
Prob > chi2	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

Source: *Author's Computation, underlying data from Field Survey 2018. (Reliability of current supply: 1=Not Reliable, ... , 5=Excellent)*

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*

Clearly from Table 4.5, the estimated LR-chi2 (Prob > chi2) in Columns 1, 2, 3, 4, and 5 of the table respectively indicate that the models are statistically significant and confirm the fitness of the models. Also, Pseudo R-squared values of 0.325 0.239, 0.322, 0.218 and 0.142 in Columns 1, 2, 3, 4, and 5 respectively confirm the fitness of the models.However, little emphasis is placed on this since ‘goodness of fit’ is not as important compared with the statistical and economic importance of the explanatory variables (Wooldridge, 2010)

Focusing on the coefficients of the regression result, Household monthly income is positive and statistically significant in Abuja and the full sample. The positive sign of the coefficients implies that an increase in come will lead to the likelihood of household willing to pay more for the reliable and improved electricity supply with good quality. Thus, this result correlates with the findings of Abdullah and Mariel (2010) and Kateregga (2009) affirming that income is an important determinant while considering the amount African households are willing to pay for electricity service improvement. The result also conforms to economic theory which posits that income is positively related to a normal good such as improved electricity supply.

Reliability of the current electricity supply was found to be statistically significant across the cities within the 1% to 5% conventional significance levels. Abuja and Port Harcourt have negative signs. This implies that as households’ impression of the reliability of the current electricity supply decrease, the likelihood of their WTP increase. This is because, those to whom electricity supply is unreliable are more likely to pay more to better the service as compared to those to whom supply is already reliable. Concerning the cost of alternative power supply in Ibadan, Lagos as well as the full sample model, a unit increase in the cost associated with alternative supply will lead to an increase in households’ WTP.The positive signs of the coefficients indicate that with an increase in the cost of alternative sources of electricity such as backup generators, households are more likely and willing to pay more for improved electricity supply.

However, as the frequency in monthly outages increase, the likelihood of their WTP decrease in Port Harcourt and the full sample model.

4.3.2 Marginal Effects for the Ordered Probit

Better interpretations of estimates from an ordered probit model can be made with the marginal effects.Mean values were used in the computation of the marginal effects by categories of households' WTP for improved quality of electricity supply across the cities and the results for the categories are quite similar; particularly in terms of the signs and statistical significance. The result actually shows the changes in probabilities for a unit change in an explanatory variable.

4.3.3 Marginal Effects for N25 – N40 Category (Pr(WTP==1))

Table 4.6 presents the marginal effects for the households' WTP between N25 – N40 (Pr(WTP==1)).

From the result, the coefficient of household monthly income is negative and statically significant at 1% and 5% at income categories of N101,000 –N200,000 and N201,000 – N500,000 respectively in Abuja. Households within the income categories of N101,000 – N200,000 in Abuja are 32.6% less likely to be in the N25-N40 category compared to households with income less than N51,000.00. In other words, this implies that households within the income category of N101,000 – N200,000 are 32.6% less willing to pay for the improved quality of electricity supply compared to households whose income falls below N51,000 category.

Households within the income categories of N201,000 – N500,000 in Abuja are 27.3% less likely to be in the N25-N40 category compared to households with income less than N51,000.00. This implies that a unit increase in household monthly income (in the income category of N201,000 – N500,000) is associated with households being 27.3% less likely to pay for the improved quality of electricity supply compared to households whose income falls below N51,000 category.

Household monthly income was also negative and statistically significant at 1% in the Full sample for households that earn above N500,000. Households are 21.2% less willing to pay for the improved electricity service (within the N25 – N40 tariff category) compared to households whose income falls below N51,000 category.

This might be because an increase in income gives the household more purchasing power to afford other alternative sources of power to compensate for the shortfall in electricity supply.

Table 4.6. Marginal Effects for N25 – N40 Category (Pr(WTP==1))

	(1) FCT	(2) Ibadan	(3) Lagos	(4) Port Harcourt	(5) Full Sample
Household Size	0.003(0.014)	0.016(0.012)	0.015(0.015)	0.006(0.019)	0.015*(0.008)
Household Monthly Income (Ref. Cat.: Below N51000)					
N51000 - N100000	-0.161(0.116)	0.059(0.092)	0.044(0.074)	-0.263(0.174)	-0.073(0.05)
N101000 - N200000	-0.326***(0.115)	0.061(0.109)	0.127(0.09)	-0.073(0.193)	-0.101*(0.056)
N201000 – N500000	-0.273**(0.135)	-0.043(0.134)	-0.007(0.141)	-0.088(0.198)	-0.082(0.068)
Above N500000	-0.052(0.171)	-0.18(0.147)	0.125(13.84)	-0.235(0.21)	-0.212***(0.075)
Highest Educational Level (Ref. Cat.: No Formal Education)					
Primary	0.141(196.924)	0.897(74.873)	0.332(22.786)	-0.15(3.335)	-0.143(0.128)
Secondary	-0.418(163.737)	0.055(0.145)	0.207(10.604)	0.078(0.109)	-0.002(0.075)
Tertiary	-0.415(163.737)	0.038(0.126)	0.205(10.604)	0.034(0.103)	0.018(0.073)
Reliability of Current Supply (Ref. Cat.: Excellent)					
Very Reliable	-0.055(0.103)	0.326(136.313)	-0.02(0.215)	-0.081(0.067)	-0.1*(0.053)
Reliable	0.243**(0.12)	-0.954(105.641)	0.24(0.192)	0.338***(0.096)	0.077(0.058)
Moderately Reliable	0.015(0.114)	-0.874(105.641)	0.216(0.197)	0.367***(0.109)	0.058(0.063)
Not Reliable	0.157(0.1)	-0.848(105.641)	0.186(0.183)	0.109(0.086)	0.024(0.054)
Cost of Damage (Ref. Cat.: Below2000)					
N2000 - N5000	-0.791(89.067)	0.012(0.135)	-1.105(128.376)	-0.006(0.212)	-0.003(0.113)
N6000 - N10000	-0.914(89.067)	-0.038(0.131)	-1.397(128.376)	-0.062(0.211)	-0.13(0.107)
N11000 - N20000	-0.717(89.067)	-0.039(0.133)	-1.376(128.376)	0.078(0.213)	-0.033(0.107)
Above N20000	-0.662(89.067)	-0.119(0.146)	-1.404(128.376)	-0.055(0.216)	-0.128(0.11)
Cost of Alternative Power Supply (Ref. Cat.: Below2000)					
N2000 - N5000	-0.047(0.122)	-0.157(0.107)	-0.138(0.158)	0.083(0.08)	-0.007(0.049)
N6000 - N10000	0.029(0.129)	-0.382***(0.11)	-0.273*(0.149)	-0.077(0.09)	-0.13**(0.051)
N11000 - N20000	-0.05(0.146)	-0.546***(0.151)	-0.38**(0.164)	-0.115(0.103)	-0.203***(0.064)
Above N20000	0.708(163.737)	-0.189(12.831)	2.719(152.823)	-0.291*(0.154)	-0.28**(0.128)
Number of Outage	-0.001(0.003)	0.005(0.005)	-0.002(0.004)	0.023***(0.004)	0.006***(0.002)

Source: *Author's Computation, underlying data from Field Survey 2018. (Reliability of current supply - - 1=Not Reliable, ... , 5=Excellent)*

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*

Reliability of the current electricity supply was significant and positive at 5% significance level in Abuja and 1% in Port Harcourt. This implies that a unit increase in the reliability of current supply at the 'reliable' category will increase the probabilities of households' WTP for improved quality of electricity supply by 24.3% in Abuja. Also, households in Port Harcourt are 33.8.% and 36.7% more willing to pay for the improved electricity service (within the N25 – N40 tariff category) if reliability of current supply is increased.

The marginal cost of alternative power supply is significant in Ibadan at 1% for households spending between the ranges of N6,000 – N10,000 and N11,000 to N20,000 on alternative power supply. Thus, an increase in households' monthly cost of alternative power supply within the category of N6,000 – N10,000 and N11,000 to N20,000 will decrease the probabilities of households' WTP by 38.2% and 54.6% respectively.

The marginal cost of alternative power supply is negative and significant in Lagos at 5%. This implies that an increase in the monthly cost of alternative power supply within the category of N11,000 – N20,000 will decrease the probabilities of households' WTP by 38% in Lagos. Considering the Full sample, the marginal cost of alternative power supply is negative and significantat 1% for households spending N11,000 to N20,000 on alternative power supply. Also, it is significant at 5% for households whose expenditure on alternative power supply fall in the ranges of N6,000 – N10,000 and above N20,000.

Thus, this implies that an increase in the monthly cost of alternative power supply within the categories of N,6000 – N10,000 and above N20,000 will decrease the probabilities of households' WTP by 13% and 28% respectively compared to the households who spend on alternative power supply within the category of below N2,000.

The marginal effect of frequency of outages was positive and significant at 1% in Port Harcourt and the Full sample model. This implies that, an increase in the frequency of monthly power outages will increase the probabilities of households' WTP for improved quality of electricity supply by 2.3% in Port Harcourt and 0.6% in the Full sample.

4.3.4 Marginal Effects for N41– N55 Category (Pr(WTP==2))

Table 4.7 presents the marginal effects for the households' WTP between N41-N55 (Pr(WTP==2)). In this tariff category (N40-N55), Table 4.7 shows that household monthly income, cost of alternative power supply and the frequency of monthly outages are determinants of factors affecting households' WTP for improved quality of electricity supply.

From the result in Table 4.7, household income coefficient is positive and statistically significant at 5% in Abuja. Households within the income categories of N101,000 – N200,000 in Abuja are 11.5% more likely to be in the N40-N55 category respectively compared to households with monthly income below N51,000.00. This implies that a unit increase in Household Monthly Income (in the income category of N101,000 – N200,000) is associated with households being 11.5% more likely to pay for the improved quality of electricity supply compared to households whose income falls below N51,000 category. Also, the coefficient of household monthly income is positive and statically significant at 1% in the Full Sample for households with monthly income above N500,000. Thus, households within this income category are 6.1% more likely to pay for the improved electricity service with good quality.

The positive sign could be attributed to the fact that an increase in household income will reduce the household budget constraints and encourage paying for an improved quality of electricity supply to cater for their various activities that require electricity supply, hence, improving their welfare.

The marginal cost of alternative power supply is significant in Ibadan at 1% for households spending between the ranges of N6,000 – N10,000 and N11,000 to N20,000 on alternative power supply. This implies that an increase in the cost of alternative power supply within the expense category of N6,000 – N10,000 and N11,000 to N20,000 will increase the probabilities of households' WTP by 26.6% and 38.1% respectively.

The marginal cost of alternative power supply in this tariff category is significant in Lagos and the Full sample model with positive signs. This implies that an increase in the monthly cost of alternative power supply within the category of N11,000 – N20,000 will increase the probabilities of households' WTP by 14.7% in Lagos. Also, considering the Full sample, an increase in the monthly cost of alternative power supply within the categories of N,6000 –

N10,000 and above N20,000 will increase the probabilities of households' WTP for the improved quality of electricity supply by 3.8% and 8.1% respectively compared to the households who spend on alternative power supply within the category of below N2,000.

The marginal effect of frequency of outages was negative and significant at 1% in the Full sample model. This implies that, an increase in the frequency of monthly power outages will decrease the probabilities of households' WTP for improved quality of electricity supply by 0.2%.

Table 4.7. Marginal Effects for N41 – N55 Category (Pr(WTP==2))

	(1) FCT	(2) Ibadan	(3) Lagos	(4) Port Harcourt	(5) Full Sample
Household Size	-0.001(0.005)	-0.011(0.008)	-0.006(0.006)	0.001(0.002)	-0.004*(0.002)
Household Monthly Income (Ref. Cat.: Below N51000)					
N51000 - N100000	0.057(0.042)	-0.041(0.064)	-0.017(0.029)	-0.022(0.02)	0.021(0.014)
N101000 - N200000	0.115**(0.046)	-0.043(0.076)	-0.049(0.036)	-0.006(0.017)	0.029*(0.016)
N201000 – N500000	0.096*(0.05)	0.03(0.093)	0.003(0.054)	-0.007(0.018)	0.024(0.02)
Above N500000	0.018(0.06)	0.126(0.105)	-0.485(53.522)	-0.02(0.021)	0.061***(0.022)
Highest Educational Level (Ref. Cat.: No Formal Education)					
Primary	-0.05(69.47)	-0.626(52.236)	-0.128(8.812)	-0.127(2.806)	0.041(0.037)
Secondary	0.147(57.762)	-0.038(0.101)	-0.802(41.007)	0.007(0.009)	0.001(0.022)
Tertiary	0.146(57.762)	-0.026(0.088)	-0.791(41.007)	0.003(0.009)	-0.005(0.021)
Reliability of Current Supply (Ref. Cat.: Excellent)					
Very Reliable	0.02(0.037)	-0.228(95.1)	0.008(0.083)	-0.007(0.006)	0.029*(0.016)
Reliable	-0.086*(0.044)	0.665(73.702)	-0.093(0.076)	0.028*(0.017)	-0.022(0.017)
Moderately Reliable	-0.005(0.04)	0.61(73.702)	-0.084(0.078)	0.031(0.019)	-0.017(0.018)
Not Reliable	-0.056(0.037)	0.592(73.702)	-0.072(0.072)	0.009(0.008)	-0.007(0.016)
Cost of Damage (Ref. Cat.: Below2000)					
N2000 - N5000	0.279(31.421)	-0.009(0.094)	0.427(49.646)	0(0.018)	0.001(0.033)
N5001 - N10000	0.322(31.421)	0.026(0.091)	0.54(49.646)	-0.005(0.018)	0.038(0.031)
N10001 - N20000	0.253(31.421)	0.027(0.093)	0.532(49.646)	0.007(0.018)	0.009(0.031)
Above N20000	0.233(31.421)	0.083(0.102)	0.543(49.646)	-0.005(0.018)	0.037(0.032)
Cost of Alternative Power Supply (Ref. Cat.: Below2000)					
N2000 - N5000	0.017(0.043)	0.11(0.075)	0.054(0.061)	0.007(0.008)	0.002(0.014)
N6000 - N10000	-0.01(0.046)	0.266***(0.078)	0.106*(0.059)	-0.006(0.008)	0.038**(0.015)
N11000 - N20000	0.018(0.052)	0.381***(0.111)	0.147**(0.066)	-0.01(0.01)	0.058***(0.019)
Above N20000	-0.25(57.762)	0.132(8.951)	-0.105(5.91)	-0.024(0.017)	0.081**(0.038)
Number of Outage	0.0002(0.001)	-0.004(0.003)	0.001(0.001)	0.002*(0.001)	-0.002***(0.001)

Source: *Author's Computation, underlying data from Field Survey 2018. (Reliability of current supply - - 1=Not Reliable, ... , 5=Excellent)*
*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*

4.3.5 Marginal Effects for above N55 Category (Pr(WTP==3))

The marginal effects for households' WTP above N55 (Pr(WTP==3)) is presented in Table 4.8. In this category of tariff (Above N55), Table 4.8 shows that household monthly income, cost of alternative power supply, and frequency of monthly outages were all significant.

From the result in Table 4.8, household income coefficient is positive and statistically significant at 1% in Abuja. Households within the income categories of N101,000 – N200,000 in Abuja are 21.1% more likely to pay for the improved quality of electricity supply compared to households whose income falls below N51,000 category. Also, the coefficient of household monthly income is positive and statically significant at 1% in the Full Sample for households with monthly income above N500,000. Thus, households within this income category are 15.1% more likely to pay for the improved supply.

Logically, households with higher incomes are capable of paying extra for improvements in electricity service delivery because they have higher purchasing power compared to households with lower incomes. The result from this study depicting the ability of income to positively influence WTP is in line with other literatures in similar studies. Abdullah and Mariel (2010) as well as Abdullah and Jeanty (2011), all postulate a direct relationship between income and WTP for reliable electricity.

Table 4.8. Marginal Effects for above N55 Category (Pr(WTP==3))

	(1) FCT	(2) Ibadan	(3) Lagos	(4) Port Harcourt	(5) Full Sample
Household Size	-0.002(0.009)	-0.005(0.004)	-0.009(0.009)	-0.007(0.021)	-0.01*(0.006)
Household Monthly Income (Ref. Cat.: Below N51000)					
N51000 - N100000	0.104(0.077)	-0.018(0.028)	-0.027(0.045)	0.285(0.191)	0.052(0.035)
N101000 - N200000	0.211***(0.081)	-0.019(0.033)	-0.078(0.057)	0.079(0.209)	0.072*(0.04)
N201000 – N500000	0.176*(0.092)	0.013(0.04)	0.004(0.086)	0.095(0.215)	0.059(0.048)
Above N500000	0.034(0.111)	0.055(0.045)	-0.769(84.878)	0.255(0.229)	0.151***(0.053)
Highest Educational Level (Ref. Cat.: No Formal Education)					
Primary	-0.091(127.455)	-0.271(22.637)	-0.203(13.974)	0.163(3.616)	0.102(0.091)
Secondary	0.27(105.975)	-0.017(0.044)	-0.127(6.503)	-0.085(0.118)	0.002(0.054)
Tertiary	0.269(105.975)	-0.011(0.038)	-0.125(6.503)	-0.037(0.112)	-0.013(0.052)
Reliability of Current Supply (Ref. Cat.: Excellent)					
Very Reliable	0.036(0.066)	-0.099(41.213)	0.013(0.132)	0.087(0.073)	0.071*(0.038)
Reliable	-0.157*(0.081)	0.288(31.94)	-0.147(0.12)	-0.366***(0.103)	-0.055(0.041)
Moderately Reliable	-0.01(0.074)	0.264(31.94)	-0.133(0.122)	-0.398***(0.118)	-0.041(0.045)
Not Reliable	-0.102(0.067)	0.256(31.94)	-0.114(0.114)	-0.118(0.093)	-0.017(0.038)
Cost of Damage (Ref. Cat.: Below2000)					
N2000 - N5000	0.512(57.647)	-0.004(0.041)	0.677(78.731)	0.006(0.229)	0.002(0.08)
N5001 - N10000	0.591(57.647)	0.011(0.04)	0.857(78.731)	0.068(0.229)	0.093(0.076)
N10001 - N20000	0.464(57.647)	0.012(0.04)	0.844(78.731)	-0.085(0.231)	0.023(0.076)
Above N20000	0.428(57.647)	0.036(0.045)	0.861(78.731)	0.059(0.234)	0.091(0.079)
Cost of Alternative Power Supply (Ref. Cat.: Below2000)					
N2000 - N5000	0.03(0.079)	0.048(0.035)	0.085(0.098)	-0.09(0.088)	0.005(0.035)
N6000 - N10000	-0.019(0.084)	0.115**(0.046)	0.168*(0.096)	0.083(0.097)	0.093**(0.036)
N11000 - N20000	0.032(0.095)	0.165***(0.063)	0.233**(0.108)	0.124(0.111)	0.144***(0.046)
Above N20000	-0.458(105.975)	0.571(38.793)	-0.167(9.372)	0.315*(0.166)	0.199**(0.091)
Number of Outage	0.0005(0.002)	-0.002(0.001)	0.001(0.002)	-0.025***(0.005)	-0.005***(0.001)

Source: *Author's Computation, underlying data from Field Survey 2018. (Reliability of current supply - - 1=Not Reliable, ... , 5=Excellent)*

*Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*

The marginal cost of alternative power supply in this tariff category is significant in Ibadan, Lagos and the Full sample model with positive signs. The marginal cost of alternative power supply is significant in Ibadan at 1% and 5% for households spending between the ranges of N11,000 to N20,000 and N6,000 – N10,000 respectively. This implies that an increase in households' monthly cost of alternative power supply within the category of N11,000 to N20,000 and N6,000 – N10,000 will increase the probabilities of households' WTP by 16.5% and 11.5% respectively.

In Lagos, marginal cost of alternative power supply in this tariff category is significant at 5%. Thus, this implies that an increase in the monthly cost of alternative power supply within the category of N11,000 – N20,000 will increase the probabilities of households' WTP by 23.3%.

Also, considering the Full sample, an increase in the monthly cost of alternative power supply within the categories of N,6000 – N10,000, N11,000 to N20,000 and above N20,000 will increase the probabilities of households' WTP for the improved quality of electricity supply by 9.3%, 14.4 and 19.9% respectively compared to the households who spend on alternative power supply within the category of 'Below N2,000'.

The marginal effect of frequency of outages was negative and significant at 1% in Port Harcourt and the Full sample model. This implies that, an increase in the frequency of monthly power outages will decrease the probabilities of households' WTP for the improved electricity service with good quality by 2.5% in Port Harcourt and 0.2% in the Full sample.

From the marginal effects Tables (4.6, 4.7 and 4.8) above, we can deduce that the determinants of households' WTP for the improved quality of electricity supply are household monthly income, reliability of the supply, the cost incurred from alternative power supply monthly and frequency of monthly outages.

4.4 Households' Willingness to Pay for the Improved Quality of Electricity Supply

This subsection gives a brief descriptive analysis of the distribution of households' WTP for the proposed hypothetical improved quality of electricity supply scenario mentioned in chapter three. Table 4.9 present the results from the respondents in the study areas.

Table 4.9. Households' WTP for Improved Quality of Electricity Supply

		Abuja	Ibadan	Lagos	Port Harcourt	Total
Household willing to pay higher for the proposed improved service (%)	Yes	64.1	88.8	89.4	97.7	85
	No	35.9	11.2	10.6	2.3	15
Maximum amount household is willing to pay (%)	N25 – N40	77.6	73.5	76.5	34.7	65.6
	N41 – N55	11.8	21.2	12.3	19.4	16.2
	Above N55	10.6	5.3	11.2	45.9	18.2
Household Mean WTP (N/kWh)		36	38.3	36.3	50.2	40.2
Household Standard Deviation WTP		±14.95	±11.43	±14.15	±10.96	±12.87
Extent quality of electricity supply is valued by consumers (%)	Not necessary	0.6	0	2.4	0	0.7
	Moderately necessary	1.2	1.8	10	0	3.2
	Necessary	4.6	7.6	13.5	3.6	7.5
	Very necessary	41.2	32.4	38.8	18.2	32.6
	Extremely necessary	52.4	58.2	35.3	78.2	56

Source: Author's Computation; underlying data from Field Survey, 2018

Table 4.9 reveals that 64.1% of the respondents are willing to pay higher than the normal electricity tariff charge in Abuja, 88.8% in Ibadan, 89.4% in Lagos and 97.7% in Port Harcourt respectively for the improved service. Table 4.9 also reveal the maximum amount in categories that the respondents were willing to pay; Abuja (77.6%), Ibadan (73.5%)and Lagos (76.5%) of respondents indicated that they are willing to pay 25 to 40 Naira for the proposed improved quality electricity service (which is not too different and slightly higher than the present electricity tariff in the different study areas with the current state of electricity supply). The result also showed that 45.9% of the respondents in Port Harcourt are willing to pay above N55/kWhfor the improved electricity service.Of the 680 households interviewed, the average households' mean WTP for the proposed improved quality of electricity service was N40.2/kWh. N36/kWh, N38.3/kWh, N36.3/kWh and N50.2/kWh were the respective mean WTP for the proposed improved quality of electricity service in Abuja, Ibadan, Lagos and Port Harcourt.
Finally, results from the table show that most respondents in all the four areas consider the value of quality of electricity supply necessary.

The total amount households are willing to pay to improve electricity is used as a measure of the value of the cost of poor electricity supply in the study areas. Hence, the amount households are willing to pay could be equated to the economic cost of power interruptions in the study areas.
From the data collected from the survey, the average monthly cost of electricity consumed by each household was estimated as N4340, N1780, N4670, N2570 for Abuja, Ibadan, Lagos and Port Harcourt respectively as seen in Table 4.10 below.
The average number of kilowatt-hour of electricity consumed monthly per Household is given as:

$$AvgEL = AvgMC / ELCG \ldots\ldots\ldots\ldots\ldots \quad (4.1)$$

Where AvgEL = Average number of kWh of electricity consumed monthly per Household (kWh)
AvgMC = Average monthly cost of electricity consumed by each household (N)
ELCG = Electricity Charge per kilowatt (N/kWh)
The total electricity that is consumed monthly for the total number of households connected to the grid in the different study areas will therefore be given as:

$$TECM = nEC * AvgEL \text{ ……………………………..... } (4.2)$$

Where TECM = Total electricity that is consumed monthly for the total number of households (kWh)

nEC = Number of electricity customers.

To estimate the total willingness to pay, the customers mean WTP per kilowatt-hour of electricity from the sample survey is used to represent the mean WTP for the electricity customers of each study area.

The total WTP is given as:

$$TWTP = (mWTP) * TECM \text{ ………………….. } (4.3)$$

Where TWTP = Total Willingness to pay (N)

mWTP = Customers Mean WTP/kWh of electricity

Table 4.10 present the final results after substituting the appropriate figures into equations (4.1), (4.2) and (4.3). The estimation was done for all the selected study areas as well as the Full sample (aggregate of selected study areas).

We can deduct from Table 4.10 that the monthly economic cost of power outages to enumerated households under the electricity distribution companies in the four cities is enormous and run into billions of naira.The fact that poor electricity supply brings huge costs to households in Nigeria cannot be overemphasized and it is indicative of how negatively it impacts on their standards of living.

Table 4.10. Willingness to Pay Estimation

Enumeration Areas	Abuja	Ibadan	Lagos	Port Harcourt	Full Sample
No. Electricity Customers	848,813	1,558,393	1,067,386	583,869	4,058,461
Average Monthly Cost of Electricity Consumed (N)	4,340.00	1,780.00	4,670.00	2,570.00	3,320.00
Electricity Charge (N/kWh)	24.30	24.97	21.30	30.23	25.00
Average number of kWh of electricity consumed monthly per Household (kWh)	178.600823	71.28554265	219.2488263	85.01488587	132.8
Total Electricity Consumed monthly by Customers (kWh)	151,598,700.41	111,090,890.67	234,023,127.70	49,637,556.40	538,963,620.80
Customers Mean WTP/kWh of electricity	36	38.3	36.3	50.2	40.2
Customers Monthly Total WTP (N)	5,457,553,214,.81	4,254,781,112.62	8,495,039,535.49	2,491,805,331.33	21,666,337,556.16

***Source**: Author's Computation; underlying data from Field Survey, 2018*

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings and Conclusion

The empirical work carried out in this study show that households in the selected study areas (Abuja, Ibadan, Lagos and Port Harcourt), are unfavourably affected by the poor quality of electricity supply. To improve the quality of electricity supply, households in Abuja, Ibadan, Lagos, Port Harcourtare prepared to pay an average amount of N36.0, N38.3, N36.3 and N50.2 per kWh of electricity respectively which is more than 50% increase of the current tariffs they pay. Households are prepared to pay this amount if and only if electricity supply is improved and made more reliable without redundant power outages. From the study, it was revealed that the factors that determine households' willingness to pay for improved quality of electricity supply include household monthly income, reliability of supply, cost of alternative power supply and frequency of monthly outages.

More than 50% of households in the selected study areas affirmed that the poor quality of electricity supply affects their daily activities and hence, have a negative impact on their welfare.

Further estimations based on the data collected revealed that the current unreliable supply of electricity costs households in Abuja, Ibadan, Lagos, and Port Harcourt city a monthly amount of about N5.4 billion, N4.2 billion, N8.4 billion, and N2.4 billion respectively. Of course, this further affects the country as a whole. The opportunity cost of these amounts are the various measures and interventions that could be made to improve the welfare of the households. Hence, the reason households are willing to pay significantly to avert this huge power outage cost.

5.2 Policy Recommendations

On the basis of this research findings, the following recommendations are made for policy consideration:

i. Electricity tariffs could be increased since households in Abuja, Ibadan, Lagos, PH cityare prepared topay more than 50% increase of what they currently pay if the quality of electricity supply is improved. The DISCOs can start with some parts of these cities to initiate this project of providing improved quality of electricity supply, and subsequently extend it to other parts of the country.
ii. The estimated mean WTP from the study shows that households are willing to pay extra amounts (up to 50%) above the current tariff being paid regardless of their income for the improved quality of electricity service. Hence, households place more value on the reliability of a more expensive and higher quality of power supply above the current subsidised tariffs charged by the DISCOs which come with low quality. Thus, it is expedient the regulator, NERC ensure a steady increase in the quality of electricity delivered to customers and then recoup the costs through higher cost reflective charges.
iii. The DISCOs should proactively engage with the electricity end users in an open and transparent manner and also ensure that information on power interruptions is effectively and timely communicated to customers. The removal of inefficiencies at all level in the power sector could improve the satisfaction of residential customers and hence, increase their willingness to support upward tariff adjustment for an improved electricity service.
iv. NERC could redesign the tariff structure to support the growth of a robust and efficient electricity market that balances the interest of consumers on the one hand and electricity providers on the other hand. A factor to ensure uninterrupted and good quality electricity supply on the supply side of electricity market and efficient use of electricity on the demand side could be incorporated in the MYTO design.
v. The government and the electricity regulators could grant licenses to private investors who intend entering the electricity distribution business to enable the consumers have options of buying power from any distribution company of their choice. Hence, this could foster effective competition and efficiency within the electricity market.

5.3 Contributions to Knowledge

Some of the contributions of this study to knowledgeinclude:

i. There are limited studies on this subject in Nigeria (Oseni, 2017; Babawale and Awosanya, 2014); this study extends the already existing literature. Oseni (2017) which is the most recent study in Nigeria showed the extent to which self-generation might affect WTP for reliable electricity service in Nigeria. This study goes beyond that by assessing the current quality of the existing power supply, and investigating the factors that affects households' WTP for improved electricity service with good quality.

ii. No prior study has examined households' WTP for improved electricity service in more than two (3) geographical location in Africa. Kateregga (2009) carried out his study in three Ugandan suburbs, Abdullah and Mariel (2010) carried out their study in Kisumu District, Kenya and Twerefou (2014) in Tema city, Ghana. In Nigeria, only Oseni (2017) carried out his studies in two locations; Osogbo and Lagos. In fact, all the studies carried out in Nigeria has been within a geopolitical region (South western part of Nigeria). The scope of this study extends the existing literature; the study was carried out in four cities (Abuja, Ibadan, Lagos and Port Harcourt) within three geopolitical regions (North Central, South West and South South) in Nigeria.

iii. Studies carried out on this subject have always used household income predictor as a continuous variable. In this study, the household income was used as a categorical variable so as to observe how it affects households' WTP at different range of income taking into consideration the peculiaritiesof Nigeria.

5.4 Limitations of the Study

While it would have been of great interest to conduct a broader survey under all the operational jurisdiction of the eleven distribution companies, the resources available were inadequate to pursue and carry out such an elaborate study. Constrained by financial, human resources and time as well as security issues limited the study survey to four cities in Nigeria: Abuja, Ibadan, Lagos and Port Harcourt. These cities were selected due to their high economic activities,ethnic diversity and electricity tariff differences.

Also, this study did not consider the costs involved in providing the improved quality of electricity supply system with all the benefits described in the hypothetical scenario since that was not the focus of this study.

5.5 Recommendations for Further Research

Results of this study have established that power outages are a cost to households and that households are willing to pay significantly to improve electricity supply.It is recommended that future studies should focus on researching what the total costs of providing such an improved electricity supply would be. This should helpguide the government and relevant stakeholdersin the electricity industry toset in motion proper strategies and a well drafted plan before executing such projects.

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APPENDIX 1

FIELD SURVEY QUESTIONNAIRE

Enumeration City:………………… L.G.A: ………………………………

Identification Number: ………………………. Date of Interview……………………

DISCO: []IBEDC [] EKEDC [] PHEDC [ ] ABEDC [ ] IKEDC

INTRODUCTION

My name is Onyeuche, Emmanuel Ikechukwu. I am a PhD student at the Centre of Petroleum, Energy Economics and Law in University of Ibadan, Ibadan. I am writing my thesis on "Households' willingness to pay for improved quality of electricity supply in selected cities in Nigeria".
The answers provided will be completelyconfidential and used strictly for research purpose.Please tick [√] or fill where appropriate.

SECTION A: SOCIO ECONOMIC CHARACTERISTICS

A1. Respondent name: ……………………………………………………………………………………

A2. Position of the respondent: [1] Head [2] Other

If other position than head, please specify: ……………………………………………………………

A3. House occupancy status: [1] Landlord [2] Tenant

A4. Sex: [1] Male [2] Female

A5. Age: [1] ≤ 29yrs [2] 30-39yrs [3] 40-49yrs [4] 50-59yrs [5] ≥ 60yrs.

A6. Highest Educational Level: [1] No formal education [2] Primary [3] Secondary [4] Tertiary

A7. How many people live in your household? [1] 1 - 2 [2] 3 - 5 [3] 6 - 8 [5] Above 8

Please specify the number of adult and children: Adult: ………… Children: ………………

A8. How many of them are working? ....

A9. On the average how much do you spend in this household in a month? ₦.....................................

A10. What is your type of occupation? [1] Artisan [2] Professional [3] Civil servant [4] Business man/Trader [5] Others

A11. Do you have other jobs you do besides your main occupation? If yes, what are they?

……
……
…………………………

A12. What is the total monthly income of your household?

[1] ≤ ₦50,000 [2] ₦51,000 - ₦100,000 [3] ₦101,000 - ₦200,000 [4] ₦201,000 - ₦500,000 [5] ≥₦500,000

SECTION B: QUALITY OF EXISTING ELECTRICITY SUPPLY AND RELATED ISSUES

B1. What are the major concerns in your neighborhood?

[]Electricity [] Water [] Waste/Pollution [ ] Transportation [ ] Road Network
[ ] Crime [ ] Others

B2. From the major concerns selected above, how serious is the issue of electricity in your area compared to other concerns in the previous question (Water, Waste/Pollution, Transportation, Road Network, and Crime)?

[1] Extremely serious [2] Very serious[3] Serious [4] Moderately serious
[5] Not serious

B3. What is your current source of electricity?

[1] National Grid (DISCO) [2]Inverters [3] Generators [4] Others (specify)………………….

B4. How regular is electricity in your neighborhood? [1] Hourly [2] Daily [3] Twice a week [4] Once a week [5] Once in two (2) weeks

B5. How many days do you experience power outages in a month? ………………. Days

B6. On average, what is the duration of power outages in hours on days when there is power interruption? ……….Hours

B7. How satisfied are you with the current state of electricity supply in your neighborhood?

[1] Very satisfied [2] Reasonably [3] Not satisfied at all [4] Don't know

B8. If not satisfied, state your reasons:

[1] Frequency of service [2] Other problems
(Explain/Specify)……………………….………………………………...

B9. Approximately how many kilowatt-hours of electricity do you consume every month?

[1] ≤ 50 kWh [2] 51-100 kWh [3] 101-200 kWh [4] 201 – 400 kWh
[5] ≥ 400 kWh

B10. Averagely, how much do you pay monthly for electricity? [1] ≤ ₦2,000 [2] ₦2,000 – ₦5,000 [3] ₦5,000 – ₦10,000 [4] ₦10,000 – ₦20,000 [5] ≥₦20,000

B11. What is your alternative source of power when electricity goes off? [1] Generator [2] Solar Energy [3] Inverters [4] No alternative [5] Others (specify)…………………………

B12. On the average, how much do you spend on this alternative source of power during power outages in a month?

[1] ≤ ₦2,000 [2] ₦2,000 – ₦5,000 [3] ₦5,000 – ₦10,000 [4] ₦10,000 – ₦20,000 [5] ≥ ₦20,000

B13. How often do a family member in your household work from home? [1] Always [2] Very Often [3] Occasionally [4] Sometimes [5] Not at all

B14. How dependent is any of your household activities/work on power supply?

[1] Highly dependent [2] Partially dependent [3] Not dependent

Kindly rate the negative effects of power outages lasting 1 to 4 hours on your welfare considering the kind of activities an electricity failure prevents your household from undertaking in the following questions.
Tick just one in each question.

SN	Activities	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
A	Kitchen appliances are not use-able					
B	Can’t work from home					
C	Laundry (Washing machines, home cleaning appliances electric pressing iron, etc., not use-able					
D	Hobby and leisure equipment like Television, laptops, mobile gadgets not use-able					
E	Crime phobia (e.g. due to street, security or apartment hallway lighting not working)					
F	Fear of domestic accidents especially at nights					
G	Households' discomfort as a result of temperature change					
H	Sensitive equipment damaged by intermittent power outages (e.g. Appliances' adapters, water pumps, digital clocks, LED television, computer hardware, kitchen appliances, etc)					

B16. On situations where there is loss or damage of home appliances or electrical equipment due to the unreliable quality of power supply, how much on average have you lost or spent in repairing or replacing these appliances in the last one year?

[1] ≤ ₦5,000 [2] ₦5,000 – ₦10,000 [3] ₦10,000 – ₦20,000 [4] ₦20,000 – ₦50,000 [5] ≥₦50,000

B17. How necessary do you consider the current quality of electricity supply an issue worth discussing?

[1] Extremely necessary [2] Very necessary [3] Necessary [4] Moderately Necessary

[5] Not Necessary

B18. How would you rank the current quality of electricity supply to your home/ neighbourhood?

A. RELIABILITY/CONTINUITY OF SUPPLY (available at every time.):

[1] Excellent [2] Very Reliable [3] Reliable [4] Moderately Reliable [5] Not reliable

B. VOLTAGE QUALITY (appropriate level of voltage and/or non-fluctuating or stable current):
[1] Excellent [2] Very Good [3] Good [4]Poor [5] Very Poor

C. RESPONSE OF DISCOs' STAFF TO TECHNICAL FAULTS OR CUSTOMERS' COMPLAINTS:
[1] Excellent [2] Very Good [3] Good [4]Poor [5] Very Poor
B19. Do you receive any prior notification before an outage (planned/unplanned)?
[1] Yes [2] No

B20. Do you agree that regular short power interruptions (≤ 1 hour) are worse than a single long power interruption (≥ 1 hour) ?
[1] Yes [2] No
B21. Do you think the appropriate authorities have done enough to solve or at least deal with the problems of providing reliable and quality electricity supply for electricity customers?
[1] Yes [2] No
B22. How much do you budget on fuel to generate power supply monthly? [1] ≤ ₦2,000

[2] ₦2,000 – ₦5,000 [3] ₦5,000 – ₦10,000 [4] ₦10,000 – ₦20,000 [5] ≥₦20,000

SECTION C: WILLINGNESS TO PAY FOR IMPROVED QUALITY OF ELECTRICITY SUPPLY

IMPROVED ELECTRICITY SYSTEM HYPOTHETICAL SCENARIO:

I would like to ask you how much you are willing to pay for the supply of uninterrupted and quality electricity supply. The supply of uninterrupted electricity among other things means, good quality electricity which includes constant, non-fluctuating current and safe for all household gadgets. Uninterrupted electricity also means power outages are to some extent ruled out or at worst reduced to its barest minimum. Power interruptions will occur only when there is aimpromptu technical fault or when there is going to be some repairs and even in the event of such rare outages occurring, you will be pre informed before it occurs and it will not take more than four hours in a day. This means that there will be little or no need for any alternative source of power.

Let us assume that you have an option for a private connection to such an uninterrupted quality of electricity supply scheme and you will be charged a monthly user fee based on the quantity of electricity your household consumes in a month. At the moment, you are paying on average of about ₦25/kWh for the current unreliable power supply.

C1. Will your household be willing to pay higher for this service? [1] Yes [2] No

If No, please state your reasons for not willing to pay for this improved electricity:

……………………..

………………………………………………………………………………………………………

C2. Will your household be willing to pay ₦40 per kilowatt hours for this service?

[1] Yes; GO TO C3 [2] No; GO TO C4

If yes, increase bid by ₦10 if no, reduce bid by ₦5

C3. If the service provider decides that the household pays ₦50 per kilowatt hours, will your household be willing to pay for the service?

[1] Yes; GO TO C5 [2] No; GO TO C7

C4. If the service provider decides that the household pays ₦35 per kilowatt hours, will your household be willing to pay for the service?

[1] Yes; GO TO C7 [2] No; GO TO C6

C5. Will your household be willing to pay ₦60 per kilowatt hours for this service?

[1] Yes; GO TO C7 [2] No; GO TO C7

C6. Will your household be willing to pay ₦30 per kilowatt hoursfor this service?

[1] Yes; GO TO C7 [2] No; GO TO C7

C7. Pleases think carefully for a moment. What is the maximum amount your household will be willing to pay to use this service such that if it would cost more than this amount, your household would not be able to pay and hence you cannot have this uninterrupted electricity supply service?

₦…….…….….….… per kilowatt hours.

C8. How much are you willing to improve the current state of electricity service and reliability in your neighborhood?

[1] up to 50% [2] up to 70% [3] up to 90% [4] 100% - (24/7 electricity)

C9. To what extent do you value the quality of electricity supply? [1] Extremely necessary

[2] Very necessary [3] Necessary [4] Moderately Necessary [5] Not Necessary

THANK YOU

APPENDIX 2

Features of Existing Electricity Supply and Other Related Issues

		Abuja	Ibadan	Lagos	Port Harcourt	Total
Major Concerns in the Neighborhood (%)	Electricity	96	86.5	79.4	50	77.9
	Water	0.6	1.2	6.5	0.6	2.2
	Waste/pollution	1.8	1.8	6.5	4.1	3.5
	Transportation	0.6	0	1.8	0	0.6
	Road network	1.2	6.4	4.0	1.8	3.4
	Crime	0	1.8	0.6	14.7	4.3
	Others	0	2.3	1.2	28.8	8.1
Other Source of Power (%)	Generator	97.6	91.7	85.9	94.7	94.7
	Solar energy	1.8	1.2	1.8	0	1.2
	Inverters	0.6	7.1	3.5	5.3	4.1
Days of Power Interruption or Blackout in a Month (%)	Below 6	4.7	25.3	31.2	5.3	16.6
	6 – 10	27.1	41.8	24.1	23.5	29.1
	11 – 15	20.6	14.7	18.8	12.4	16.6
	16 – 20	14.1	7.1	11.2	9.4	10.4
	Above 20	33.5	11.2	14.7	49.4	27.2
Duration of power outage in hours on days when there is Power Interruption (%)	Below 6	36.5	28.8	37.6	40.6	35.9
	6 – 10	27.6	51.2	37.1	15.9	32.9
	11 – 15	21.2	14.7	11.8	24.7	18.1
	16 – 20	4.7	4.1	6.5	8.2	5.9
	Above 20	10	1.2	7.1	10.6	7.2
Current State of Electricity Supply and Level of Satisfaction (%)	Not satisfied at all	69.4	64.7	75.8	57.6	67
	Reasonably	27.1	33.5	21.2	42.4	31
	Very satisfied	3.5	1.8	3	0	2
Reasons for not Satisfied Responses (%)	Frequency of service	67	88.2	46.7	100	73.1
	Others	33	11.8	53.3	0	26.9
Monthly Electricity Consumption (%)	Below 51kwh	30	6.5	13	16.5	16.5
	51-100kwh	44.1	40	33.5	32.9	37.6

	101-200kwh	11.2	38.8	40	26.5	29.1
	201-400kwh	10.6	11.2	13.5	20.6	14
	Above 400kwh	4.1	3.5	0	3.5	2.8
Monthly expenditure on electricity (%)	Less than N2,000	5.3	32.9	6.5	18.8	16
	N2,000 - N5,000	33.5	45.3	35.3	51.8	41.5
	N5,000 - N10,000	39.4	21.2	27.6	21.2	27.4
	N10,000 - N20,00	21.8	0.6	24.1	8.2	13.6
	Above N20,000	0	0	6.5	0	1.5
Expenditure on alternative power source during outages (%)	Less than N2,000	21.1	20	7.6	45.3	23.5
	N2,000 - N5,000	36.5	39.4	29.4	18.2	30.9
	N5,000 - N10,000	32.4	32.9	45.9	15.3	31.6
	N10,000 - N20,00	9.4	7.1	15.9	16.5	12.2
	Above N20,000	0.6	0.6	1.2	4.7	1.8
Household work dependence on electricity (%)	Not dependent	64.7	18.2	38.2	18.2	34.9
	Partially dependent	25.9	48.2	41.2	67.6	45.7
	Highly dependent	9.4	33.6	20.6	14.2	19.4
Cost incurred in repairing or replacing the Appliances in the last one year (%)	Less/equal N2,000	1.8	4.1	1.2	1.8	2.1
	N2,000 - N5,000	7.6	12.4	10.6	8.8	9.9
	N5,000 - N10,000	35.3	31.8	23.5	17.1	26.9
	N10,000 - N20,000	33.5	38.2	44.7	29.4	36.5
	Above N20,000	21.8	13.5	20	42.9	24.6
Reliability of Electricity Supply (%)	Not reliable	36.5	52.4	51.8	37.1	44.4
	Moderately reliable	26.5	32.9	24.7	44.7	32.2
	Reliable	15.3	11.2	16.5	17.6	15.1
	Very reliable	15.9	2.4	5.3	0.6	6
	Excellent	5.9	1.2	1.8	0	2.2
Voltage Quality of Electricity Supply (%)	Very poor	10.6	0.6	5.3	7.1	5.9
	Poor	24.7	7.6	40	12.9	21.3
	Good	34.1	35.3	37.1	41.2	36.9
	Very good	30.6	44.7	14.1	31.2	30.1
	Excellent	0	11.8	3.5	7.6	5.7
Commercial quality of electricity supply (%)	Very poor	29.4	7.6	15.9	28.2	20.3
	Poor	44.1	58.8	60.6	35.9	49.9
	Good	14.1	29.4	17.6	33.5	23.7
	Very good	11.8	4.1	4.7	2.4	5.7
	Excellent	0.6	0	1.2	0	0.4
Prior notification before an outage (planned/unplanned) (%)	Yes	15.9	4.1	3.5	2.4	6.5
	No	84.1	95.9	96.5	97.6	93.5
Respondents' perception on Appropriate Authorities solving power problems. (%)	Yes	20	14.7	10	30	18.7
	No	80	85.3	90	70	81.3

Source: Author's Computation; underlying data from Field Survey, 2018

APPENDIX 3

Effect of Poor-Quality Supply on Household's Activities

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Abuja	Kitchen appliances not use-able	1.8	12.4	4.7	44.7	36.5
	Can't work from home	11.8	16.5	18.2	30.6	22.9
	Laundry (Washing machines, home cleaning appliances electric pressing iron, etc., not use-able	2.4	4.7	8.2	50.6	34.1
	Hobby and leisure equipment like Television, laptops, mobile gadgets not use-able	4.7	6.5	4.1	39.4	45.3
	Crime phobia (e.g. due to street, security or apartment hallway lighting not working)	5.3	12.9	7.1	50	24.7
	Fear of domestic accidents especially at nights	8.2	11.2	11.8	47.6	21.2
	Households' discomfort (e.g. due to change in home temperature)	5.3	13.5	9.4	40.6	31.2
	Sensitive equipment damaged by intermittent power outages (e.g. Appliances' adapters, water pumps, digital clocks, LED television, computer hardware, kitchen appliances, etc)	4.1	13.5	8.8	49.4	24.1
Ibadan	Kitchen appliances not use-able	1.8	13.5	13.5	50.6	20.6
	Can't work from home	1.8	11.8	20.6	45.3	20.6
	Laundry (Washing machines, home cleaning appliances electric pressing iron, etc., not use-able	0.6	6.5	9.4	38.8	44.7
	Hobby and leisure equipment like Television, laptops, mobile gadgets not use-able	1.8	14.7	20.6	46.5	16.5
	Crime phobia (e.g. due to street, security or apartment hallway lighting not working)	0.6	7.1	22.4	48.8	21.2
	Fear of domestic accidents especially at nights	1.2	7.1	33.5	42.4	15.9
	Households' discomfort (e.g. due to change in home temperature)	0	4.7	17.6	57.6	20
	Sensitive equipment damaged by intermittent power outages (e.g. Appliances' adapters, water pumps, digital clocks, LED television, computer hardware, kitchen appliances, etc)	0.6	5.9	10	40	43.5
Lagos	Kitchen appliances not use-able	2.4	7.1	14.1	37.1	39.4
	Can't work from home	8.8	17.1	16.5	37.6	20
	Laundry (Washing machines, home cleaning appliances electric pressing iron, etc., not use-able	1.8	10	11.2	48.8	28.2

	Hobby and leisure equipment like Television, laptops, mobile gadgets not use-able	1.2	7.1	13.5	54.1	24.1
	Crime phobia (e.g. due to street, security or apartment hallway lighting not working)	0.6	11.8	32.4	38.2	17.1
	Fear of domestic accidents especially at nights	2.4	12.9	30	41.8	12.9
	Households' discomfort (e.g. due to change in home temperature)	0	4.1	12.4	57.1	26.5
	Sensitive equipment damaged by intermittent power outages (e.g. Appliances' adapters, water pumps, digital clocks, LED television, computer hardware, kitchen appliances, etc)	0.6	6.5	12.4	49.4	31.2
Port Harcourt	Kitchen appliances not use-able	0	8.8	31.2	28.8	31.2
	Can't work from home	2.9	15.9	32.4	21.2	27.6
	Laundry (Washing machines, home cleaning appliances electric pressing iron, etc., not use-able	0	2.4	22.9	28.2	46.5
	Hobby and leisure equipment like Television, laptops, mobile gadgets not use-able	0	6.5	2.9	24.1	66.5
	Crime phobia (e.g. due to street, security or apartment hallway lighting not working)	0	3.5	15.3	25.9	55.3
	Fear of domestic accidents especially at nights	0	5.9	17.6	24.7	51.8
	Households' discomfort (e.g. due to change in home temperature)	0	0	2.9	23.5	73.5
	Sensitive equipment damaged by intermittent power outages (e.g. Appliances' adapters, water pumps, digital clocks, LED television, computer hardware, kitchen appliances, etc)	0	0	17.6	32.4	50

Source: Author's Computation; underlying data from Field Survey, 2018

APPENDIX 4

RAW OUTPUT OF THE REGRESSION ANALYSIS

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-------------------------------------------------------------------------------------------------
--------------------------------------------------------------------------------------------

. *
. preserve

. *
. keep if Enum_city ==1
(510 observations deleted)

. * Regression Analysis (FCT)
. oprobit WTP HHZ N51000_N100000 N101000_N200000 N201000_N500000 /*
> **/ Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliable /*
> **/ Reliab_ReliableReliab_NotReliable  /*
> **/ N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000 N11000_N20000
Above20000_ b5


Iteration 0:   log likelihood = -116.61454
Iteration 1:   log likelihood = -82.033576
Iteration 2:   log likelihood = -78.881252
Iteration 3:   log likelihood = -78.766586
Iteration 4:   log likelihood =  -78.75371
Iteration 5:   log likelihood = -78.752233
Iteration 6:   log likelihood = -78.751946
Iteration 7:   log likelihood = -78.751885
Iteration 8:   log likelihood = -78.751873
Iteration 9:   log likelihood = -78.751871

Ordered probit regression                         Number of obs   =        170
                                                  LR chi2(21)     =      75.73
                                                  Prob > chi2     =     0.0000
Log likelihood = -78.751871                       Pseudo R2       =     0.3247

------------------------------------------------------------------------------------------
                     WTP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------------+----------------------------------------------------------------

                     HHZ |   -.014823   .0775375    -0.19   0.848    -.1667937    .1371477
          N51000_N100000 |   .8784839   .6365423     1.38   0.168    -.3691162    2.126084
         N101000_N200000 |   1.778105   .6653919     2.67   0.008     .4739611     3.08225
         N201000_N500000 |   1.487453    .762164     1.95   0.051    -.0063607    2.981267
             Above500000 |   .2838225   .9344758     0.30   0.761    -1.547716    2.115361
Primary_edu|  -.7705464   1074.872    -0.00   0.999    -2107.482    2105.941
Secondary_edu |   2.281086   893.7261     0.00   0.998     -1749.39    1753.952
Tertiary_edu |   2.264438   893.7261     0.00   0.998    -1749.407    1753.935
Reliab_VeryReliable |    .302679   .5634402     0.54   0.591    -.8016436    1.407002
Reliab_ModeratelyReliable|  -1.323667   .6695456    -1.98   0.048    -2.635952   -.0113813
Reliab_Reliable|  -.0823975   .6230147    -0.13   0.895    -1.303484    1.138689
Reliab_NotReliable|  -.8593579     .55369    -1.55   0.121     -1.94457    .2258545
             N2000_N5000 |    .431848   48.61562     0.01   0.993    -94.85301     95.7167
            N5000_N10000 |    .49871548.61560     0.01   0.992    -94.78610    95.78353
           N10000_N20000 |    .39143548.61560     0.01   0.994    -94.89338    95.67625
              Above20000 |    .361234   48.61562     0.01   0.994    -94.92363    95.64610
            N2000_N5000_ |   .2559997   .6634126     0.39   0.700    -1.044265    1.556265
            N6000_N10000 |   -.158997   .7056114    -0.23   0.822     -1.54197    1.223976
           N11000_N20000 |   .2735395   .7977903     0.34   0.732    -1.290101     1.83718
             Above20000_ |  -.386479   89.37262    -0.00   0.997    -175.5536    174.7806
                      b5 |   .0038196   .0178996     0.21   0.831     -.031263    .0389022
-------------------------+----------------------------------------------------------------
                   /cut1 |   8.112098   1017.396                      -1985.947    2002.171
                   /cut2 |   8.899156   1017.396                       -1985.16    2002.958
```

```
------------------------------------------------------------------------------------------
Note: 7 observations completely determined.  Standard errors questionable.

. *
. outreg2 using FullSample.doc, dec(4) replace title("Table 1: Ordered Probit") ctitle(FCT) /*
> **/ addstat(Pseudo R-squared, e(r2_p), Wald-chi2, e(chi2), Prob > chi2, e(p))
FullSample.doc
dir :seeout

. *
. margins, dydx(*) predict (outcome(1))

Average marginal effects                          Number of obs   =        170
Model VCE    : OIM

Expression   :Pr(WTP==1), predict(outcome(1))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

------------------------------------------------------------------------------------------
                          |            Delta-method
                          |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------------+---------------------------------------------------------------
                      HHZ |   .0027157   .0141847     0.19   0.848    -.0250858    .0305172
          N51000_N100000 |  -.1609445   .1155404    -1.39   0.164    -.3873994    .0655105
         N101000_N200000 |  -.3257615   .1154909    -2.82   0.005    -.5521194   -.0994035
         N201000_N500000 |   -.272512   .1351747    -2.02   0.044    -.5374494   -.0075745
             Above500000 |  -.0519983   .1709237    -0.30   0.761    -.3870025    .2830059
Primary_edu |   .1411696   196.9242     0.00   0.999    -385.8232    386.1056
Secondary_edu|  -.4179112    163.737    -0.00    0.998    -321.3365    320.5007
Tertiary_edu |   -.414861    163.737    -0.00    0.998    -321.3335    320.5038
Reliab_VeryReliable|  -.0554529   .1029192    -0.54   0.590    -.2571708    .1462649
Reliab_ModeratelyReliable |   .2425051   .1195008     2.03   0.042     .0082879    .4767223
Reliab_Reliable |   .0150958   .1142048     0.13   0.895    -.2087415    .2389331
Reliab_NotReliable |   .1574405   .1002916     1.57   0.116    -.0391275    .3540084
             N2000_N5000 |  -.7911753   89.06729    -0.01   0.993    -175.3598    173.7775
            N5000_N10000 |  -.9136818   89.06724    -0.01   0.992    -175.4823    173.6549
           N10000_N20000 |   -.717137   89.06725    -0.01   0.994    -175.2857    173.8515
              Above20000 |  -.6618057   89.06729    -0.01   0.994    -175.2305    173.9069
            N2000_N5000_ |   -.046901   .1215107    -0.39   0.700    -.2850576    .1912557
            N6000_N10000 |   .0291294   .1292014     0.23   0.822    -.2241006    .2823594
           N11000_N20000 |  -.0501144   .1460888    -0.34   0.732    -.3364431    .2362144
             Above20000_ |   .7080576    163.737     0.00   0.997    -320.2105    321.6267
                      b5 |  -.0006998   .0032814    -0.21   0.831    -.0071312    .0057317
------------------------------------------------------------------------------------------

. *
. margins, dydx(*) predict (outcome(2))

Average marginal effects                          Number of obs   =        170
Model VCE    : OIM

Expression   :Pr(WTP==2), predict(outcome(2))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

------------------------------------------------------------------------------------------
                          |            Delta-method
                          |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------------+---------------------------------------------------------------
                      HHZ |   -.000958   .0050093    -0.19   0.848     -.010776      .00886
          N51000_N100000 |   .0567769   .0416211     1.36   0.173    -.0247989    .1383528
         N101000_N200000 |     .11492   .0459362     2.50   0.012     .0248868    .2049532
         N201000_N500000 |    .096135    .050023     1.92   0.055    -.0019084    .1941783
             Above500000 |   .0183436   .0602858     0.30   0.761    -.0998145    .1365017
Primary_edu|  -.0498009   69.46963    -0.00    0.999    -136.2078    136.1082
Secondary_edu |   .1474279   57.76205     0.00    0.998    -113.0641     113.359
Tertiary_edu |   .1463519   57.76205     0.00   0.998    -113.0652    113.3579
Reliab_VeryReliable |   .0195623   .0368871     0.53   0.596     -.052735    .0918596
Reliab_ModeratelyReliable|  -.0855493   .0444672    -1.92   0.054    -.1727035    .0016048
Reliab_Reliable|  -.0053254   .0402586    -0.13   0.895    -.0842309    .0735801
Reliab_NotReliable|  -.0555408    .036685    -1.51   0.130    -.1274421    .0163605
             N2000_N5000 |   .2791056    31.4206     0.01   0.993    -61.30414    61.86235
            N5000_N10000 |   .3223226   31.42059     0.01   0.992    -61.26091    61.90555
           N10000_N20000 |   .2529868   31.42058     0.01   0.994    -61.33021    61.83619
              Above20000 |   .2334674    31.4206     0.01   0.994    -61.34977     61.8167
            N2000_N5000_ |   .0165454   .0430286     0.38   0.701    -.0677891    .1008799
```

```
            N6000_N10000 |  -.0102761   .0456486    -0.23   0.822    -.0997456    .0791935
           N11000_N20000 |    .017679   .0515477     0.34   0.732    -.0833526    .1187106
             Above20000_ |  -.2497839   57.76206    -0.00   0.997    -113.4613    112.9618
                      b5 |   .0002469   .0011597     0.21   0.831     -.002026    .0025198
------------------------------------------------------------------------------------------

. *
. margins, dydx(*) predict (outcome(3))

Average marginal effects                          Number of obs   =        170
Model VCE    : OIM

Expression   :Pr(WTP==3), predict(outcome(3))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

------------------------------------------------------------------------------------------
                         |            Delta-method
                         |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------------+----------------------------------------------------------------
                     HHZ |  -.0017577    .009182    -0.19   0.848     -.019754    .0162387
        N51000_N100000 |   .1041676    .076696     1.36   0.174    -.0461539    .2544891
       N101000_N200000 |   .2108416   .0805194     2.62   0.009     .0530266    .3686567
       N201000_N500000 |   .1763771   .0918714     1.92   0.055    -.0036876    .3564418
             Above500000 |   .0336547    .110836     0.30   0.761    -.1835798    .2508892
Primary_edu|  -.0913687   127.4547    -0.00   0.999     -249.898    249.7152
Secondary_edu |   .2704834    105.975     0.00   0.998    -207.4367    207.9777
Tertiary_edu |   .2685093    105.975     0.00   0.998    -207.4387    207.9757
Reliab_VeryReliable |   .0358906   .0664017     0.54   0.589    -.0942543    .1660356
Reliab_ModeratelyReliable|  -.1569558   .0810504    -1.94   0.053    -.3158118    .0019001
Reliab_Reliable|  -.0097704   .0739712    -0.13   0.895    -.1547512    .1352104
Reliab_NotReliable|  -.1018997   .0666573    -1.53   0.126    -.2325455    .0287461
             N2000_N5000 |     .51207   57.64678     0.01   0.993    -112.4736    113.4977
            N5000_N10000 |   .5913595   57.64677     0.01   0.992    -112.3942    113.5769
           N10000_N20000 |   .4641504   57.64676     0.01   0.994    -112.5214    113.4497
              Above20000 |   .4283385   57.64677     0.01   0.994    -112.5573    113.4139
            N2000_N5000_ |   .0303556   .0787088     0.39   0.700    -.1239108    .1846219
            N6000_N10000 |  -.0188533   .0836351    -0.23   0.822    -.1827751    .1450685
           N11000_N20000 |   .0324354   .0947564     0.34   0.732    -.1532838    .2181546
             Above20000_ |   -.458274    105.975    -0.00   0.997    -208.1655     207.249
                      b5 |   .0004529   .0021236     0.21   0.831    -.0037093    .0046151
------------------------------------------------------------------------------------------

. *
. restore

. *
. *
. preserve

. *
. keep if Enum_city ==2
(510 observations deleted)

. * Regression Analysis (Ibadan)
. oprobit WTP HHZ N51000_N100000 N101000_N200000 N201000_N500000 /*
> **/ Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliable /*
> **/ Reliab_ReliableReliab_NotReliable  /*
> **/ N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000 N11000_N20000
Above20000_ b5

Iteration 0:   log likelihood = -120.76481
Iteration 1:   log likelihood = -93.064675
Iteration 2:   log likelihood = -92.034912
Iteration 3:   log likelihood = -91.917147
Iteration 4:   log likelihood = -91.894845
Iteration 5:   log likelihood = -91.890514
Iteration 6:   log likelihood = -91.889613
Iteration 7:   log likelihood = -91.889475
Iteration 8:   log likelihood = -91.889454
Iteration 9:   log likelihood =  -91.88945


Ordered probit regression                         Number of obs   =        170
                                                  LR chi2(21)     =      57.75
                                                  Prob > chi2     =     0.0000
Log likelihood =  -91.88945                       Pseudo R2       =     0.2391
```

```
------------------------------------------------------------------------------
                     WTP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------------+----------------------------------------------------------------
                     HHZ |  -.0650565   .0483748    -1.34   0.179    -.1598694    .0297564
          N51000_N100000 |  -.2442958   .3806873    -0.64   0.521    -.9904292    .5018377
         N101000_N200000 |  -.2526786   .4505846    -0.56   0.575    -1.135808     .630451
         N201000_N500000 |    .178315   .5510821     0.32   0.746    -.9017861    1.258416
             Above500000 |   .7434166   .6072239     1.22   0.221    -.4467204    1.933554
Primary_edu|  -3.697835   308.5737    -0.01   0.990    -608.4913    601.0956
Secondary_edu|  -.2273735   .5980369    -0.38   0.704    -1.399504    .9447573
Tertiary_edu|  -.1561721    .520141    -0.30   0.764    -1.17563    .8632856
Reliab_VeryReliable |   -1.34519   561.7847    -0.00   0.998    -1102.423    1099.733
Reliab_ModeratelyReliable |   3.931295    435.378     0.01   0.993    -849.3939    857.2565
Reliab_Reliable |   3.602637   435.3781     0.01   0.993    -849.7228    856.9281
Reliab_NotReliable |   3.494512   435.3781     0.01   0.994    -849.8308    856.8199
             N2000_N5000 |  -.0511254   .5565214    -0.09   0.927    -1.141887    1.039636
            N5000_N10000 |   .1554437   .5383249     0.29   0.773    -.8996538    1.210541
           N10000_N20000 |   .1600372   .5476822     0.29   0.770    -.9134002    1.233475
              Above20000 |   .4914308   .6012442     0.82   0.414    -.6869862    1.669848
            N2000_N5000_ |   .6478557   .4471257     1.45   0.147    -.2284946    1.524206
            N6000_N10000 |   1.574207   .4876994     3.23   0.001     .6183336     2.53008
           N11000_N20000 |   2.252127   .6700757     3.36   0.001     .9388023    3.565451
             Above20000_ |   7.777784   528.7915     0.01   0.988    -1028.635     1044.19
                      b5 |  -.0223268   .0189026    -1.18   0.238    -.0593752    .0147216
-------------------------+----------------------------------------------------------------
                   /cut1 |   4.738889   435.3787                     -848.5876    858.0654
                   /cut2 |   6.109866   435.3787                     -847.2167    859.4365
------------------------------------------------------------------------------
Note: 11 observations completely determined.  Standard errors questionable.

. *
. outreg2 using FullSample.doc, dec(4) title("Table 1: Ordered Probit") ctitle(Ibadan) /*
> **/ addstat(Pseudo R-squared, e(r2_p), Wald-chi2, e(chi2), Prob > chi2, e(p)) append
FullSample.doc
dir :seeout

. *
. *
. margins, dydx(*) predict (outcome(1))

Average marginal effects                        Number of obs   =        170
Model VCE    : OIM

Expression   :Pr(WTP==1), predict(outcome(1))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

------------------------------------------------------------------------------
                         |            Delta-method
                         |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------------+----------------------------------------------------------------
                     HHZ |   .0157855   .0115957     1.36   0.173    -.0069418    .0385127
          N51000_N100000 |   .0592765   .0919485     0.64   0.519    -.1209392    .2394922
         N101000_N200000 |   .0613105   .1089451     0.56   0.574    -.1522179    .2748389
         N201000_N500000 |  -.0432668   .1336961    -0.32   0.746    -.3053063    .2187728
             Above500000 |  -.1803843    .146892    -1.23   0.219    -.4682873    .1075187
Primary_edu |    .897251   74.87305     0.01   0.990    -145.8512    147.6457
Secondary_edu |   .0551704   .1449252     0.38   0.703    -.2288778    .3392186
Tertiary_edu |   .0378939   .1261669     0.30   0.764    -.2093887    .2851766
Reliab_VeryReliable |   .3263999   136.3127     0.00   0.998    -266.8415    267.4943
Reliab_ModeratelyReliable|  -.9538984   105.6412    -0.01   0.993    -208.0068     206.099
Reliab_Reliable|  -.8741519   105.6412    -0.01   0.993    -207.9271    206.1788
Reliab_NotReliable|  -.8479164   105.6412    -0.01   0.994    -207.9009     206.205
             N2000_N5000 |   .0124052   .1350218     0.09   0.927    -.2522328    .2770431
            N5000_N10000 |  -.0377172   .1305943    -0.29   0.773    -.2936773    .2182429
           N10000_N20000 |  -.0388318   .1328976    -0.29   0.770    -.2993062    .2216427
              Above20000 |  -.1192419   .1456391    -0.82   0.413    -.4046893    .1662056
            N2000_N5000_ |  -.1571972   .1073567    -1.46   0.143    -.3676125    .0532181
            N6000_N10000 |  -.3819691   .1096537    -3.48   0.000    -.5968864   -.1670518
           N11000_N20000 |  -.5464611    .151077    -3.62   0.000    -.8425665   -.2503557
             Above20000_ |  -.1887219   12.83072    -0.01   0.988    -25.33648    24.95903
                      b5 |   .0054174   .0045246     1.20   0.231    -.0034507    .0142856
------------------------------------------------------------------------------
```

. *
. margins, dydx(*) predict (outcome(2))

Average marginal effects Number of obs = 170
Model VCE : OIM

Expression :Pr(WTP==2), predict(outcome(2))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

	Delta-method dy/dx	Std. Err.	z	P>|z|	[95% Conf.	Interval]
HHZ	-.0110129	.0081732	-1.35	0.178	-.0270319	.0050062
N51000_N100000	-.0413547	.0640476	-0.65	0.518	-.1668858	.0841763
N101000_N200000	-.0427738	.0759739	-0.56	0.573	-.19168	.1061324
N201000_N500000	.0301854	.093444	0.32	0.747	-.1529614	.2133322
Above500000	.1258467	.1049113	1.20	0.230	-.0797757	.331469
Primary_edu	-.6259749	52.23587	-0.01	0.990	-103.0064	101.7544
Secondary_edu	-.0384901	.1011733	-0.38	0.704	-.2367862	.1598059
Tertiary_edu	-.026437	.0881225	-0.30	0.764	-.199154	.1462799
Reliab_VeryReliable	-.2277157	95.0997	-0.00	0.998	-186.6197	186.1643
Reliab_ModeratelyReliable	.6654954	73.70158	0.01	0.993	-143.7869	145.1179
Reliab_Reliable	.6098596	73.70158	0.01	0.993	-143.8426	145.0623
Reliab_NotReliable	.5915562	73.70158	0.01	0.994	-143.8609	145.044
N2000_N5000	-.0086546	.0942104	-0.09	0.927	-.1933035	.1759944
N5000_N10000	.0263137	.0911277	0.29	0.773	-.1522932	.2049207
N10000_N20000	.0270913	.0927873	0.29	0.770	-.1547684	.2089511
Above20000	.0831901	.1020314	0.82	0.415	-.1167878	.283168
N2000_N5000_	.10967	.0752664	1.46	0.145	-.0378495	.2571894
N6000_N10000	.266484	.077799	3.43	0.001	.1140008	.4189672
N11000_N20000	.3812433	.1105461	3.45	0.001	.1645769	.5979097
Above20000_	.1316635	8.951488	0.01	0.988	-17.41293	17.67626
b5	-.0037795	.0031554	-1.20	0.231	-.009964	.002405

. *
. margins, dydx(*) predict (outcome(3))

Average marginal effects Number of obs = 170
Model VCE : OIM

Expression :Pr(WTP==3), predict(outcome(3))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

	Delta-method dy/dx	Std. Err.	z	P>|z|	[95% Conf.	Interval]
HHZ	-.0047726	.0036955	-1.29	0.197	-.0120156	.0024704
N51000_N100000	-.0179217	.0283897	-0.63	0.528	-.0735645	.037721
N101000_N200000	-.0185367	.0334148	-0.55	0.579	-.0840284	.046955
N201000_N500000	.0130813	.0404334	0.32	0.746	-.0661667	.0923294
Above500000	.0545376	.0448203	1.22	0.224	-.0333086	.1423839
Primary_edu	-.2712761	22.63732	-0.01	0.990	-44.6396	44.09705
Secondary_edu	-.0166803	.0440235	-0.38	0.705	-.1029649	.0696043
Tertiary_edu	-.0114569	.0381918	-0.30	0.764	-.0863115	.0633977
Reliab_VeryReliable	-.0986842	41.21298	-0.00	0.998	-80.87464	80.67727
Reliab_ModeratelyReliable	.288403	31.93975	0.01	0.993	-62.31236	62.88917
Reliab_Reliable	.2642923	31.93975	0.01	0.993	-62.33647	62.86506
Reliab_NotReliable	.2563602	31.93974	0.01	0.994	-62.34438	62.8571
N2000_N5000	-.0037506	.0408262	-0.09	0.927	-.0837685	.0762673
N5000_N10000	.0114035	.0396076	0.29	0.773	-.0662259	.0890328
N10000_N20000	.0117405	.0402572	0.29	0.771	-.0671622	.0906431
Above20000	.0360518	.044864	0.80	0.422	-.0518802	.1239837
N2000_N5000_	.0475272	.0349745	1.36	0.174	-.0210215	.1160759
N6000_N10000	.1154851	.0464274	2.49	0.013	.0244891	.206481
N11000_N20000	.1652178	.0628061	2.63	0.009	.0421201	.2883155
Above20000_	.5705844	38.7927	0.01	0.988	-75.46172	76.60288
b5	-.0016379	.0014508	-1.13	0.259	-.0044813	.0012055

. *
. restore

```
. *
. *
. preserve

. *
. keep if Enum_city ==3
(510 observations deleted)

. * Regression Analysis (Lagos)
. oprobit WTP HHZ N51000_N100000 N101000_N200000 N201000_N500000 /*
> **/ Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliable /*
> **/ Reliab_ReliableReliab_NotReliable  /*
> **/ N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000 N11000_N20000
Above20000_ b5


Iteration 0:   log likelihood = -120.42694
Iteration 1:   log likelihood = -106.91326
Iteration 2:   log likelihood =  -105.8052
Iteration 3:   log likelihood = -105.68413
Iteration 4:   log likelihood = -105.66505
Iteration 5:   log likelihood = -105.66163
Iteration 6:   log likelihood = -105.66094
Iteration 7:   log likelihood = -105.66083
Iteration 8:   log likelihood = -105.66081
Iteration 9:   log likelihood = -105.66081

Ordered probit regression                         Number of obs   =        170
                                                  LR chi2(21)     =      75.19
                                                  Prob > chi2     =     0.0000
Log likelihood = -79.020872                       Pseudo R2       =     0.3224

------------------------------------------------------------------------------------------
                    WTP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------------------+-----------------------------------------------------------------
                    HHZ |  -.0584982   .0565749    -1.03   0.301    -.1693831    .0523866
         N51000_N100000 |  -.1682803   .2838025    -0.59   0.553    -.7245229    .3879624
        N101000_N200000 |  -.4873563   .3523796    -1.38   0.167    -1.178008     .203295
        N201000_N500000 |   .0259643   .5392596     0.05   0.962    -1.030965    1.082894
            Above500000 |  -4.804204   530.2596    -0.01   0.993    -1044.094    1034.485
Primary_edu|  -12.70942   873.0179    -0.01   0.988    -1723.793    1698.374
Secondary_edu|  -7.943597   406.2656    -0.02   0.984    -804.2095    788.3223
Tertiary_edu|  -7.835895   406.2655    -0.02   0.985    -804.1017    788.4299
Reliab_VeryReliable |   .0784688   .8243631     0.10   0.924    -1.537253    1.694191
Reliab_ModeratelyReliable|  -.9182267   .7446846    -1.23   0.218    -2.377782    .5413283
Reliab_Reliable|  -.8290803   .7601846    -1.09   0.275    -2.319015    .6608541
Reliab_NotReliable|  -.7113454   .7080434    -1.00   0.315    -2.099085    .6763941
            N2000_N5000 |   4.232161    491.852     0.01   0.993     -959.78    968.2443
           N5000_N10000 |   5.351006   491.8518     0.01   0.991    -958.6608    969.3628
          N10000_N20000 |    5.27027   491.8518     0.01   0.991    -958.7416    969.2821
             Above20000 |   5.381043   491.8519     0.01   0.991    -958.6309     969.393
           N2000_N5000_ |    .530187   .6084101     0.87   0.384    -.6622748    1.722649
           N6000_N10000 |   1.046501   .5824555     1.80   0.072    -.0950911    2.188093
          N11000_N20000 |   1.454472   .6487164     2.24   0.025     .1830115    2.725933
            Above20000_ |  -10.41763   585.5148    -0.02   0.986    -1158.005     1137.17
                     b5 |   .0061851   .0145163     0.43   0.670    -.0222663    .0346366
------------------------+-----------------------------------------------------------------
                  /cut1 |  -2.105292   637.9428                       -1252.45     1248.24
                  /cut2 |  -1.526425   637.9428                      -1251.871    1248.818
------------------------------------------------------------------------------------------
Note: 8 observations completely determined.  Standard errors questionable.

. *
. outreg2 using FullSample.doc, dec(4) title("Table 1: Ordered Probit") ctitle(Lagos) /*
> **/ addstat(Pseudo R-squared, e(r2_p), Wald-chi2, e(chi2), Prob > chi2, e(p)) append
FullSample.doc
dir :seeout

. *
. *
. margins, dydx(*) predict (outcome(1))

Average marginal effects                          Number of obs   =        170
Model VCE    : OIM

Expression   :Pr(WTP==1), predict(outcome(1))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
```

```
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

------------------------------------------------------------------------------------------
                          |            Delta-method
                          |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------------+---------------------------------------------------------------
                      HHZ |   .0152684   .0146226     1.04   0.296    -.0133913    .0439281
           N51000_N100000 |   .0439221   .0737076     0.60   0.551    -.1005421    .1883864
          N101000_N200000 |   .1272028   .0902238     1.41   0.159    -.0496325    .3040381
          N201000_N500000 |  -.0067768   .1407745    -0.05   0.962    -.2826898    .2691361
              Above500000 |   .1253925   13.84008     0.01   0.993    -27.00067    27.25145
Primary_edu |   .3317232   22.78626     0.01   0.988    -44.32853    44.99198
Secondary_edu |   .2073325   10.60375     0.02   0.984    -20.57564    20.99031
Tertiary_edu |   .2045214   10.60375     0.02   0.985    -20.57845    20.98749
Reliab_VeryReliable|  -.0204808   .2151312    -0.10   0.924    -.4421303    .4011686
Reliab_ModeratelyReliable |   .2396625   .1920634     1.25   0.212    -.1367748    .6160998
Reliab_Reliable |   .2163948   .1970891     1.10   0.272    -.1698928    .6026824
Reliab_NotReliable |   .1856653    .183401     1.01   0.311     -.173794    .5451246
              N2000_N5000 |  -1.104618   128.3763    -0.01   0.993    -252.7176    250.5083
             N5000_N10000 |  -1.396644   128.3763    -0.01   0.991    -253.0096    250.2163
            N10000_N20000 |  -1.375571   128.3763    -0.01   0.991    -252.9885    250.2374
               Above20000 |  -1.404483   128.3763    -0.01   0.991    -253.0174    250.2085
             N2000_N5000_ |  -.1383819   .1582752    -0.87   0.382    -.4485956    .1718318
             N6000_N10000 |  -.2731428   .1491062    -1.83   0.067    -.5653855       .0191
            N11000_N20000 |  -.3796257   .1635621    -2.32   0.020    -.7002014     -.05905
              Above20000_ |   2.719061   152.8227     0.02   0.986    -296.8079     302.246
                       b5 |  -.0016144   .0037831    -0.43   0.670     -.009029    .0058003
------------------------------------------------------------------------------------------

. *
. margins, dydx(*) predict (outcome(2))

Average marginal effects                          Number of obs   =        170
Model VCE    : OIM

Expression   :Pr(WTP==2), predict(outcome(2))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

------------------------------------------------------------------------------------------
                          |            Delta-method
                          |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------------+---------------------------------------------------------------
                      HHZ |  -.0059046   .0056978    -1.04   0.300     -.017072    .0052628
           N51000_N100000 |  -.0169856   .0286246    -0.59   0.553    -.0730889    .0391177
          N101000_N200000 |   -.049192   .0358253    -1.37   0.170    -.1194083    .0210244
          N201000_N500000 |   .0026207   .0544414     0.05   0.962    -.1040825    .1093239
              Above500000 |  -.4849187   53.52246    -0.01   0.993     -105.387    104.4172
Primary_edu|  -.1282842   8.811965    -0.01   0.988    -17.39942    17.14285
Secondary_edu|  -.8017976   41.00741    -0.02   0.984    -81.17484    79.57125
Tertiary_edu|  -.7909266    41.0074    -0.02   0.985    -81.16395    79.58209
Reliab_VeryReliable |   .0079204   .0831726     0.10   0.924    -.1550949    .1709357
Reliab_ModeratelyReliable|  -.0926824   .0758476    -1.22   0.222    -.2413411    .0559762
Reliab_Reliable|  -.0836843   .0778531    -1.07   0.282    -.2362736     .068905
Reliab_NotReliable|  -.0718006   .0721296    -1.00   0.320    -.2131721    .0695709
              N2000_N5000 |   .4271788   49.64577     0.01   0.993    -96.87674     97.7311
             N5000_N10000 |    .540111   49.64577     0.01   0.991    -96.76381    97.84403
            N10000_N20000 |   .5319617   49.64577     0.01   0.991    -96.77195    97.83588
               Above20000 |   .5431428   49.64577     0.01   0.991    -96.76079    97.84707
             N2000_N5000_ |   .0535151   .0614309     0.87   0.384    -.0668873    .1739175
             N6000_N10000 |     .10563   .0590336     1.79   0.074    -.0100738    .2213337
            N11000_N20000 |   .1468091   .0663769     2.21   0.027     .0167127    .2769055
              Above20000_ |  -.1051517    5.91002    -0.02   0.986    -11.68858    11.47828
                       b5 |   .0006243   .0014644     0.43   0.670    -.0022458    .0034944
------------------------------------------------------------------------------------------

. *
. margins, dydx(*) predict (outcome(3))

Average marginal effects                          Number of obs   =        170
Model VCE    : OIM

Expression   :Pr(WTP==3), predict(outcome(3))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5
```

```
------------------------------------------------------------------------------------------
                          |            Delta-method
                          |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------------+---------------------------------------------------------------
                      HHZ |  -.0093638   .0091164    -1.03   0.304    -.0272316     .008504
          N51000_N100000 |  -.0269365   .0453991    -0.59   0.553    -.1159172    .0620441
         N101000_N200000 |  -.0780109   .0565437    -1.38   0.168    -.1888345    .0328128
         N201000_N500000 |   .0041561    .086337     0.05   0.962    -.1650614    .1733736
             Above500000 |  -.7690064   84.87847    -0.01   0.993    -167.1277    165.5897
Primary_edu |   -.203439   13.97436    -0.01   0.988    -27.59269    27.18581
Secondary_edu|  -.1271527   6.503067    -0.02   0.984    -12.87293    12.61862
Tertiary_edu|  -.1254288   6.503066    -0.02   0.985    -12.8712    12.62035
Reliab_VeryReliable |   .0125605   .1319822     0.10   0.924      -.24612    .2712409
Reliab_ModeratelyReliable|  -.1469801   .1198022    -1.23   0.220    -.3817882     .087828
Reliab_Reliable|  -.1327105   .1220886    -1.09   0.277    -.3719997    .1065788
Reliab_NotReliable|  -.1138647   .1135316    -1.00   0.316    -.3363824    .1086531
             N2000_N5000 |   .6774398   78.73065     0.01   0.993    -153.6318    154.9867
            N5000_N10000 |   .8565328   78.73069     0.01   0.991    -153.4528    155.1659
           N10000_N20000 |   .8436094   78.73069     0.01   0.991    -153.4657    155.1529
              Above20000 |   .8613408   78.73071     0.01   0.991     -153.448    155.1707
            N2000_N5000_ |   .0848668   .0983007     0.86   0.388    -.1077991    .2775326
            N6000_N10000 |   .1675128       .096     1.74   0.081    -.0206438    .3556695
           N11000_N20000 |   .2328166   .1075156     2.17   0.030     .0220899    .4435434
             Above20000_ |  -.1667544   9.372312    -0.02   0.986    -18.53615    18.20264
                      b5 |   .0009901    .002327     0.43   0.671    -.0035708    .0055509
------------------------------------------------------------------------------------------

. *
. restore

. *
. *
. preserve

. *
. keep if Enum_city ==4
(510 observations deleted)

. * Regression Analysis (PrtHar)
. oprobit WTP HHZ N51000_N100000 N101000_N200000 N201000_N500000 /*
> **/ Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliable /*
> **/ Reliab_ReliableReliab_NotReliable  /*
> **/ N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000 N11000_N20000
Above20000_ b5

Iteration 0:   log likelihood = -177.30299
Iteration 1:   log likelihood =  -139.8269
Iteration 2:   log likelihood =  -138.8198
Iteration 3:   log likelihood = -138.72728
Iteration 4:   log likelihood =  -138.7123
Iteration 5:   log likelihood = -138.70964
Iteration 6:   log likelihood = -138.70924
Iteration 7:   log likelihood = -138.70919
Iteration 8:   log likelihood = -138.70917

Ordered probit regression                         Number of obs   =        170
                                                  LR chi2(21)     =      77.19
                                                  Prob > chi2     =     0.0000
Log likelihood = -138.70917                       Pseudo R2       =     0.2177

------------------------------------------------------------------------------------------
                      WTP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------------+---------------------------------------------------------------

                      HHZ |  -.0231937   .0726863    -0.32   0.750    -.1656562    .1192688
          N51000_N100000 |   .9995669   .6769693     1.48   0.140    -.3272686    2.326402
         N101000_N200000 |   .2766742   .7355669     0.38   0.707     -1.16501    1.718359
         N201000_N500000 |    .333767   .7553374     0.44   0.659    -1.146667    1.814201
             Above500000 |   .8963842   .8103471     1.11   0.269     -.691867    2.484635
Primary_edu |   5.727462   126.9662     0.05   0.964    -243.1218    254.5767
Secondary_edu|  -.2977427   .4149831    -0.72   0.473    -1.111095    .5156092
Tertiary_edu|  -.1307366   .3930359    -0.33   0.739    -.9010728    .6395997
Reliab_VeryReliable |   .3067503    .257719     1.19   0.234    -.1983697    .8118703
Reliab_ModeratelyReliable|  -1.286649   .3889619    -3.31   0.001       -2.049   -.5242971
Reliab_Reliable|  -1.396549   .4411053    -3.17   0.002      -2.2611   -.5319989
Reliab_NotReliable|  -.4149362   .3296225    -1.26   0.208    -1.060984     .231112
             N2000_N5000 |   .0219667    .805371     0.03   0.978    -1.556531    1.600465
            N5000_N10000 |   .2378812   .8049716     0.30   0.768    -1.339834    1.815597
           N10000_N20000 |  -.2970996   .8104828    -0.37   0.714    -1.885617    1.291417
              Above20000 |   .2085817   .8224875     0.25   0.800    -1.403464    1.820627
```

```
            N2000_N5000_ |  -.3159854   .3087318    -1.02   0.306    -.9210887    .2891178
            N6000_N10000 |   .2917496   .3424031     0.85   0.394     -.379348    .9628473
           N11000_N20000 |   .4362486   .3937186     1.11   0.268    -.3354257    1.207923
             Above20000_ |   1.105924   .5966277     1.85   0.064    -.0634451    2.275292
                      b5 |  -.0880368    .018567    -4.74   0.000    -.1244275   -.0516462
-------------------------+----------------------------------------------------------------
                   /cut1 |   -2.58157   1.325749                      -5.179989    .0168497
                   /cut2 |  -1.892465   1.319956                      -4.479531    .6946005
------------------------------------------------------------------------------------------
Note: 4 observations completely determined.  Standard errors questionable.

. *
. outreg2 using FullSample.doc, dec(4) title("Table 1: Ordered Probit") ctitle(PortH) /*
> **/ addstat(Pseudo R-squared, e(r2_p), Wald-chi2, e(chi2), Prob > chi2, e(p)) append
FullSample.doc
dir :seeout

. *
. *
. margins, dydx(*) predict (outcome(1))

Average marginal effects                          Number of obs   =        170
Model VCE    : OIM

Expression   :Pr(WTP==1), predict(outcome(1))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

------------------------------------------------------------------------------------------
                         |            Delta-method
                         |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------------+----------------------------------------------------------------
                     HHZ |   .0060927    .019073     0.32   0.749    -.0312897    .0434751
         N51000_N100000 |  -.2625742   .1742366    -1.51   0.132    -.6040718    .0789233
        N101000_N200000 |   -.072679   .1927255    -0.38   0.706     -.450414     .305056
        N201000_N500000 |  -.0876766   .1977541    -0.44   0.658    -.4752675    .2999143
             Above500000 |  -.2354694    .210441    -1.12   0.263    -.6479262    .1769874
Primary_edu|  -.1504536    3.33526    -0.05   0.964    -6.687443    6.386536
Secondary_edu |   .0782134   .1088918     0.72   0.473    -.1352106    .2916374
Tertiary_edu |   .0343429   .1032833     0.33   0.740    -.1680885    .2367744
Reliab_VeryReliable|  -.0805796   .0672676    -1.20   0.231    -.2124217    .0512624
Reliab_ModeratelyReliable |   .3379871   .0957346     3.53   0.000     .1503508    .5256235
Reliab_Reliable |   .3668568   .1088167     3.37   0.001       .15358    .5801336
Reliab_NotReliable |   .1089988   .0860037     1.27   0.205    -.0595655     .277563
             N2000_N5000 |  -.0057704   .2115622    -0.03   0.978    -.4204246    .4088838
            N5000_N10000 |  -.0624886   .2114705    -0.30   0.768    -.4769631     .351986
           N10000_N20000 |   .0780445   .2125718     0.37   0.714    -.3385885    .4946775
              Above20000 |  -.0547919   .2160448    -0.25   0.800     -.478232    .3686482
            N2000_N5000_ |   .0830056   .0803294     1.03   0.301    -.0744371    .2404483
            N6000_N10000 |  -.0766391   .0898725    -0.85   0.394     -.252786    .0995077
           N11000_N20000 |  -.1145973   .1028533    -1.11   0.265     -.316186    .0869915
             Above20000_ |  -.2905129   .1540709    -1.89   0.059    -.5924863    .0114606
                      b5 |   .0231262   .0041634     5.55   0.000     .0149662    .0312863
------------------------------------------------------------------------------------------

. *
. margins, dydx(*) predict (outcome(2))

Average marginal effects                          Number of obs   =        170
Model VCE    : OIM

Expression   :Pr(WTP==2), predict(outcome(2))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

------------------------------------------------------------------------------------------
                         |            Delta-method
                         |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------------+----------------------------------------------------------------
                     HHZ |   .0005125   .0016362     0.31   0.754    -.0026943    .0037194
         N51000_N100000 |   -.022087   .0201481    -1.10   0.273    -.0615766    .0174025
        N101000_N200000 |  -.0061136   .0169463    -0.36   0.718    -.0393277    .0271006
        N201000_N500000 |  -.0073751   .0176768    -0.42   0.677    -.0420209    .0272707
             Above500000 |   -.019807   .0214448    -0.92   0.356    -.0618381     .022224
Primary_edu|  -.1265574   2.805989    -0.05   0.964    -5.626194     5.37308
Secondary_edu |   .0065791   .0094621     0.70   0.487    -.0119663    .0251245
Tertiary_edu |   .0028888   .0086648     0.33   0.739    -.0140939    .0198716
```

```
Reliab_VeryReliable|  -.0067781   .0064847    -1.05   0.296    -.0194879    .0059317
Reliab_ModeratelyReliable |   .0284305   .0166651     1.71   0.088    -.0042324    .0610935
Reliab_Reliable |    .030859   .0188301     1.64   0.101    -.0060474    .0677654
Reliab_NotReliable |   .0091687   .0083313     1.10   0.271    -.0071604    .0254977
            N2000_N5000 |  -.0004854   .0178004    -0.03   0.978    -.0353736    .0344028
           N5000_N10000 |  -.0052564   .0178601    -0.29   0.769    -.0402616    .0297489
          N10000_N20000 |   .0065649   .0184153     0.36   0.721    -.0295285    .0426583
             Above20000 |  -.0046089   .0182651    -0.25   0.801    -.0404079      .03119
           N2000_N5000_ |   .0069822   .0081028     0.86   0.389    -.0088989    .0228633
           N6000_N10000 |  -.0064467   .0077397    -0.83   0.405    -.0216161    .0087228
          N11000_N20000 |  -.0096396   .0099148    -0.97   0.331    -.0290724    .0097931
            Above20000_ |  -.0244371   .0173667    -1.41   0.159    -.0584753    .0096011
                     b5 |   .0019453   .0010833     1.80   0.073    -.0001778    .0040685
------------------------------------------------------------------------------------------

. *
. margins, dydx(*) predict (outcome(3))

Average marginal effects                          Number of obs   =        170
Model VCE    : OIM

Expression   :Pr(WTP==3), predict(outcome(3))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

------------------------------------------------------------------------------------------
                          |            Delta-method
                          |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------------+---------------------------------------------------------------

                      HHZ |  -.0066052   .0206869    -0.32   0.750    -.0471508    .0339404
          N51000_N100000 |   .2846614   .1908087     1.49   0.136    -.0893168    .6586397
         N101000_N200000 |   .0787926   .2093698     0.38   0.707    -.3315647    .4891499
         N201000_N500000 |   .0950518   .2150112     0.44   0.658    -.3263625     .516466
             Above500000 |   .2552766   .2292193     1.11   0.265     -.193985    .7045381
Primary_edu |   .1631094   3.615783     0.05   0.964    -6.923694    7.249913
Secondary_edu|  -.0847926   .1177061    -0.72   0.471    -.3154924    .1459072
Tertiary_edu|  -.0372318   .1118155    -0.33   0.739    -.2563861    .1819225
Reliab_VeryReliable |   .0873578   .0726914     1.20   0.229    -.0551147    .2298303
Reliab_ModeratelyReliable|  -.3664179   .1031464    -3.55   0.000    -.5685811   -.1642548
Reliab_Reliable |   -.397716   .1183991    -3.36   0.001     -.629774   -.1656581
Reliab_NotReliable|  -.1181675   .0928132    -1.27   0.203     -.300078     .063743
            N2000_N5000 |   .0062558   .2293609     0.03   0.978    -.4432834    .4557949
           N5000_N10000 |    .067745   .2291164     0.30   0.767    -.3813149    .5168049
          N10000_N20000 |  -.0846094   .2306625    -0.37   0.714    -.5366996    .3674808
             Above20000 |   .0594009   .2341489     0.25   0.800    -.3995225    .5183243
           N2000_N5000_ |  -.0899878   .0875689    -1.03   0.304    -.2616196     .081644
           N6000_N10000 |   .0830859   .0968537     0.86   0.391     -.106744    .2729157
          N11000_N20000 |    .124237   .1113776     1.12   0.265    -.0940592    .3425331
            Above20000_ |   .3149502   .1658215     1.90   0.058    -.0100539    .6399543
                     b5 |  -.0250716   .0045221    -5.54   0.000    -.0339347   -.0162084
------------------------------------------------------------------------------------------

. *
. restore

. *
. * Regression Analysis (Full Sample)
. oprobit WTP HHZ N51000_N100000 N101000_N200000 N201000_N500000 /*
> **/ Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliable /*
> **/ Reliab_ReliableReliab_NotReliable  /*
> **/ N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000 N11000_N20000
Above20000_ b5

Iteration 0:   log likelihood =  -599.5131
Iteration 1:   log likelihood = -514.58664
Iteration 2:   log likelihood = -514.06153
Iteration 3:   log likelihood = -514.06142
Iteration 4:   log likelihood = -514.06142

Ordered probit regression                         Number of obs   =        680
                                                  LR chi2(22)     =     170.90
                                                  Prob > chi2     =     0.0000
Log likelihood = -514.06142                       Pseudo R2       =     0.1425

------------------------------------------------------------------------------------------
                      WTP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------------+---------------------------------------------------------------
```

```
                      HHZ |  -.0484854   .0259415    -1.87   0.062    -.0993298     .002359
          N51000_N100000 |   .2407657   .1643713     1.46   0.143    -.0813961    .5629276
         N101000_N200000 |   .3343149   .1871946     1.79   0.074    -.0325798    .7012095
         N201000_N500000 |   .2724852   .2241853     1.22   0.224    -.1669099    .7118803
             Above500000 |   .7005109   .2504091     2.80   0.005     .2097181    1.191304
Primary_edu |   .4728851   .4233466     1.12   0.264     -.356859    1.302629
Secondary_edu |   .0079516   .2491489     0.03   0.975    -.4803713    .4962744
Tertiary_edu|  -.0596801   .2405485    -0.25   0.804    -.5311466    .4117863
Reliab_VeryReliable |   .3312484   .1777574     1.86   0.062    -.0171497    .6796465
Reliab_ModeratelyReliable|  -.2538049   .1911775    -1.33   0.184    -.6285059     .120896
Reliab_Reliable|  -.1902695   .2097707    -0.91   0.364    -.6014125    .2208734
Reliab_NotReliable|  -.0783989   .1788613    -0.44   0.661    -.4289607    .2721629
             N2000_N5000 |    .010315   .3734467     0.03   0.978    -.7216271     .742257
            N5000_N10000 |   .4313406   .3537474     1.22   0.223    -.2619917    1.124673
           N10000_N20000 |   .1080368   .3556227     0.30   0.761    -.5889708    .8050444
              Above20000 |   .4228836   .3662611     1.15   0.248    -.2949749    1.140742
            N2000_N5000_ |   .0246811   .1613719     0.15   0.878     -.291602    .3409642
            N6000_N10000 |   .4308501   .1703333     2.53   0.011      .097003    .7646972
           N11000_N20000 |   .6701384   .2162202     3.10   0.002     .2463546    1.093922
             Above20000_ |   .9273003   .4251521     2.18   0.029     .0940175    1.760583
                      b5 |  -.0214397   .0067594    -3.17   0.002    -.0346878   -.0081916
-------------------------+----------------------------------------------------------------
                   /cut1 |   4.409159   .7956089                      2.849795    5.968524
                   /cut2 |   5.031829   .7998832                      3.464086    6.599571
------------------------------------------------------------------------------------------

. *
. outreg2 using FullSample.doc, dec(4) append title("Table 1: Ordered Probit") ctitle(Full
Sample) /*
> **/ addstat(Pseudo R-squared, e(r2_p), Wald-chi2, e(chi2), Prob > chi2, e(p))
FullSample.doc
dir :seeout

. *
. *
. margins, dydx(*) predict (outcome(1))

Average marginal effects                          Number of obs   =        680
Model VCE    : OIM

Expression   :Pr(WTP==1), predict(outcome(1))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

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                         |            Delta-method
                         |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------------+----------------------------------------------------------------
                      HHZ |   .0146531   .0077983     1.88   0.060    -.0006313    .0299375
          N51000_N100000 |  -.0727633   .0495322    -1.47   0.142    -.1698446     .024318
         N101000_N200000 |  -.1010354   .0562978    -1.79   0.073     -.211377    .0093063
         N201000_N500000 |  -.0823494   .0675812    -1.22   0.223    -.2148061    .0501072
             Above500000 |  -.2117057   .0747042    -2.83   0.005    -.3581232   -.0652882
Primary_edu|  -.1429135   .1276673    -1.12   0.263    -.3931368    .1073097
Secondary_edu|  -.0024031   .0752973    -0.03   0.975     -.149983    .1451768
Tertiary_edu |   .0180363   .0726898     0.25   0.804    -.1244332    .1605058
Reliab_VeryReliable|  -.1001086   .0534134    -1.87   0.061    -.2047969    .0045796
Reliab_ModeratelyReliable |    .076704    .057584     1.33   0.183    -.0361586    .1895665
Reliab_Reliable |   .0575025   .0633012     0.91   0.364    -.0665656    .1815706
Reliab_NotReliable |   .0236934   .0540285     0.44   0.661    -.0822006    .1295874
             N2000_N5000 |  -.0031173   .1128612    -0.03   0.978    -.2243213    .2180866
            N5000_N10000 |  -.1303581   .1066191    -1.22   0.221    -.3393277    .0786115
           N10000_N20000 |  -.0326505    .107454    -0.30   0.761    -.2432563    .1779554
              Above20000 |  -.1278023   .1104096    -1.16   0.247    -.3442012    .0885967
            N2000_N5000_ |   -.007459   .0487634    -0.15   0.878    -.1030336    .0881156
            N6000_N10000 |  -.1302099   .0508517    -2.56   0.010    -.2298774   -.0305424
           N11000_N20000 |  -.2025267   .0642183    -3.15   0.002    -.3283923   -.0766611
             Above20000_ |  -.2802452   .1276679    -2.20   0.028    -.5304697   -.0300206
                      b5 |   .0064794   .0020144     3.22   0.001     .0025314    .0104275
------------------------------------------------------------------------------------------

. *
. margins, dydx(*) predict (outcome(2))

Average marginal effects                          Number of obs   =        680
Model VCE    : OIM

Expression   :Pr(WTP==2), predict(outcome(2))
```

```
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

------------------------------------------------------------------------------------------
                          |            Delta-method
                          |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------------+---------------------------------------------------------------
                      HHZ |  -.0042259   .0022734    -1.86   0.063    -.0086817    .0002299
          N51000_N100000 |   .0209847   .0143103     1.47   0.143    -.0070629    .0490323
         N101000_N200000 |   .0291382   .0163002     1.79   0.074    -.0028095     .061086
         N201000_N500000 |   .0237493   .0195263     1.22   0.224    -.0145215    .0620201
             Above500000 |   .0610552    .022347     2.73   0.006     .0172559    .1048545
Primary_edu |   .0412158   .0369283     1.12   0.264    -.0311624    .1135939
Secondary_edu |    .000693    .021715     0.03   0.975    -.0418676    .0432537
Tertiary_edu|  -.0052016   .0209706    -0.25   0.804    -.0463033    .0359001
Reliab_VeryReliable |    .028871   .0157481     1.83   0.067    -.0019947    .0597367
Reliab_ModeratelyReliable|  -.0221212   .0165756    -1.33   0.182    -.0546087    .0103664
Reliab_Reliable|  -.0165835   .0182272    -0.91   0.363    -.0523083    .0191412
Reliab_NotReliable|  -.0068331   .0155571    -0.44   0.660    -.0373244    .0236582
             N2000_N5000 |    .000899   .0325476     0.03   0.978    -.0628931    .0646912
            N5000_N10000 |   .0375948   .0308733     1.22   0.223    -.0229157    .0981054
           N10000_N20000 |   .0094163    .031003     0.30   0.761    -.0513485    .0701811
              Above20000 |   .0368577   .0319789     1.15   0.249    -.0258197    .0995352
            N2000_N5000_ |   .0021512   .0140703     0.15   0.878    -.0254261    .0297284
            N6000_N10000 |   .0375521   .0150108     2.50   0.012     .0081314    .0669728
           N11000_N20000 |    .058408   .0192486     3.03   0.002     .0206814    .0961346
             Above20000_ |   .0808217   .0379155     2.13   0.033     .0065087    .1551347
                       b5 |  -.0018686    .000593    -3.15   0.002    -.0030309   -.0007064
------------------------------------------------------------------------------------------

. *
. margins, dydx(*) predict (outcome(3))

Average marginal effects                          Number of obs   =        680
Model VCE    : OIM

Expression   :Pr(WTP==3), predict(outcome(3))
dy/dx w.r.t. : HHZ N51000_N100000 N101000_N200000 N201000_N500000 Above500000
Primary_eduSecondary_eduTertiary_eduReliab_VeryReliableReliab_ModeratelyReliableReliab_Reliable
Reliab_NotReliable N2000_N5000 N5000_N10000 N10000_N20000 Above20000 N2000_N5000_ N6000_N10000
N11000_N20000 Above20000_ b5

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                          |            Delta-method
                          |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------------+---------------------------------------------------------------
                      HHZ |  -.0104272   .0055766    -1.87   0.062    -.0213571    .0005027
          N51000_N100000 |   .0517786    .035423     1.46   0.144    -.0176492    .1212064
         N101000_N200000 |   .0718971   .0403384     1.78   0.075    -.0071647    .1509589
         N201000_N500000 |   .0586001   .0482438     1.21   0.224     -.035956    .1531562
             Above500000 |   .1506505   .0534726     2.82   0.005     .0458462    .2554548
Primary_edu |   .1016978   .0910402     1.12   0.264    -.0767378    .2801333
Secondary_edu |   .0017101   .0535824     0.03   0.975    -.1033095    .1067296
Tertiary_edu|  -.0128347   .0517276    -0.25   0.804    -.114219    .0885496
Reliab_VeryReliable |   .0712376   .0380152     1.87   0.061    -.0032708    .1457461
Reliab_ModeratelyReliable|  -.0545828   .0412004    -1.32   0.185    -.1353341    .0261685
Reliab_Reliable |   -.040919   .0451723    -0.91   0.365    -.129455    .047617
Reliab_NotReliable|  -.0168603    .038491    -0.44   0.661    -.0923014    .0585807
             N2000_N5000 |   .0022183   .0803138     0.03   0.978    -.1551938    .1596304
            N5000_N10000 |   .0927633   .0760459     1.22   0.223    -.0562839    .2418105
           N10000_N20000 |   .0232342   .0764696     0.30   0.761    -.1266436    .1731119
              Above20000 |   .0909445   .0787093     1.16   0.248    -.0633228    .2452119
            N2000_N5000_ |   .0053079   .0346953     0.15   0.878    -.0626937    .0733094
            N6000_N10000 |   .0926578   .0364644     2.54   0.011     .0211889    .1641267
           N11000_N20000 |   .1441187   .0461574     3.12   0.002     .0536519    .2345855
             Above20000_ |   .1994234    .090896     2.19   0.028     .0212705    .3775763
                       b5 |  -.0046108   .0014603    -3.16   0.002    -.0074729   -.0017487
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. *
. log close
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