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ASSESSMENT OF INVESTMENT AND FINANCIAL FLOWS TO MITIGATE CLIMATE CHANGE EFFECTS IN THE POWER SECTOR

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ABBREVIATIONS AND ACRONYMS

AfDB	African Development Bank
ATC&C	Aggregate Technical, Commercial and Collection
BPE	Bureau of Public Enterprises
CBN	Central Bank of Nigeria
DisCos	Distribution Company
EIA	Energy Information Administration
FF	Financial Flow
FGN	Federal Government of Government
FMoEnv	Federal Ministry of Environment
FMoP	Federal Ministry of Power
GenCos	Generation Company
GTSC	Gas Turbine Single Cycle
CCGT	Combined Cycle Gas Turbine
IF	Investment Flow
MYTO	Multi Year Tariff Order
NBS	Nigerian Bureau of Statistics
NDPHC	Niger Delta Power Holding Company
NEPA	National Electric Power Authority
NERC	Nigerian Electricity Regulatory Commission
O&M	Operations and Maintenance
PHCN	Power Holding Company of Nigeria
TCN	Transmission Company of Nigeria
WB	World Bank

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Executive Summary

Electricity generation from fossil fuels are highest contributors of Green House Gas (GHG) emissions. While provision of electricity is fundamental for economic growth and prosperity, the impact of fossil fuel due to the carbon content is a concern. With growth in population and change in lifestyle especially in urban areas implies that electricity demand continues to increase. The increase in demand in electricity except when checked, gives rise to increase in carbonization resulting consequently in the climate change.

In Nigeria with population of over 200 million, the available power capacity averaged at about 5GW is grossly inadequate which implies that more capacity is expected to be generated. The current state of the value chain for power in Nigeria is very poor. While the capacity generation is abysmally low, it is impacted by grossly poor gas infrastructure to supply the required gas otherwise the current generation potential in the country is about 13GW. Beyond the power generation is the bigger issue of lower wheeling transmission capacity which is far lower than the potential capacity of power that can be generated. The current wheeling capacity is less than 7GW. The most challenging part of the electric power value chain is the distribution network which is currently struggling with poor revenue collection, inadequate metering, aged transformers, and distribution lines. Should more power be produced, it is important that this is implemented in accordance with the Nationally Determined Contributions strategy which suggests increase in the utilization of renewables particularly to explore more of off-grid and mini-grid systems and thereby reduce the challenges of transmission networks and the associated losses with transmission. While the use of natural gas is inevitable considering the aggressive need to increase power generation capacity in the country, there is need to reduce the carbon footprint using these technologies by ensuring high efficiency power plants are built.

Since the cheaper options of producing power particularly in Nigeria is through the use of off-grid petrol motor spirit or diesel generators which has flooded the market and contributing to the emissions from the power sector.

The I&FF assessment is to determine the specific activities needed by Nigeria to address climate change in the Energy (Power) sub-sector, and the level of financial contributions and sources required to achieve this objective. The scope of the I&FF assessment was narrowed to increase in gas power generation, conversion of the overwhelming number of open cycle power generating plants in the country into combined cycle power generation, utilization of LNG and LPG as replacement for the off-grid power generators and use of renewable energy particularly solar and hydro for both grid and off grid power generation.

A historical perspective was built within the 2010 to 2014 period while the Base year was 2015. Also, the Baseline and Climate Scenario periods were between 2015 and 2030. In the Climate Scenario period, climate actions were introduced which are activities Nigeria needs to carry out differently to avoid attaining the projection by the Third National Communication that emissions may grow to about 900 million tonnes in 2030 with the economy operating under Business-as-Usual (BAU) approach. Therefore, this report seeks to address the investment and financial flows necessary for the mitigation scenario to reduce the level of emissions. The investment and financial flows assessment will enable government to create a viable pathway towards low GHG emissions and climate resilient development.

It is expected that as the power industry continue to grow particularly with the experience of mini grids in the country, some of the assumptions are expected to also change over the years, the estimates projected for the mitigation and adaptation plans will consequentially change.

Chapter One

1.0 Introduction

In December 2015, about 195 countries under the United Nations Framework Committee for Climate Change, UNFCCC came together in Paris and pledged their commitment towards a global action to limit the global temperature rise well below 2 degrees Celsius above the pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius that is now known as the Paris Agreement.

The Paris Agreement establishes the obligation of all parties to contribute to climate change mitigation and adaptation actions. All party countries are hence required to develop plans and strategies on how to contribute to climate change decarbonization. The Agreement does not formulate country specific emission targets rather it depends on voluntary mitigation/adaptation processes that seek to ensure individual progress in meeting the collective goal.

To meet the National Determined Contributions (NDCs) through investments on mitigation and adaptation processes, an investment and financial flows framework must be developed by each country party that seek to answer the needs of the country party to address climate change and he financial architecture to do so.

The I&FF assessment constitutes the mitigation/adaptation options for key sectors of the country party economy, major sources of public and private funds and the investor with the changes needed for climate action.

I&FF basically use both current and historical information for projection of future needs. The Nigerian Inter-Ministerial Dialogue identified 5 key sectors of the economy namely: Energy, Oil and Gas, Agriculture, Transport, Forestry and Businesses for the Investment and Financial Flows Assessment.

It is important to stress that while the report refers to the Energy sector, it basically covers electricity because the oil and gas as well as Transportation sectors could all be regarded to be under the broader Energy spectrum.

Electric power generation through fossil fuels, coal and natural gas has been identified as the highest percentage contributor of GHG emissions. Provision of electricity is fundamental for economic growth and prosperity. High consumption per capita of electricity is an indication of the economic status of the country and corresponds positively with the Gross Domestic Product, GDP of the nation. With the growth in population and the subsequent development in technology resulting in lifestyle changes, electricity demand continues to increase. The increase in demand however gives rise to increase in carbonization of the environment resulting in severe climate change.

Therefore, it has become imperative that the way and manner electricity is being produced and used will be addressed to combat climate change drastically through mitigation and adaptation actions. And one of the most notable mitigation means is by the replacement of fossil fuels, coal and natural gas generation by renewable energy sources in the likes of wind, solar and hydro.

Therefore, this report seeks to address the investment and financial flows necessary for the mitigation scenario to reduce the level of emissions. The investment and financial flows assessment will enable the

government to create a viable pathway towards low greenhouse gas emissions and climate resilient development.

1.1 Objectives

The main objective of the assessment of the investment and financial flows is to know the approximate capital expenditure required and its sources to reliably address climate change in the power sector.

Notably, the assessment aims at achieving the following results:

- Creation of a consolidated data on I&FF in the power sector;
- Expression of BAU I&FF scenario;
- Identification of Mitigation scenario with the projection of I&FF associated with the implementation; and
- Preparation of least-cost GHG mitigation projections; as well as
- Policy implications.

1.2 Background

Electricity generation in Nigeria dates to 1856 in Lagos. In 1950, the Electricity Corporation of Nigeria (ECN) was formed to oversee the electricity generation and distribution in Nigeria. In 1962, through a parliamentary Act, the Niger Dams Authority came into being to generate electricity by hydro power within the upper Niger. By 1972, the National Electric Power Authority, NEPA was formed out of the merger of ECN and the Niger Dams Authority. The historical low-level investment in Nigeria's power sector has been a significant barrier to private and commercial investments which has seriously affected the growth of the Industry. The National Electric Power Report of 2001 and the Electric Power Sector Reform of 2005 became the cornerstone under which the sector experienced some significant changes in operations and management.

In 2005, NEPA became Power Holding Company of Nigeria, PHCN and later to be unbundled into 18 successor companies to be privatized later. The 18 successor companies are made up of 6 generating companies (GenCos), 1 transmission Company and 11 distribution companies (DisCos). These successor companies became privatized in 2013 except for the Transmission Company of Nigeria that remains under the control of the Federal Government of Nigeria.

The Nigerian power sector remains in need of significant investments in its utility scale. Capacity continues to fall short of meeting domestic demands. Currently, Nigeria has an installed electricity generation capacity of about 12,522MW with an average available capacity of about 4,500MW to meet the needs of a population of over 180 million people, with a consumption precept of 136KWH.

1.2.1 Policy Documents with Plans and Programmes

The NDC Implementation Action Plan for the Power sector, the National Renewable Energy and Energy Efficiency Policy (NREEEP), 2015 and the Nigeria Power Baseline Report of 2015 are some of the documents used for the purpose of generating data in the projection of investments in the power sector. The plans and programs as communicated in these documents form the basis for the generation of both the baseline and

mitigation scenarios for the assessment of the investment and financial flows. The communications through the various documents became necessary towards closing the energy gap within the Nigerian economy and at the same time creating a sustainable developmental pathway for the decarbonization of the power sector. Most of the communications are related and reflect the ambitions of government in the quest for the realization of adequate supply of electricity by the year 2030.

The publications used for the Analysis/Evaluation and the Final Outcomes are as follows:

- Nigeria Power Baseline Report, 2015
- IRENA-Renewable Power Generation Costs, 2018
- National Renewable Energy Action Plans (NREAP) 2015 - 2030
- National Renewable Energy and Energy Efficiency Policy (NREEEP), 2015
- NDC Implementation Action Plan for the Power Sector
- National Energy Efficiency Action Plan (NEEAP) 2016
- Rural Electrification Strategy and Implementation Plan (RESIP) 2016
- Sustainable Energy for All (SE4ALL) Action Agenda, 2016
- First National Communication
- Second National Communication.

1.2.2 Institutions and Governance

The Federal Ministry of Power (FMoP) has the overall responsibility over the power sector. Its main objective is to provide the nation with stable, adequate, and reliable electricity by implementing generation, transmission and distribution guidelines through her agencies and departments.

The Transmission Company of Nigeria (TCN) is responsible for the transmission of electricity through the national grid. It is made up of two subdivisions of Systems Operations and Market Operations. The Market Operator sees to the administration of wholesale electricity trading through bulk metering while the Systems Operator is responsible for the planning, dispatch, and operation of the transmission grid. It is also responsible for the security and reliability of the grid network.

The Nigerian Electricity Regulatory Commission (NERC) as the name implies is saddled with sole responsibility for the regulation of the electricity industry in Nigeria. NERC issues permits and licenses to market participants and enforces compliance to market rules and operating guidelines.

The Rural Electrification Agency (REA) was established with the responsibility of provision of access to electricity to unserved and underserved remote communities across the country that are without grid electricity.

The ECN has the statutory mandate for the strategic planning and coordination of national policies in the field of energy. The ECN serves primarily as a centre for information dissemination relating to national energy policy and provides solutions to inter-related technical problems as well as monitoring the performance of the energy sector in the execution of government policies on energy.

Other notable institutions of the power sector include:

i. The Niger Delta Power Holding Company (NDPHC) is an intervention agency of government with the responsibility of implementing the National Integrated Power Projects (NIPP);

ii. The Nigerian Bulk Electricity Trader (NBET) is a government owned public liability company with the role of engaging in the purchase and resale of electric power and ancillary services from power producers through the application of Power Purchase Agreements, PPAs.

1.2.3 Basic Methodology and Key Parameters

The approach methodology for the investment and financial flows assessment will basically follow the eight steps of the UNDP methodological guide:

i. Establishing key parameters.
   - Determine in detail the scope of the sector;
   - Identify the preliminary measures of mitigation;
   - Specify the period of evaluation and the reference year; and
   - Select the analytical approach.

ii. Compiling Historical Data
   Data for the period 2015 to 2017 is compiled to indicate the state of the sector and give guidance to the projections of plans and programs towards the targets set forth by the government.

iii. Defining the Baseline Scenario
   The baseline is a critical factor in the assessment exercise as it is the basis for determining the difference between the business-as-usual scenario and the mitigation scenario. In doing this, historical data of plans and programs must be identified and projected into the outer years up to 2030.

iv. Estimating the I&FF of the Baseline Scenario
   - Estimates of I&FF annually disaggregated by investment entity and funding sources;
   - Estimates of O&M annually disaggregated by investment entity and funding sources; and
   - Estimates of subsidy annually disaggregated for each investment type and for IF, FF and O&M costs, if subsidy is included explicitly in the investment.

v. Defining the Mitigation Scenario
   - Identification of the mitigating interventions in the investment types.

vi. Deriving Detailed Annual I&FF estimates of the Mitigation Scenario
   - Estimating annual changes, I&FF and O&M required to implement mitigation scenarios;
   - Estimating the annual IF, FF and O&M costs and subsidy if included in the investments;
   - Estimating the annual IF and FF for each investment type, disaggregated by investment entity and funding source;
   - Estimating the annual O&M costs for each IF, disaggregated by investment entity and funding source; and
   - Estimating annual subsidy costs for each relevant investment type and for IF, FF, and O&M costs if subsidies are included in the investments.

vii. Calculate the Changes in IF, FF, and O&M costs, and in subsidy costs.
   - Calculate changes in cumulative IF, FF and O&M costs for all investment types;
   - Calculate changes in annual IF, FF and O&M costs for individual investment types, for individual sources of funds, and for all investment types and funding sources;

- If subsidies are included explicitly, calculate changes in cumulative and/or in annual subsidies for IF, FF, and O&M for each investment type and all investment types.

viii. Assessing Policy Implications

- Based on the necessary change determined, identify policies and incentives to induce the necessary change.
- Integrate climate change in regional and national strategy.
- Strengthen the capacities of all stakeholders.
- Integrating these options into the national reference.
- Involve local entities proactively, give responsibility/empowerment to the people; and
- Develop activities that support the generation of income/revenue.

Definitions

Mitigation

In the context of climate change, the UN defines mitigation in terms of human interventions to reduce the sources of greenhouse gases. In the power sector, these interventions include switching to renewable energy, and altering consumption of energy such that end-use efficiency will all reduce greater amounts of greenhouse gases.

Investment Flows (IF)

Investment Flows (IF) is defined as the amount of capital needed for new physical assets with lifespan of more than one year. Example would be the amount of capital required for the purchase of solar PV kits.

Financial Flows (FF)

Financial flows (FF) are the on-going expenditures of programmatic measures; the FF covers expenditures other than capital expenditures.

Operation and Maintenance (O&M) Costs

The O&M costs is the expenditure associated with the operation and maintenance of the asset acquired. Examples include on-going salaries and wages, maintenance material and variable costs of raw materials.

Investment Entity

An Investment Entity is the body or thing making the investment in the asset. This study defines three types of investment entities: households, corporations, and government.

Sources of I& FF Funds

The sources of I & FF funds are the origins of the funds invested by the investment entities e.g. domestic equity, foreign debt, domestic subsidies, and foreign aid.

Households

Households are individuals or groups of people (e.g. families) acting as one unit financially. Households invest in assets such as rooftop solar PV, and energy saving appliances.

Corporations

Corporations include both financial firms and non-financial businesses, and organisations may be profit or non-profit. Their sources of investment funds are from domestic sources and external sources and can be in the form of domestic loans, debt equity and foreign aids.

Governments

Governments are the national, states and local governments of a country. Financial and non-financial corporations owned by governments, such as public universities, oil companies, utilities and management of water resources and forestry reserves.

Scenario

A scenario is an internally consistent and plausible characterisation of future outcomes over a specified period. For each sectoral assessment of I & FF for mitigation, it must include a baseline scenario for that sector. In both cases, the baseline scenario describes the conditions of the status quo that is a description of what will probably happen if no new policy measure to address climate change is put in place.

Mitigation Scenario

The mitigation scenario includes measures to mitigate GHG emissions that is; the mitigation scenario addresses the expected socio-economic developments, technological change, new measures to mitigate GHG emissions and the expected investment in the sector given the implementation of mitigation measures.

Evaluation Period

The evaluation period is the time horizon of the assessment period in this case 2015-2030.

Base Year

This is the first year of the assessment period. It is the first year of both the baseline and the mitigation scenarios. It is a recent year for which information on the IF, FF and O&M costs are available.

Chapter Two

2.0 Scope, Input Data and Scenarios

2.1 Scope

The power sector in Nigeria is plagued with structural issues in all its key areas of generation, transmission, and distribution. The operational capacity of the power plants is less than a third of their installed capacity because most of the plants are old with high maintenance costs. Vandalism has crippled the oil and gas infrastructure, creating gas shortages at the power plants. Underinvestment in maintenance and infrastructure has constrained the transmission grid. Worse still is the high collection and commercial losses that have impacted the financial viability of the commercialized distribution companies.

Nigeria is equally the biggest economy in Africa with a GDP of USD397.3 (2018) but a per capita of electricity of 361KWh which is very low compared to other economies of similar population and size. Over half of Nigeria's (55%) population of about 180 million people is without access to grid electricity and those with grid connection suffer frequent and extensive power outages. To improve the power sector, the Nigerian government undertook long term structural reforms from 2005 that finally led to the privatization of the legacy assets in 2013.

The challenges of the power sector are evident in the four segments of the electricity power sector value chain:

- Generation: As at today, Nigeria has 12,522MW of installed capacity but due to maintenance, gas, water and transmission constraints, an average of 3,879MW of capacity is operational. This is highly inadequate when viewed from population and GDP level.
- Primary Energy-Gas: The majority (85%) of the installed capacity is gas-fired and availability of gas molecules is always low due to insufficient production, economic disincentives, inadequate infrastructure, and frequent vandalism.
- Transmission: The Nigeria's transmission system has the capacity of around 5,300MW but it is disrupted by system collapses and forced outages. Currently transmission capacity is higher than the operational generation capacity but likely to be a constraint with a possible rise in generation's operational capacity.
- Distribution: The distribution companies suffer significant losses with 46% of energy loss due through technical, commercial and collection issues. Nigeria must fix most if not all these fundamental issues for supply to meet demand. Due to the insufficiency of the operational capacity, most industries and individuals employ the use of diesel generating sets for their electricity needs. The impact of using these diesel generating sets on the environment is enormous in terms of its contribution to greenhouse gas emissions and therefore needs to be addressed to reduce GHG emissions.

The scope of the mitigation action included in the IFF analysis therefore span across the power industry from generation to distribution of power. This is considered for both grid and off-grid connected scenarios.

2.2 Input Data and Scenarios

2.2.1 Assessment Period and Key Economic Indicators

The time frame chosen for the analysis is 13 years beginning with the base year of 2015 and ending with the year 2030. This time frame was adopted to provide historical data and establish a possible trend to the planning period. The Nigerian economy is the largest economy in Africa with a huge projected population figure of over 200 million people and a land mass of 923,768 square kilometers. The country is endowed with huge energy resources in fossil fuels, water resources, high solar irradiation, and arable land for agriculture. Nigeria's major foreign exchange earnings is from crude oil exploration and exploitation with composite natural gas all over the Niger Delta region. In 2015 Nigeria's economy had gone into recession with GDP growth at -2.5% due to very low oil prices in the international market. Prior to 2015, Nigeria's GDP advanced year on year with an average growth rate of 2.5% before oil prices slumped from an average of 110USD per barrel to about 56USD per barrel on the average.

Apart from the drop in international oil prices, disturbances in the Niger Delta region in the form of youth restiveness resulting occasionally into vandalism of the pipeline infrastructure affect adversely the production of the crude oil and gas molecules.

The inflation rate for the first quarter of 2015 on a year-on-year basis stood at 17.26 percent compared with 12.6 percent in the preceding quarter. This indicated about 5 percent point increase above the level in the preceding quarter.

2.2.2 Analytical Approach

The overriding guide in the analytical approach is the UNDP's 'Methodology for Assessing Investment and Financial Flows to Address Climate Change'. Identified investments entities were Households, Corporations and Governments while the investment types were energy efficiency and conservation, generation assets of gas power plants, hydro power plants, solar power plants, wind energy and biomass. From the Transmission and Distribution sub-sector, various investments in the sub-sector have been combined as Transmission and Distribution Network Expansion. Due to absence of reliable data on investments by households, its investment assessment was dropped. Apart from the historical data gathered from the relevant stakeholders, future projections used in the assessment were results of studies conducted by government bodies using the following models in the projections:

- The MARKEL- Market Allocation Model
- The MADE- Model for Analysis of Demand for Energy.

Also, Government's pronouncement of its future ambitions in the National Communications I & II and the Baseline Report on Power Supply 2015 were used as projections in the country's energy needs. Some reliable data were gathered through publications by agencies and the internet. They were however highlighted in the list of references in this report.

Projections were in terms of ratings and not cost; hence the estimates for Investment Flow, Financial Flow and Operations and Maintenance Costs were derived using industrial rates. Except were expressly stated, all investments are considered at inception without spreading of investments over a period. As a result, only the operations and maintenance costs of previous assets are considered through the useful life of such

assets. The financial flows occur along with the assets at the inception period. Table 1 shows the various rates used in determining the investment costs of projects of different types.

Table 1: Industrial cost estimates by IRENA, 2018

Plant Type	Project Cost in US$/KW	Operations and Maintenance Cost in US$/KW-year	Financial Flows in % of Investment
Simple Cycle Gas Turbine	815	7.34	1.00
Wind Farm, WF	2088	39.55	1.00
Utility Solar, PV	3,735	15.25	1.00
Hydro Power Plant, HPP	2,446	14.13	1.00
Solar Thermal Plant	4406	65.26	1.00
Biomass	3428	105.63	1.00

2.2.2.1 Data Collection Methods

One of the main methods of data collection was primarily through questionnaires given to agencies relevant to the study. Also, some of the data were obtained from publications such as periodicals and official bulletins from relevant government agencies and departments.

The main sources of the data were the Ministry of Power, Transmission Company of Nigeria, the Rural Electrification Agency and the Nigerian Electricity Regulatory Commission, NERC. Other sources were the National Bureau of Statistics, NBS and the Central Bank of Nigeria, CBN. There were serious challenges on data collection during the exercise, mostly bordering on sensitivities to the project and lukewarm attitude of the relevant authorities in responding to enquiries. Feedbacks from most of the corporate entities in the electricity supply industry were scanty if not totally absent and sometimes there were conflicting information made in line with political agenda setting. The absence of a central database for the industry compounded the problems of relevant and reliable data collection. For this reason and for the purposes of the exercise, consultations were both national and international.

Some of the calculations were derived from published data in professional international bodies like Energy Information Administration, EIA and the International Renewable Energy Agency, IRENA.

2.2.3 Historical IF, FF, and O&M Data

The power sector basically consists of three sub-sectors of generation, transmission, and distribution. Up until the year 2013, the power sector was under the total control of the Federal Government of Nigeria. Privatization of the sector saw the emergence of eleven distribution companies, six generating companies and one transmission company which is under the control of the government.

Since privatization, there has been no visible investment in the power sector. Installed generation capacity has remained within 15GW with available capacity of about 5GW due to ageing machines with high maintenance costs. Operational capacity is always below the available capacity within an average of about 2GW due to gas constraints, poor water management and transmission bottlenecks.

Most of the power generation is by gas. They are mostly gas turbine plants of both the single and combined cycles. The percentage generation by gas is about 80 percent on the average while the balance of 20 percent is through hydroelectric power. Hydro power development in Nigeria is getting some improved attention by the government in a bid to increase the energy mix and enhance energy security.

Table 2: List of Hydro power plants yet to be connected to the grid

Hydro Plants	Activity	Capacity
Zungeru	Project	700MW
Gurara II	Project	360MW
Gurara I	Project	30MW
Itisi	Project	40MW
Kashimbilla	Project	40MW

Due consideration is equally being given to solar energy sources because of its global attention and potential in Nigeria. Irradiation level of the sun in the northern part of Nigeria is quite high hence the resultant solar power projects being promoted in the following states in northern Nigeria:

- Katsina 120MW
- Bauchi 100MW

Wind energy is not left out in the development of renewable energy in the country. First of its kind sited in Katsina State with a capacity of 10MW is at completion stage but to be commissioned. There is an existing interest by private investors for the development of power generation projects across the country mainly due to the existing gap between the suppressed demand and the operational capacity.

The transmission Company of Nigeria, TCN is responsible for wheeling the generated power or its evacuation to the load centers through two main grid networks of 330KV and 132KV levels. As of 2015, the theoretical wheeling capacity of the transmission network is put at 6,500MW with about 75 percent efficiency due to ageing of some of its installations. Available statistics of the transmission network as of 2017 is as stated in Table 3.

Table 3: Transmission Infrastructure Capacity as of 2017

	330KV	132KV
Lines, KM	5650	6687
Substations, NOS.	32	105

Source: TCN annual report

The distribution sub sector is not exempted from the myriad of problems facing the Nigerian Electricity Supply Industry, NESI. Upon privatization, there are eleven distribution companies in the industry namely, Yola, Kano, Jos, Ibadan, Enugu, Abuja, Ikeja, Eko, Port Harcourt, Benin, and Kaduna. The Distribution grid operates on two main voltages of 33KV and 11KV networks with an approximate total length of 24,000km.

As at Q4 2017, the Aggregated Technical, Commercial and Collection, ATC&C losses was an average of 46% due to technical issues on maintenance, poor revenue collection and the huge metering gap. All these have led to the very poor liquidity position of the electricity industry. Table 4 shows the historical data on investments in Transmission and Distribution sub-sector collected through responses from the TCN, NDPHC and REA.

Table 4: Historical Investments in Transmission and Distribution Sector

	2015	**2016**	**2017**	**2018**	**2019**
TCN (in million dollars)	83.17	83.17	92.61	97.47	97.47
NDPHC (in million dollars)	14.25	31.18	61.83	19.36	25.15
REA (in million dollars)	1.73	12.81	40.59	31.19	41.17

As a result of the huge deficit in electricity supply, individuals and companies continue to rely on captive power generation using diesel and PMS generators. According to the GIZ 2015 report on the Nigerian Energy Sector, approximately 80% of Nigerians use alternative sources of electricity such as generators and/or solar inverters. It claimed that between 8 - 14GW of decentralized diesel generator capacity is currently installed in the country. The report also claimed that about 86% of the companies in Nigeria own or share a generator and about 48% of their total electricity demand is covered by these private generators. The report further stated that Nigeria is one of the biggest importers of these generators worldwide with an annual turnover of US$112 million.

Table 5: Historical Costs for Transmission and Distribution by Investment Type

year	Gas Fired Plant			Hydro Power Plant			Wind Turbine Plant			Solar PV Plant			Biomass Energy Plant			Solar Thermal Plant			All Investment Types		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2015	0.00	0.00	28.39	0.00	0.00	13.04	20.88	0.20	0.39	978.4	9.87	5.65	0.00	0.00	0.00	0.00	0.00	0.00	999.2	9.99	47.83
2016	107.5	107.5	34.86	98.56	0.98	12.19	0.00	0.00	0.34	21.52	21.52	17.04	0.00	0.00	0.00	0.00	0.00	0.00	33.25	33.25	64.79
2017	697.2	6.97	37.58	117.7	1.17	11.43	0.00	0.00	0.30	0.00	0.00	15.62	0.00	0.00	0.00	0.00	0.00	0.00	814.9	8.14	49.01
2018	110.4	110.4	43.01	0.00	0.00	10.12	0.00	0.00	0.27	0.00	0.00	13.84	0.00	0.00	0.00	0.00	0.00	0.00	11.04	11.04	67.24
2019	0.00	0.00	38.09	0.00	0.00	8.97	0.00	0.00	0.24	0.00	0.00	12.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.56

Table 6: Historical Costs for Transmission and Distribution by Investment Type

Year	Annual IF, FF, O&M Historical Costs for T&D by Investment Type (in million 2015USD)											
	Transmission Lines/Substation			Distribution Networks and Substations			Distributed Renewable Energy			All Investment Types		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O & M
2015	83.17	0.83		15.98	0.15		0.00	0.00		97.42	0.97	
2016	73.18	0.73		38.42	0.38		0.00	0.00		111.60	1.11	
2017	73.15	0.73		79.86	0.79		40.59	0.40		193.60	1.93	
2018	68.22	0.68		35.10	0.35		31.19	0.31		134.51	1.34	
2019	60.42	0.60		40.65	0.40		41.17	0.41		142.24	1.42	

2.2.4 Baseline emissions

Nigeria is the largest economy in Africa with a gross domestic product, GDP of 460 billion dollars in 2015 and an annual growth rate of 2.92%. The population of Nigeria is estimated at over 180 million people as of 2015 with an annual growth rate of about 2.7%. The performance of the Nigerian economy has been poor due largely to the abysmal performance of the power sector. It is no gainsaying that stable and constant electricity in any economy is the basis for economic growth and prosperity of its people. Out of the entire population of over 180 million people, it is estimated that only about 55% have access to grid energy. Available records indicate that in 2018, the number of registered electricity customers stood at 8,720,050 with residential customers having the highest figure of 6,907,539.

Grid energy generation in Nigeria is mainly by gas fired turbines and hydro energy. The energy mix of thermal and hydro generation is about 80% to 20% respectively with total installed generation capacity at about 12,522MW, a combination or mix of thermal and hydro power stations. Out of the installed capacity of 12,522MW power generation of 5191MW was recorded as peak in the 4th quarter of 2018 but hovers mostly between 3000 and 3800MW up until this day.

There are key elements in certain areas of the sector that are responsible for the low performance. In generation for instance, most of the machines are old and near obsolete resulting in frequent breakdowns with high maintenance costs. Gas supply constraint is another major hindrance to the availability of power plants for generation. Gas infrastructure for domestic use is inadequate and economic disincentives are responsible for the lack of interest by oil majors to get involved in the domestic gas supply ventures. One other issue that requires our mention here is that of pipeline vandalism. The restiveness of the vandals in host communities has not abated up until this moment. This is another situation that is beyond the control of the actors in the power sector but of serious concern due to the disruption it causes to the power system balance. For instance, in the 4th quarter of 2018, 2,272MW was recorded as stranded power. Stranded power is usually occasioned by any or all the following:

- water management constraints
- transmission line limitation
- limited distribution network
- gas constraints

All the problems bedeviling the electricity industry has continued well after the unbundling and consequent privatization of the industry in 2013. The Electric Power Sector Reform (ESPR) Act that was established in 2005 to address the many problems affecting the stable and constant delivery of electricity to the economy and the people is yet to yield the desired result.

Generation capacity has not improved since new plants have not been added by the Gencos and the plants added by the NIPP intervention scheme in most cases are constrained by the absence of adequate gas infrastructure as it were. Table 7 shows the projected power generation for 2015 to 2030.

Table 7: Planned and Projected Electricity Generation 2015 - 2030

Year	Gas Turbine Plants (MW)	Cumulative Generation (MW)	Hydro Power Plants (MW)	Cumulative Generation (MW)
2015	3896	3896	879	879
2016	1500	5396	30	909
2017	1083	6479	40	949
2018	1937	8416	0	949
2019	0	8416	0	949
2020	0	8416	0	947
2021	2200	10616	0	947
2022	2200	12816	0	947
2023	2200	15016	0	947
2024	2200	17216	0	947
2025	2200	19416	0	947
2026	2200	21616	0	947
2027	2200	23816	0	947
2028	2200	26016	0	947
2029	2200	28216	0	947
2030	2200	30416	0	947

Source: Authors' compilation from National ambitions

The Transmission of electricity is the responsibility of TCN. Poor investment in the sector contributed to the high energy losses due to underrated capacities of its networks, ageing transmission lines and overloaded base stations and these loses are still very high at 7.95% compared to industry average of between 2 - 6%. It is expected that with new investments in transmission infrastructure, the transmission losses will reduce.

According to the Nigerian Electricity Regulatory Commission, NERC's 4th quarter report of 2018, Aggregated Technical, Commercial and Collection, ATC&C losses was reported as 47.92%. ATC&C is the combined index of losses due to technical, billing and collection inefficiencies in the industry. The high ATC&C losses reflect the low investments in distribution networks aggravated by the low level of metering of end-use customers thus creating lingering liquidity challenge in the industry. In effect for every N10

worth of energy received by the Discos, N4.79 was unrecovered. To attest to collection inefficiency, out of 8,720,059 registered customers only 3,793,895 was metered representing 43.5% in 2017.

The huge deficit in generation capacity and power supply is filled with the existence of diesel power generation as captive power across the country. According to a 2015 study under the framework of the NESP-Nigerian Energy Support Programme, funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) and the European Union and administered by the Deustche Gesellshaft Fur Internationale Zusammenarbet (GIZ) in cooperation with the Federal Ministry of Power and other Nigerian partner organizations, Nigeria imports an average of USD120 million of diesel generators of different categories annually. This trend might continue if the critical deficit in power supply is not addressed urgently.

The government of Nigeria has continued with efforts to diversify its energy mix by developing renewable energy sources like wind energy, solar energy, and small hydro power stations across the country.

2.2.4.1 Baseline Estimates

In arriving at the IF, FF and O&M costs, the planned and projected ambitions of the Nigerian government were used. The IF, FF and O&M estimates were calculated using industrial rates as established in professional periodicals and publications. Tables 8 and 9 as follows are the IF, FF and O&M costs estimates. The figures are in millions of dollars using 12.5 percent as rate of return to achieve the Present Value, PV in 2015.

Table 8: Baseline Scenario: Cumulative Discounted IF, FF, and O&M Estimates, By Investment Type, Investment Entity, and Funding Source

	Gas Fired Plants			Large Hydro			Captive Power			Renewables			All Investment Types		
Investment Entity Category	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
Household	0	0	0	0	0	0	2126	0	213	610	6	27	737	6	240
Corporations	6265	63	485	173	2	86	1418	0	142	0	0	0	686	64	723
Government	1566	16	121	43	0.4	22	0	0	0	2441	24	111	13041	40	254
Total	7831	78	606	216	2	108	3544	0	354	3051	31	139	14643	111	1207

Table 9: Baseline Scenario: Annual IF, FF, and O&M Estimates by Investment Type

Year	Annual IF, FF, & O&M Estimates for Baseline Scenario (million 2015US$)														
	Gas-Fired Plant			Hydro Power Plant			Captive Power			Renewables			All Investment Types		
	IF	FF	O&M Costs	IF	FF	O&M Costs	IF	FF	O&M Costs	IF	FF	O&M Costs	IF	FF	O&M Costs
2015	0	0	28.39	0	0	13	230	0	23	999	10	6	1229	10	71
2016	1075	11	35	99	1	12	228	0	23	2052	21	18	3454	32	88
2017	697	7	38	118	1	11	228	0	23	0	0	16	1043	8	88
2018	1104	11	43	0	0	10	227	0	23	0	0	14	1331	11	90
2019	0	0	38	0	0	9	225	0	23	0	0	13	225	0	82
2020	0	0	34	0	0	8	224	0	22	0	0	11	224	0	75
2021	799	8	37	0	0	7	223	0	22	0	0	10	1022	8	77
2022	717	7	40	0	0	6	222	0	22	0	0	9	939	7	78
2023	636	6	41	0	0	6	221	0	22	0	0	8	857	6	77
2024	554	6	41	0	0	5	220	0	22	0	0	7	774	6	74
2025	489	5	41	0	0	4	219	0	22	0	0	6	708	5	73
2026	440	4	40	0	0	4	218	0	22	0	0	5	658	4	72
2027	391	4	39	0	0	3	217	0	22	0	0	5	608	4	69
2028	342	3	38	0	0	3	215	0	22	0	0	4	558	3	66
2029	310	3	37	0	0	3	214	0	21	0	0	4	524	3	65
2030	277	3	35	0	0	2	213	0	21	0	0	3	490	3	63
Total	**7831**	**78**	**606**	**216**	**2**	**108**	**3544**	**0**	**354**	**3051**	**31**	**139**	**14643**	**111**	**1207**

2.2.5 Mitigation Scenario

In December 2015, Nigeria committed to the Paris Climate Agreement under the United Nations Framework Convention on Climate Change, UNFCCC. The aim of the agreement among others was:

i. holding the increase in global average temperature to well below 2 degrees above pre-industrial levels
ii. increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development.
iii. making financial flows consistent with a pathway towards low greenhouse gas emissions and climate resilient development.

These goals lead to the intensification of efforts towards channeling investments to a greener economy. The areas of focus for mitigation in the energy power sector therefore include the following:

- Increase in Renewable Energy Generation in the Country for grid, mini-grid and off grid connections.
- National LPG Expansion Implementation Plan to switch household use of power generators run on premium motor spirit (PMS) and Automotive Gas Oil (AGO) to LPG.
- Increase in Large Hydro Power Capacity to displace use of diesel generators as captive power.
- Improving the efficiency of transmission and distribution systems in the country to reduce losses.
- Improving the efficiency of gas power plants by upgrading the current *Open Cycle Gas Turbines* to *Combined Cycle Gas Turbines*

Renewable Energy Generation

Towards achieving the objectives of the green economy, the Federal Government of Nigeria through its agencies established the National Renewable Energy Action Plan (NREAP) (2015-2030). Under NREAP, 2015, the country stated its ambition of achieving an electricity vision of attaining 30GW of electric power by the year 2030 with at least 30% renewable energy in the electricity mix.

In furtherance of this ambition, the Federal Ministry of Power was mandated to take steps towards the achievement of the targets. The Ministry of Power carries out this mandate through the Department of Renewable Energy and Rural Power Access (RRD) of the Ministry, partners and stakeholders that are involved in providing technical assistance in renewable energy deployment. The RRD is currently undertaking a wide range of projects around the country and are working to develop a coordinated delivery plan to implement the commitments made in the National Renewable Energy Action Plan. In the same manner, all ministries and MDAs were directed to channel their projects towards renewable energy to mitigate against climate change and achieve the NDC target of 2030.

Nigeria is abundantly blessed with energy resources like solar, hydro, wind, biomass, and fossil fuels. Solar radiation is fairly distributed in Nigeria with an average of about 19.8MJm2-day. Average sunshine hours per day is about 6 hours. Studies have established an assumed potential of concentrated solar and photovoltaic generation at about 427,000MW. Already in June 2016, a total of 14 Independent generation licenses with a capacity of around 1,125MW have been granted to private developers. Hydropower in Nigeria has remained the cornerstone in electricity generation accounting for an average of about 20 percent in the generation mix. The country is reasonably endowed with large rivers and some few natural falls. In most parts of Nigeria, there are potential sites for small hydro estimated to about 3,500MW with only about 64.2MW under exploitation. A multitude of river systems, providing a total of 70 micro dams, 126 mini dams and 86 small sites will supply technically a hydro potential of 11,250MW while about 83 percent remain untapped.

Table 10 is sourced from the NREAP report showing grid connected renewable energy estimates and trajectory up to 2030 in MW.

Other effort towards mitigation pathways is through the Rural Electrification Agency, REA which is a key agency of government that has been quite effective while achieving the national ambitions of the nation for a green economy by developing and implementing programs through Distributed Renewable Energy like the solar home system, SHS and solar mini grids for unserved communities.

Hitherto, REA had concentrated its efforts towards extension of electricity supply to unserved communities through the national grid. But currently the concentration is on the deployment of mini-grids, solar home systems to those communities that are yet to be served with electricity which is predominantly using solar energy which is in alignment with mitigation action plan under the NDC Paris agreement.

Energizing Institutions
Another mitigation project being implemented by the REA is the Energizing Electrification Program, EEP that seeks to provide uninterrupted power to 37 Federal Universities and 7 University Teaching Hospitals through hybrid solar power plants. There is also the Energizing Economies Initiative, EEI that aims to provide efficient, clean, and sustainable power to strategic economic clusters across Nigeria for example the Ariaria market in Aba, Abia state, the Sabon Gari market in Kano State just to mention a few. The deployment of mini grids across the country is mostly supported by the World Bank and the African Development Bank, AfDB. REA on behalf of the FMoP and with the support of NESP/GIZ is developing the MG markets in Nigeria under the EEI.

National LPG Expansion Implementation Plan
To further complement efforts in the reduction of carbon emissions, the National LPG Expansion Implementation Plan is committed to bridging the gap of transition from the diesel power back up to LPG based power back up in solar hybrid for power generation.

REA estimates to deploy USD2.5 billion over a projected period of 6 years starting 2020 to 2025 to provide access to electricity to more than 4 million homes and businesses across the country with mini-grids and solar home systems, SHS. Table 2.2.5a below shows the planned and projected national renewable energy sources.

2.2.5.1: Mitigation Estimates

The IF, FF and O&M mitigation estimates are derived information from the following:

i. Transmission Company of Nigeria for improved grid efficiency and capacity.
ii. Rural Electrification Agency, REA for activities in the solar mini grids and home systems.
iii. Projected renewable energy sources from the Nigerian Renewable Energy Action Plan (NREAP) of 2015.

The IF, FF and O&M estimates were calculated using industrial rates and averages as established in professional periodicals and publications. Tables 11 and 12 as follows represent the estimates for the Investment Type, Entity and Sources of Funds. The figures are in millions of dollars using 12.5 percent as rate of return to achieve the Present Value, PV in 2015.

Year	Unit	Large Hydro (>30)	Small Hydro (<30)	Solar PV	Solar Thermal	Wind	Bioenergy	Total
2015	MW	1097	15	0	0	0	0	1112
2016	MW	1200	45	100	0	10	0	1355
2017	MW	1650	125	500	0	50	50	2375
2018	MW	1920	205	1200	0	90	180	3595
2019	MW	2200	285	1600	0	130	240	4455
2020	MW	2540	305	2000	50	170	300	5365
2021	MW	2800	325	2300	200	210	360	6195
2022	MW	3100	405	2600	300	250	420	7075
2023	MW	3400	485	2900	400	290	480	7955
2024	MW	3700	565	3200	500	330	540	8835
2025	MW	4000	625	3500	600	370	600	9695
2026	MW	4200	705	3840	700	450	720	10615
2027	MW	4500	785	4180	800	530	840	11635
2028	MW	4600	865	4520	900	610	960	12455
2029	MW	4700	945	4860	950	750	1080	13285
2030	MW	4700	1200	5000	1000	800	1100	13800

Table 10: Trajectory of Planned and Projected Renewable Energy Sources

Table 11: Target Scenario: Cumulative Discounted IF, FF, and O&M Estimates, By Investment Type, Investment Entity, and Funding Source

Cumulative Discounted IF, FF, & O&M Estimates (million 2015US$)																		
	Gas Fired Plants			Large Hydro			Renewables			Transmission and Distribution			CNG/LPG			All Investment Types		
Investment Entity Category	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
Household	0	0	0	0	0	0	20418	204	1021	0	0	0	0	0	0	20418	204	1021
Corporations	12337	123	905	10409	104	520	25523	255	1276	0	0	0	6980	70	349	55250	552	3050
Government	3084	31	226	2602	26	130	56150	562	2808	2379	24	119	10470	105	524	74686	747	3806
Total	15422	154	1132	13012	130	651	102092	1022	5105	2379	24	119	17450	174	873	152754	1528	7878

Table 12:Target Scenario: Annual IF, FF, and O&M Estimates by Investment Types

YEAR	Annual IF, FF, O & M in million 2015 USD																	
	GAS TURBINE POWER PLANTS			LARGE HYDRO POWER PLANTS			RENEWABLES			Transmission and Distribution			CNG/LPG			ALL INVESTMENT TYPES		
	IF	FF	O & M	IF	FF	O& M	IF	FF	O& M	IF	FF	O & M	IF	FF	O& M	IF	FF	O & M
2015	1,500	15	75	1,180	12	59	17,495	175	875	97	1	5	0	0	0	20,272	203	1,014
2016	2,150	22	108	197	2	20	33,895	339	1,695	112	1	6	0	0	0	36,353	364	1,818
2017	1,394	14	70	235	2	22	5,552	56	278	153	2	8	0	0	0	7,335	73	367
2018	2,208	22	110	667	7	33	4,516	45	226	103	1	5	0	0	0	7,495	75	375
2019	900	9	75	1,104	11	55	3,539	35	177	101	1	5	0	0	0	5,644	56	312
2020	896	9	75	688	7	34	3,818	38	191	255	3	13	1,400	14	70	7,058	71	383
2021	1,565	16	108	1,430	14	72	5,326	53	266	208	2	10	1,450	15	73	9,978	100	529
2022	1,402	14	100	1,281	13	64	4,770	48	239	207	2	10	1,500	15	75	9,161	92	488
2023	919	9	61	1,132	11	57	4,215	42	211	184	2	9	1,550	16	78	8,001	80	415
2024	854	9	58	1,013	10	51	3,771	38	189	161	2	8	1,600	16	80	7,399	74	385
2025	789	8	54	894	9	45	3,328	33	166	142	1	7	1,650	17	83	6,802	68	355
2026	740	7	52	805	8	40	2,995	30	150	164	2	8	1,600	16	80	6,303	63	330
2027	691	7	50	715	7	36	2,663	27	133	146	1	7	1,600	16	80	5,815	58	306
2028	642	6	47	626	6	31	2,329	23	116	127	1	6	1,650	17	83	5,374	54	284
2029	610	6	45	566	6	28	2,107	21	105	116	1	6	1,700	17	85	5,099	51	270
2030	561	6	43	477	5	24	1,774	18	89	103	1	5	1,750	18	88	4,665	47	248
Total	15,422	154	1,131	13,012	130	651	102,092	1,021	5,105	2,379	24	119	17,450	175	873	152,754	1,528	7,878

Chapter Three

3.0 Results

3.1 Incremental Changes in IF, FF and O&M Costs

Incremental changes in the IF, FF, and O&M costs for the Investment Types, Entity and Sources of funds are expressed in Tables 13 and 14. As shown on the summary table, a total sum of more than USD157 billion will be required towards the reduction of carbon emissions with the selected interventions in the power sector. Unfortunately, due to lack of access to relevant data or the lack of it, energy efficiency as a major factor in the mitigation protocol of the power sector was not included in the assessment. In due course, the relevant agencies should be compelled to respond on this vital activity of the mitigation scenario. Conversion of single cycle gas turbine plants to combined cycle is another energy efficiency model which should have been part of the analysis.

Table 13: Incremental Cumulative Discounted IF & FF Estimates, By Investment Type, Investment Entity, and Funding Source

Incremental Cumulative Discounted IF, FF, & O&M Estimates (million 2015US$)																		
	Gas Fired Plants			Large Hydro			Renewables			Transmission and Distribution			CNG/LPG			All Investment Types		
Investment Entity Category	ΔIF	ΔFF	ΔO&M Costs	ΔIF	ΔFF	ΔO&M Costs	ΔIF	ΔFF	ΔO&M Costs	ΔIF	ΔFF	ΔO&M Costs	ΔIF	ΔFF	ΔO&M Costs	ΔIF	ΔFF	ΔO&M Costs
Household	0	0	0	0	0	0	20418	204	1276	0	0	0	0	0	0	20418	204	1021
Corporations	9662	97	483	10409	104	520	25523	255	1276	0	0	0	6980	70	349	52574	526	2108
Government	2416	24	121	2602	26	130	56150	562	2808	2379	24	119	10470	105	209	74017	740	3387
Total	**12078**	**121**	**604**	**13012**	**130**	**651**	**102092**	**1021**	**5105**	**2379**	**24**	**119**	**17450**	**175**	**873**	**147010**	**1470**	**7351**

Table 14:Incremental Annual IF & FF Estimates by Investment Type

YEAR	Annual IF, FF, O & M in million 2015 USD																	
	GAS TURBINE POWER PLANTS			LARGE HYDRO POWER PLANTS			RENEWABLES			Transmission and Distribution			CNG/LPG			ALL INVESTMENT TYPES		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2015	1500	15	47	1180	12	46	17495	175	869	97	1	5	0	0	0	20042	200	1002
2016	1078	11	73	197	2	8	33895	339	1677	112	1	6	0	0	0	36125	361	1806
2017	697	7	32	235	2	10	5552	56	262	153	2	8	0	0	0	7107	71	355
2018	1104	11	67	667	7	23	4516	45	212	103	1	5	0	0	0	7268	73	363
2019	900	9	37	1104	11	46	3539	35	164	101	1	5	0	0	0	5418	54	271
2020	896	9	41	688	7	26	3818	38	180	255	3	13	1400	14	70	6834	68	342
2021	685	7	71	1430	14	64	5326	53	257	208	2	10	1450	15	73	9955	100	498
2022	84	1	60	1281	13	58	4770	48	230	207	2	10	1500	15	75	8938	89	447
2023	300	3	20	1132	11	51	4215	42	203	184	2	9	1550	16	78	7480	75	374
2024	300	3	17	1013	10	46	3771	38	200	161	2	8	1600	16	80	6879	69	344
2025	300	3	14	894	9	40	3328	33	182	142	1	7	1650	17	83	6284	63	314
2026	300	3	12	805	8	36	2995	30	164	164	2	8	1600	16	80	5786	58	289
2027	300	3	10	715	7	32	2663	27	145	146	1	7	1600	16	80	5298	53	265
2028	300	3	9	626	6	28	2329	23	129	127	1	6	1650	17	83	4859	49	243
2029	300	3	9	566	6	24	2107	21	113	116	1	6	1700	17	85	4585	46	229
2030	284	3	8	477	5	21	1774	18	12	103	1	5	1750	18	88	4152	42	208
Total	**12078**	**121**	**604**	**13012**	**130**	**651**	**102092**	**1021**	**5105**	**2379**	**24**	**119**	**17450**	**175**	**873**	**147010**	**1470**	**7351**

3.2 Policy Implications

Nigeria is the largest economy in Africa with a huge population of over 200 million people. The economy is mainly agrarian but with over 80 percent of its foreign earnings from crude oil. The volatility of crude oil prices in the international oil market is a major bane for proper planning and execution of projected programmes.

The inadequacy of power supply to the Nigerian economy has been attributed by many researchers as the main reason for its underdevelopment. The electricity per capita in Nigeria is estimated at 36kWh which is very low compared to advanced nations (see table below)

Table 15: Global Electricity Per Capita

Continents	Electricity (kWh) per Capita
North America	14,167
West Europe	6,646
East Europe	4,411
East/South East Asia	3,400
North Africa	1,771
Sub-Saharan Africa	490

It is estimated that over 50 percent of the population in Nigeria are without grid electricity. Grid electricity is mostly unavailable due to inadequacy resulting in load shedding most times. Most people and industries employ the use of diesel generators to generate own power supply resulting in climate change consequences. It is estimated that Nigeria's captive generation is close to between 20 to 40GW.

80% of power generation is by natural gas with about 20 percent contribution through hydro power generation. Installed generation capacity is estimated at 12,522MW but majority of these pants are old and almost obsolete. Available generation is always around 5GW for the recent past. Even the gas power plants occasionally have insufficient gas supply due to other gas related constraints and sometimes vandalisation of gas pipelines. Poor water management is another factor affecting the delivery of the appropriate capacity from the hydro stations.

The Nigerian government sees renewable energy as an important part of diversifying the country's energy mix beyond fossil fuel-based generation. Several policies have been developed over the years which has enhanced the government's pursuit of renewable energy sources as an additional instrument to solve the electricity challenge in the country. Similarly, with the privatization process, independent power producers can feed electricity into the grid after an approved license from NERC and a signed Power Purchase Agreement (PPA) with NBET.

Major policies and regulations governing renewable energy are as follows:

Electric Power Sector Reform (EPSR) Act 2005

The Electric Power Sector Reform is the turning point in the national energy policy, as it determined the framework upon which the private actors could participate in the generation, transmission, and distribution of electricity. Furthermore, it established the Nigerian Electricity Regulatory Commission, NERC which provides for the development of a competitive electricity market and serves as the basis for determination of tariffs, customer rights and obligations, and other related matters.

Roadmap for Power Sector Reform 2013

The Roadmap targets for renewable energy technologies in 2025 which contribute to the overall target to achieve 18 percent of electricity generated from renewables and 20 percent by 2030.

National Renewable Energy Master Plan (REMP) 2011/12

The REMP, first put into action in 2006, provides a comprehensive framework through which the development and exploitation of renewable energy resources was to be achieved. The programme was reviewed in 2012 and made to support:

- expanding access to energy services to Nigerians (75 percent by 2025)
- raising the standard of living, especially in the rural areas
- stimulating economic growth, employment, and empowerment
- reducing environmental degradation and health risks

National Renewable Energy and Energy Efficiency Policy (NREEEP)

The National Renewable Energy and Energy Efficiency Policy NREEEP was developed by the Federal Ministry of Power in 2013/14 and was approved by the Federal Executive Council in May 2015. NREEEP seeks to bring to the attention of policymakers the economic, political, and social potential of renewable energy. It recommends that an appropriate strategy should be developed to harness these potentials to add value to the ongoing changes in Nigeria's power sector.

The document also stipulates that existing policies lack a coherent and all-encompassing framework that drives the sector and therefore calls for an integrated renewable energy and energy efficiency policy which will serve as a useful vehicle that limits conflicts in the future and promotes development of renewable energy technologies in Nigeria. It can be regarded as an umbrella document consolidating the various other afore-mentioned policies and strategies in one document. This policy encourages the development of a national energy efficiency action plan which will facilitate the overall achievement of the objectives it set out. The overall focus of the policy is on optimal utilization of the nation's energy resources for sustainable development.

National Renewable Energy Action Plan (2015-2030)

The National Action Plan presents the expected development and expansion of renewable energies in Nigeria to achieve the national target under the ECOWAS Renewable Energy Policy (EREP), and thus Nigeria's contribution to the overall ECOWAS target of 23 percent and 31 percent renewable energy in 2020 and 2030 respectively. It contains existing and currently planned measures, with which the national target is to be achieved. It also outlines the expected percentage of homes to be connected to off-grid renewable energy supply by 2020 and 2030. The plans set a target of the renewable energy share (hydro power inclusive) of total installed power capacity by 2020 to 52 percent and 49 percent in 2030. Renewable energy share in the electricity mix (including medium and large hydro) is planned to be 38 percent and 29 percent in 2020 and 2030, respectively.

Regulation for Mini Grid

The objective of the mini grid regulation is to accelerate electrification in areas without an existing distribution network and areas with an existing but poorly electrified or non-functional distribution grid by attracting the participation of the private sector, communities, non-governmental organization in achieving nationwide electrification. The regulation seeks to minimize major risks associated with Mini Grid (<1MW) investments such as: sudden tariff changes, (tariffs would have been agreed in advance by the relevant parties: and Standard Mini Grid Operator investments) that occur during the extension of main grid to cover the mini-grid area. The regulation also provides for permit and tariff approval procedures which will ease the administrative burden on the Mini Grid Operator and ensure the process of obtaining the mini grid permits in a timely manner.

Investment Considerations

The Nigerian government through the Nigerian Investment Promotion Commission (NIPC) grants tax holidays to qualified or (eligible) industries anywhere in the country and seven-year tax holiday in respect of industries located in poor local government areas in Nigeria. Now there is a list of 71 approved industries declared pioneer industries which can benefit from tax holiday. The Government encourages investors in industries related to renewable energy with tax holidays of 5-7 years, applying pioneer status measure.

Feed-in-Tariff

Feed-in-Tariffs (FIT) are developed by NERC and paid by NBET in Naira. Potential suppliers of electricity from renewable energies can apply to NBET. The FIT is developed based on NERC's Multi Year Tariff Order (MYTO). Feed-in-Tariffs in the MYTO are set to ensure clear rules in the interim market for energy. In January 2015, the MYTO 2.1 was initiated that sets feed-in-tariffs for: new entrance gas power plants, coal power plants, small hydropower plants, land mounted wind power plants and solar power plants. To date, the feed-in-tariffs laid down in MYTO 2.1 do not give priority access to electricity for renewable energies. There is no compensation for electricity that is produced but cannot be sold. For embedded generation (connection to the distribution network), FITs must be negotiated between the independent renewable energy generation company and the DisCos directly.

Green Bonds

Nigeria plans to launch the country's flagship 20 billion naira (about USD 64 million) green bond in April 2017 with proceeds targeted to fund projects aimed at reducing carbon emissions, and renewable energy development in the country.

The issuance of a green bond enables the country to achieve commitments made in the nationally determined contribution (NDC) at COP21. Broadly, the green bond issuance, which is the second of its kind in Africa, is aimed at developing and sustaining a long-term approach to green project financing in the country.

Energy Efficiency and Energy Conservation

The increasing role of energy efficiency as a catalyst for sustainable development is realism in the industrialized world. In Nigeria, the story is different now as the huge benefits derivable from the adoption of energy efficiency and conservation measures by various economic sectors remain largely untapped due to lack of awareness of the economic and social benefits of energy efficiency measures. The processes of energy utilization and conversion are prone to wastage hence the consequences of environmental degradation, faster depletion of energy resources and increased cost of energy products and services. Therefore, the concept of sustainable development dictates that deliberate effort is made to promote efficiency in the production, conversion and utilization of energy. Energy resources and their utilization intimately relate to sustainable development.

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