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Report on Oil & Gas IFF Assessment



Prepared for

UNDP/Federal Ministry of Environment

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The author(s) gratefully acknowledge the technical comments received from the UNDP Support Programme and Department of Climate Change, the focal point for this project.

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Table of Content

ABBREVIATIONS AND ACRONYMS	3
LIST OF FIGURES.....	6
LIST OF TABLES.....	7
EXECUTIVE SUMMARY	8
CHAPTER ONE	9
1.1 Introduction.....	9
1.2 Aims and Objectives.	9
1.3 Sector Background.....	10
1.4 <i>Global Health Hazards and Economic Impacts of COVID-19 on Oil and Gas Sector</i>	10
1.5 Industry Outlook.....	11
1.6 Reference of Manuals Used for Analysis/Evaluations and Final Output Calculations	12
1.7 Stakeholder Mapping - Institutional Arrangements and Collaborations	12
1.8 Methodology and Key Terminology	13
1.9. Focus for the IFF Report	15
1.10. Rationale.....	17
CHAPTER TWO	18
2.0 Scope, Data Inputs and Scenarios.....	18
2.1. Scope of Work	18
2.2 Data Input and Scenarios.....	18
3.0 Results, Analysis and Findings - Calculation of the IFF.....	40
3.1. Incremental Changes in IF, FF and O&M Cost	40
3.2 Demand and Supply Side	46
3.3 Supply Side	49
3.4 Gas Value Chain.....	53
3.5 Structural Shifts Affecting the Gas Sector.....	55
3.6 Other Assumptions from the Study:.....	56
3.7 Key Uncertainties and Methodological Limitations.....	56
CHAPTER FOUR	58
4.0 Conclusion, Recommendations & Challenges	58
4.1 Conclusion	58
4.2. Policy Implications.....	58
4.3 Challenges	61
ANNEX.....	62
Annex 1: List of projects considered under the baseline scenario Implemented Projects	62
Annex 2: List of projects considered under the baseline scenario Ongoing Projects	62
Annex 3: List of projects considered under the baseline scenario Planned Projects	62
REFERENCES.....	63

Abbreviations and Acronyms

Abbreviations

AG

AGO

BAU

BECCS

BS

CAPEX

CCS

CDM

CLN

CNG

DACCS

COVID-19

DOC

ENCON

EOR

EU

FEC

FGN

FID

GDP

GFU

GPP

GTL

HKK

IOC

IPPs

JV

LCD

LEDS

LNG

LPG

NAOC

NBS

NDC

NDC-SP

NGCFP

NGP

NIPP

NNPC

NOC

Definitions

Associated Gas

Automotive Gas Oil

Business as Usual

Bio-Energy with Carbon Capture and Storage

Baseline Scenario

Capital Expenditure

Climate Change Scenario

Clean Development Mechanism

Carbon Limits Nigeria

Compressed Natural Gas

Direct Air Capture with Carbon Storage

Corona Virus Disease 2019

Domestic Oil Companies

Energy Company of Nigeria

Enhanced Oil Recovery

European Union

Federal Executive Council

Federal Government of Nigeria

Final Investment Decision

Gross Domestic Product

Gas Flare Utilization

Gas Pipeline Projects

Gas to Liquid

Household Kerosene

International Oil Companies

Independent Power Projects

Joint Venture

Low Carbon Development

Low Emission Development Strategy

Liquefied Natural Gas

Liquefied Petroleum Gas

Nigeria Agip Oil Company

National Bureau of Statistics

Nationally Determined Contribution

Nationally Determined Contribution Support Programme

Nigerian Gas Flare Commercialization Program

National Gas Policy

National Integrated Power Project

Nigerian National Petroleum Corporation

National Oil Companies

O&M	Operation and Maintenance
OPEC	Organization of Petroleum Exporting Countries
OPEX	Operational Expenditure
PIB	Petroleum Industrial Bill
PMS	Premium Motor Spirit
PPPRA	Petroleum Products Price Regulation Agency
PSC	Production Sharing Contract
QIT	Qua Iboe Terminal
R&B	Refining and Blending
REEP	Renewable Energy and Energy Efficiency Partnership
SNEPCo	Shell Nigeria Exploration and Production Company
SPDC	Shell Petroleum Development Company
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WAGP	West African Gas Pipeline

List of Figures

Figure 1: Low Carbon Scenario: Emission Reduction from Oil and Gas

Figure 2: Gas Pipeline Network in Nigeria

Figure 3: Seven Energy Infrastructure in the South-southern Region

Figure 4: Annual Total IF, FF, O&M Cost for individual investment types in million 2015USD

Figure 5: Discounted Annual total IF, FF, O&M costs for four individual investment types in million 2015USD

Figure 6: 10 Year Gas Production and Utilization (bcf)

Figure 7: Annual Total IF, FF and O&M Cost by Investment Type

Figure 8: Total IF, FF & O&M by Investment Type

Figure 9: CCS - Cumulative Annual Total Discounted IF, FF & O&M Estimates by Investment Type and Entity (in million 2015USD)

Figure 10: Annual Discounted Total IF, FF and O&M Estimates by Investment Types (million 2015USD)

Figure 11: Cumulative Discounted IF, FF and O&M Cost for All Investment Types

Figure 12: Cumulative Incremental Annual Total IF, FF and O&M Cost by Investment Types

Figure 13: Cumulative Annual Non-Discounted and Discounted Incremental IF, FF and O&M Cost for All Investment Types

Figure 15: Electrical Power Capacity Projection

Figure 16: Gas Demand Projection in the Electricity Industry

Figure 17: CNG Distribution Line

Figure 18: Map showing built, planned and proposed oil and gas pipelines.

Figure 19: Comparing US and Nigerian Gas Prices

Figure 20: Revenues and Costs for the Low Carbon Scenario

Figure 21: Dangote Industrial and Energy Complex Schematic

List of Tables

Table 1: Taxonomy of investment entities and sources of I&FF funds

Table 2: Assumptions on Cost Accounting Parameters for IF, FF and O&M

Table 3: Projects in Nigeria registered by the CDM Executive Board (as at June, 2020)

Table 4: BAU Historical IF, FF, and O&M Cost in million 2015USD (2013 -2014)

Table 5: Climate Friendly Investments for Historical IF, FF, and O&M Cost by Investment types/entities in million 2015USD (2013 -2014)

Table 6: BAU Historical IF, FF, O&M Costs by Investment Types (million 2015USD)

Table 7: Annual Climate Friendly Investments for Historical IF, FF, O&M Costs by Investment Types (million 2015USD)

Table 8: Baseline Scenario Cost

Table 9: BAU Scenario - Discounted Annual Total IF, FF, O&M costs by investment types in million 2015 USD

Table 10: BAU Total IF, FF AND O&M Cost by Investment Type/ Entity

Table 11: 10 YEAR GAS PRODUCTION AND UTILIZATION (bcf)

Table 123: CCS Scenario - Annual Total IF, FF and O&M Cost by Investment Type and Carbon Equivalent Reduced (million 2015USD)

Table 134: CCS - Cumulative Annual Total IF, FF & O&M Estimates by Investment Type and Entity (in million 2015USD)

Table 145: CCS - Cumulative Annual Total Discounted IF, FF & O&M Estimates by Investment Type and Entity (in million 2015USD)

Table 16: CCS - Annual Total Discounted IF, FF & O&M Estimates BY Investment Types (million 2015USD)

Table 157: Cumulative Discounted IF, FF and O&M Cost for All Investment Types

Table 168: Incremental Annual Total IF, FF, O&M costs by Investment Types.

Table 179: Discounted Cumulative Incremental Annual IF, FF & O&M Cost for Investment Types

Table 20: Cumulative Annual Non-Discounted and Discounted Incremental IF, FF and O&M Cost for all Investment Types

Table 21: Incremental Annual Total IF, FF, O&M costs by Investment types/entity (million 2015USD)

Figure 14: Discounted Cumulative Incremental Annual Total IF, FF, O&M costs by Investment types/entity (million 2015USD)

Discounted Incremental Annual Total IF, FF and O&M Cost

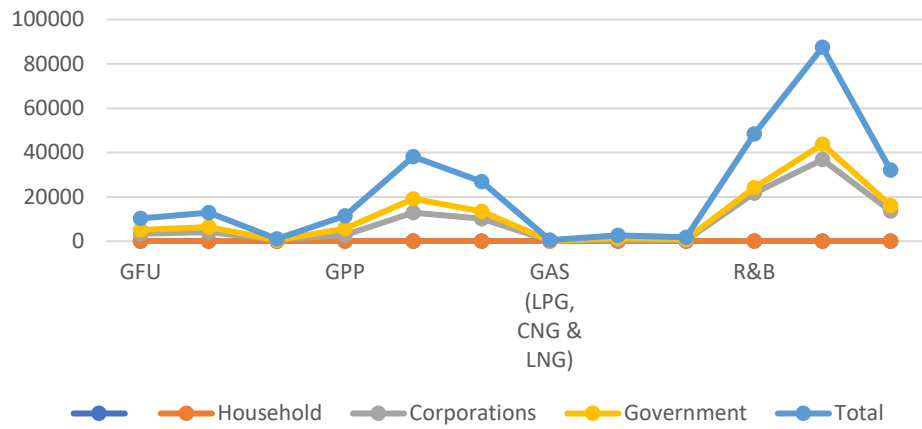


Table 18: Discounted Cumulative Incremental Total IF, FF, O&M costs by Investment types/entity (million 2015USD)

Table 24: Planned Gas Supply Projects

Table 25: Existing, On-going and Proposed Gas Infrastructure

Table 19: Examples of Operators in Supplying Non-Grid Connected Customers

Table 27: Low-, Mid- and High Product Price Scenarios, 2012 - 2035

Table 28: Breakdown of Investment Entity

Executive Summary

The NDC Sectoral Plans for the oil and gas sector focuses primarily on the need to power the Nigeria economy with gas with thrust on the need to end gas flaring by 2030, and if feasible by 2020-2025. This has led to the launching of the NDC Support Program's first phase of intervention - developing a financial strategy for funding the country's NDCs Sectoral Action Plan. Capacity development of policy makers to undertake the IFF assessment was conducted of which this report is the product. The assessment addresses changes of investments in physical assets and in programmatic measures needed to mitigate GHG emissions in the oil and gas sector.

The IFF assessment reports are based on historical expenditures from 2013 – 2014, trends from 2015 - 2020; forecast 2020-2030 hence presenting a concise guide and plan towards restructuring of budget spending that encourages *low emission development* while growing the economy. It focuses on economic growth, poverty reduction, and expanding access to energy services for the poor, transition away from carbon-intensive fossil fuels, expanding the diversity of energy sources to include the use of renewable energy within the energy mix, improving the efficiency of energy use, and ending gas flaring.

In scoping of the oil and gas streams, four key mitigation areas – Gas Flare Commercialization, Gas Pipeline Projects, LPG, LNG & CNG gases and Refining and Blending - were identified of which application of mitigation actions would contribute to a drastic reduction of GHG emissions hence the need to invest in a just transition from dirty fossil fuel to a cleaner and affordable energy. Relevant activities that took place in the previous years including CDM Projects were only highlighted for clarity as these activities had already existed in Nigeria before it officially signed the Paris Agreement 2015.

Historical climate friendly cumulative IF, FF and O&M Cost in million 2015USD for all investment types (GFU, GPP, GAS and R&B) were \$2,365.46, \$8.81 and \$994.87 respectively. Analysis showed that the total discounted IF, FF and O&M cost were \$14,778.09, 17.78 and \$8,240.65 respectively for BAU while cumulative IF, FF and O&M cost for climate change scenario for all investment types would cost \$18,639.36 \$150.28 and \$17,057.27 respectively. The total discounted incremental cost for IF, FF and O&M are \$8333.08, \$161.58 and \$12905.07 respectively. It should be stressed that the estimated investments include implementing projects that; will reduce gas flaring to zero, build pipelines that are managed with advanced leak detection and repair programme, switch the consumers from the use of diesel, kerosene, LPFO that are high carbon intensive fossil fuel to the use of natural gas which is low carbon fossil fuel and also the build efficient refineries and bioethanol plant for blending of petroleum motor spirit (PMS).

The investments flow is for the execution of various gas related projects which include treatment and processing plants, compression systems, complete trunk of gas pipeline systems, setting up of LNG, LPG and CNG plants, building and maintenance of refineries which include modular and large-scale plants as well as building of bioethanol and blending plant. The operation and maintenance cost are estimates for the operations of the facilities to be built or refurbished as well as the maintenance as applicable. Financial flow received will be channeled into capacity building programmes, trainings, workshops, and corporate social responsibility programmes. This is aimed at ensuring knowledge transfer and building the local content of the human resources in the country to manage these facilities and also create local innovation for sustainability of the technologies in the country.

The Federal Government and various states have over the years developed several policy documents to promote key elements of climate compatible development, enabling policies, emerging investments, existing local level implementation efforts, and the role of international partnerships. These policies alone will not transform Nigeria's oil and gas sector towards climate mitigation. To incentivize the flow of international finance to mitigation projects in Nigeria, domestic policies and institutions must be properly

aligned with more traditional economic incentives to attract investments, enforce efficiency measures, establish sustainable tariff practices for just transition, demonstrate the feasibility of modern technologies, and ensure responsible use of gas resources. Adequate governance, accountability and transparency are key values that will drive this to fruition.

Therefore, report of Investment and Financial Flows assessment will help guide stakeholders and readers through historical trends while comparing its projections with alignment to NDC strategies to promote investments. The analysis may be utilized for the various NDC strategies e.g., Long Term Low Emissions Development, Decarbonization approaches, and others as outlined in Chapter 1.

While possible and economically attractive, low-carbon development is by no means easy in Nigeria or anywhere in the world. A combination of better knowledge expanded human capacity, reformed policies, and suitable financing is needed to overcome the barriers to adopting low-carbon development options. The FGN can play a catalytic role in getting the transition under way as there is little or no time to waste: once locked into the country's economic fabric, higher carbon technologies are costly and impractical to reverse.

Chapter One

1.1 Introduction

The submission of Nigeria's Intended Nationally Determined Contribution (INDC) in 2015 and signing of the Paris Agreement at the United Nations General Assembly in 2016 indicated the intention of FGN for a new era of action on climate change. NDC implementation plans were developed for five main sectors covering more than 80 percent of the Nigerian economy with associated GHG emissions: oil and gas, transport, agriculture, industry and power. The NDC Sectoral Plans for the oil and gas sector focuses on the need to end gas flaring by 2030, and if feasible by 2020-2025. In view of implementing the NDCs, various policies have been developed and projects are on-going to tackle climate change mitigation (*especially for oil and gas*) and adaptation measures while receiving extended support from UNDP such as NDC Support Program. The NDC –SP was launched in 2017 by UNDP, together with the European Union [EU] and Governments of Germany and Spain and implemented in Nigeria by 2018. The NDCs Support Programme helps countries integrate climate and development solutions through the implementation of the Paris Agreement on Climate Change.

The NDC Support Programme in Nigeria focuses its intervention on four [4] axes:

1. developing a financial strategy for funding the country's NDCs Sectoral Action Plan
2. increasing private sector involvement in meeting the country's NDCs targets either by participating in mitigation and adaptation projects or by adopting climate-friendly measures in their current operations.
3. establishing a registry of adaptation and mitigation actions that are contributing to the achievement of NDCs targets in order to start monitoring, reporting and verifying progress; and
4. increasing the visibility of the NDCs through an effective strategic communication and full integration of the NDCs in the SDGs and the next Economic Recovery Growth Plan [ERGP]; ERGP is officially ending by December 2020 as another Medium-Term National Development Plan 2021 – 2025 and Nigeria Agenda 2050 is underway as at the time of this writing.

The first axes or intervention of developing a financial strategy is currently on-going; underpinned by capacity development of policy makers has been conducted in 2019 and the IFF assessment is now at the tail end. The assessment addresses changes of investments in physical assets and in programmatic measures (collectively referred to as investment and financial flows – I&FF) needed to mitigate GHG emissions and adapt to climate change in key sectors. The approach is designed to be operationalized at the country level while addressing country-specific needs and conditions. The results of I&FF assessments will be used in financial decision making and policy development regarding investment shifts and/or additional capital needed to address climate change, as well as in the development of national negotiation positions for the UNFCCC process.

1.2 Aims and Objectives.

This analysis seeks to address the mitigation changes needed in acquisitions, operation and maintenance of physical assets and human resources transitioning in the programmatic measures to mitigate GHGs emitted as a result of the increase in production, supply and use of fossil fuels within and without the sector.

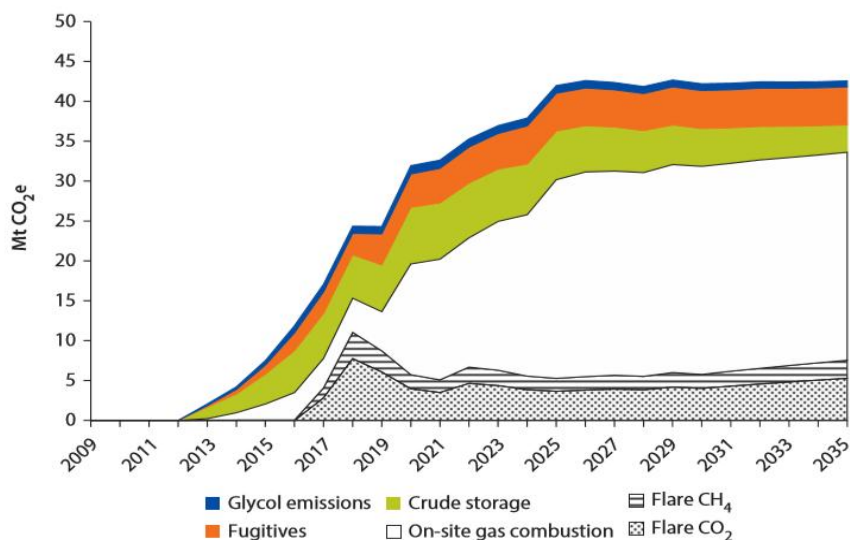
Specifically, the objectives include:

- a. identification of cost-effective measures to address climate change with a 10yr projection of future I&FF associated with their business as usual (BAU) and conditional implementation.
- b. determine the entities that are responsible for those investments and the sources of their investment funds.
- c. provide information needed to evaluate policy instruments that might be used to induce those entities to invest in the proposed measures.
- d. strengthen national capacities of the oil and gas sector team in order to enable the assessment and development of policy options that address climate change mitigation options in oil & gas;
- e. to identify and redirect national policies, investment and financial commitments to climate friendly activities with the aim of reducing greenhouse emissions;
- f. identify key elements of climate compatible development, enabling policies, emerging and expected investments and other existing local level implementation efforts;
- g. to present a consolidate report on the historical, baseline and projection of conditional and unconditional I&FF scenario on carbon mitigation measures within the sector; and
- h. contribute to national climate change policy strategies by engaging line ministries and encouraging an enabling environment.

1.3 Sector Background

The global oil and gas exploration and production sector makes up a large portion of the global economy as growth of the sector is expected to increase in the future. Nigeria has the world's seventh largest gas reserves, with 187 trillion cubic feet (TCF) of high-quality proven reserves of which around half is associated gas (AG)ⁱ. The oil and gas sector contribute up to 14% of Nigeria's GDP, and is responsible for 95% of the foreign exchange earningsⁱⁱ. It also contributes about 65% of the Federal budget (reduced to 45% since the drop in international crude oil prices). However, it employs only around 0.01% of the working population. For Nigeria, gas could serve as a 'bridging fuel' due to its competitive advantage in low emissions and cost effectiveness over other energy sources needed to drive industrial growth and create a pathway for Low Emission Development Strategy (LEDS) in the sector. The gas sub-sector has limitations such as low investments and poor availability of transmission and distribution infrastructure for gas transportation from producing areas in the south to consumers across the country, which is exacerbated by social unrests in the Niger Delta causing losses of over \$14bn annually. This has been a discouragement to new investments to upgrade the gas network. However, to support environmental compliance based on the NDC and attract new investments, the FGN has acceded to new policies such as the National Gas Policy (NGP) and Petroleum Industrial Bill (PIB); and implementation of projects such as Nigerian Gas Flare Commercialization Program (NGCFP) and National LPG Expansion Plan in compliance with commercial utilization of gas flares. World Bank studies on LED for Nigeria indicates a continued decline of emissions from gas flaring based on existing flare-reduction programs of the FGN in collaboration with oil companies, as seen in Figure 1.

Figure 1: Low Carbon Scenario: Emission Reduction from Oil and Gas



Source: Calculations based on NNPC Annual Statistical Bulletin, 2011 ⁱⁱⁱ

1.4 Global Health Hazards and Economic Impacts of COVID-19 on Oil and Gas Sector

The slowdown in the global economy and lockdown in some countries, such as Nigeria, Italy, Spain, most Eurozone economies and beyond, as a result of the COVID-19 pandemic has taken its toll on the global demand for oil. This is also coming at a time when two key players in the global oil industry – Russia and the OPEC cartel – are at loggerheads on the decision to cut output, however, even with the agreement to cut output, global demand remains very low and the recovery of oil price would be very slow and unlikely to return quickly to status quo due to Post-COVID impacts. In Nigeria, all economic activities seem to have been grounded except for essential and COVID 19 related services such as food, water, medicals, security, LPG distribution value chain, etc. are permitted to engage in business.

A global recession has been predicted by the IMF and World Bank, putting severe pressure on all economies, especially in African and other developing countries. For Nigeria, having a “sluggish” recovery from the 2016 economic recession as a result of global oil price crash, economic recovery and growth must be driven by sustainability elements, which has compelled the government to establish an Economic Sustainability Committee in the Office of the Vice President to oversee a rapid response to Post COVID-19 economic recovery. Key takeaways from a citizens dialogue session on government fiscal policy decisions, held in April 2020 and led by the Honourable Minister of Finance, Budget and National Planning in response to the fall in oil prices and the COVID-19 Pandemic has resulted in Nigeria reviewing its budget downwards to a benchmark of oil sales at \$20 per barrel (vs. budget benchmark of \$57 per barrel) as against the earlier projected revenue of N8.24 Trillion (an increase of about 20% from 2019 figure). The impact of low oil prices on the economy would conservatively contract GDP from 2.2% to -3.5% YoY in 2020/21. Oil earnings is now projected to decline by 90.0% in 2020 with an estimated net oil & gas revenue available for Federation Account Allocation Committee (FAAC) distribution of 80.0% lower at N1.1 trillion (vs. N5.5 trillion previously), despite a N649 billion reduction in allowable fiscal deductions by NNPC for federally funded projects/expenditures. Specifically, projected PMS investments under-recovery has been reduced from N457 billion to zero as oil production is currently projected at 1.7mbpd (vs. 2.18mbpd previously). Average production cost of Nigerian crude has been revised downward to \$28 per barrel from \$33 per barrel (with implications for Petroleum Profit Tax).

The pre-COVID revenue assumptions had been premised on increased global oil demand at a stable oil price and production of \$57 per barrel and 2.18 mbpd. The downward review of the budget, contractions in public spending would have devastating impacts on poverty and unemployment considering that the 2018 unemployment report released by the National Bureau of Statistics (NBS) ranks Nigeria 21st among 181 countries with an unemployment rate of about 23.1%. The country has also been rated as the poverty capital of the world with an estimated 87 million people living on less than \$2 a day threshold.

In view of the challenges, government has approved an integrated policy framework with adjustments to the 2020 budget. The budget office is finalizing a revised 2020-2022 Medium Term Expenditure Framework and Strategy Paper (MTEF/FSP) as well as an amendment

to the 2020 Appropriation act. According to Nigerian Economic Summit Group (NESG), Nigeria needs N10.1 trillion worth of interventions but current intervention capacity stands at N4.5 trillion. The implied funding gap of N5.6 trillion is likely to be covered by medium to long term domestic and external borrowings (possibly from World Bank, IMF, IFC, AfDB).

FGN in deciding to cut the retail price of gasoline under a price modulation arrangement expected to curb rising inflation, especially the food price sub-index, which will mainly benefit the poor. However, rather than the price capping regime introduced, where the Petroleum Products Price Regulation Agency (PPPRA) issues monthly guides on petrol pricing it is expected that government will use this opportunity to completely deregulate the petroleum industry in line with existing suggestions and reports. In the event that the global economy becomes healthier and crude oil price recovers, the government may turn its attention to the under-recovery of the oil price shortfall by the Nigerian National Petroleum Corporation (NNPC). A policy that annually costs the government huge revenues and recurring losses to the NNPC^{iv}. Such palliatives should be translated into practical investments to drive GDP growth and economic recovery across multiple non-oil sectors like agriculture, off-grid power, transport, mining, manufacturing, service sectors and others.

1.5 Industry Outlook

The future of oil and gas across the world is coming under intense scrutiny. While oil majors are already cutting back on exploration activities in Nigeria with risks of having 'stranded assets', Shell Energy Transition Report revealed plans to empty reserves by over 80% before 2030 stating that keeping large part of oil and gas reserves in the ground would be risky although they would welcome and support the Paris climate agreement^v. Shell's investments for the new business unit - New Energies would focus on sustainable energy and add about \$ 2 billion per year until 2020. While there is need to drastically reduce the amount of CO₂ per unit of energy produced in 2050, Shell said it would halve CO₂ by 2050 while limiting the financial consequences of an increasing price for CO₂. The company also plans to invest more into electricity, expand its customer base in solar, wind and gas. Earlier, energy analysts at the Grantham Institute of Climate Change and the Environment Dept. at Imperial College London and the Carbon Tracker think-tank had said oil would reach its peak by 2020, and cut supply to the market by two million barrels a day by 2025, -- this is the same volume that caused the oil price collapse in 2014 and 2015^{xi}.

The Shell Nigeria Exploration and Production Company (SNEPCo) a key player in the industry pioneered Nigeria's deep-water oil and gas production at the Bonga field, increased Nigeria's oil capacity by over 10 per cent when output began in 2005. At full output, Bonga has the potential to add more than 200,000 barrels of crude oil and 150 million standard cubic feet of gas to Nigeria's daily production.

Given the number of activities that took place in 2019 and some policy pronouncements made by government officials, the industry looks promising. Having secured the final investment decision (FID) on Nigeria Liquefied Natural Gas (NLNG) Train 7, it is hoped that the industry would be energized and by extension scale up investments, create jobs and boost the economy.

In Post-COVID, if the government decides to keep to its promise of organizing oil licensing rounds for marginal or big oil fields, it will then mean that activities in oil and gas industry would likely be scaled up. As Dangote Refinery nears completion and WalterSmith modular refinery commences production, there will be positive impact on huge savings of foreign exchange used for importation of petroleum products. Also, if the Niger Delta Petroleum Refinery comes on stream with Jet Fuel, Premium Motor Spirit (PMS) and increase of its Automotive Gas Oil (AGO) production, it means that the removal of the petroleum subsidy on the advent of COVID will be permanent. In 2020, the Nigeria Content Development and Monitoring Board (NCDMB) was expected to be more aggressive in raising the Nigerian content in most projects. The current Minister of State, Petroleum, Sylva Timipre assured that the Petroleum Industry Bill (PIB) will be passed into law by mid-year 2020 clearing the uncertainty around fiscals and sanctity of contracts. However, certain concerns raised by Oil and Gas operators indicate that Nigeria must take necessary steps to checkmate some development in the international market for it to increase sales and sustain revenue.

For instance, US crude oil production average 13.33million barrels per day (mbpd) and its bilateral trade deals with India and China (the traditional buyers of Nigeria's crude oil), there may be pressure on ability of the country to sell to these countries. Other areas predicted to affect oil and gas in 2020 include weakening global economic growth in USA, Europe and China; Trade tensions, health risks like the COVID 19 pandemic, political risks like 2020 USA elections, the outcome of Brexit in Europe and tensions in Middle East. Currently little is known about the effect of Production Sharing Contract (PSC) amendment and the new finance bill on investments in 2020.

1.6 Reference of Manuals Used for Analysis/Evaluations and Final Output Calculations

1.7 Stakeholder Mapping - Institutional Arrangements and Collaborations

The project was implemented by the Department of Climate Change (DCC) of the Federal Ministry of Environment which is the National Focal Point (NFP) for climate change. The DCC provided policy guidance to it and maintained overall oversight of the activities through the Project Lead. The Program had a 16-member Technical Working Group (TWG) drawn from ministries and private sector. In addition, five team leaders were assigned to coordinate the five NDC sectors namely Agriculture, Oil and Gas, Transport, Industry and Power. Each sector was comprised of Data analysts, Economist and Finance experts, Climate experts and Institutional support.

While the FME was the lead ministry for the study, several disciplines from a broad group of stakeholders were required for inputs: Federal Ministry of Agriculture, Federal Ministry of Power, Federal Ministry of Petroleum Resources, Federal Ministry of Transport, Federal Ministry of Industry, Trade and Investments took the lead in their sectors. Other ministries with cross-cutting or cross-thematic or inter-sectoral linkages such as the National Bureau of Statistics, Federal Ministry of Water Resources, Federal Ministry of Finance, NNPC, DPR, etc., played key roles in the thematic area consultative groups together with relevant civil society, NGOs, academia and think tanks.

1.7.1 GOVERNMENT STAKEHOLDERS

Some of the government institutions relevant to the activities of the Oil and Gas group include: Nigeria National Petroleum Corporation (NNPC), Department of Petroleum Resources (DPR), National Oil Spill Detection and Response Agency (NOSDRA), Office of The Vice President – National LPG Expansion Plan, Nigerian Gas Flare Commercialization Program (NGCFP), Nigeria Liquefied Natural Gas Company (NLNG), International Oil Companies (IOCs) and the National Oil Companies (NOCs). Owing to the proprietary challenges in the Oil and Gas Sector DPR and NNPC were the key sources of information.

1.8 Methodology and Key Terminology

The methodological approach of the national assessment of I&FF mitigation followed the eight steps outlined.

1. Establishing key assessment parameters

Key parameters were identified to:

- 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 an analytical approach in the methodological guide

2. Compile historical IF, FF, and O&M cost data, subsidy cost data (if included explicitly) and other input data for scenarios from 2007 – 2017.

3. Describe baseline scenario.

Defining the baseline scenario is very important and it is the basis for determining the cost between 'business as usual' scenarios and the more efficient alternatives, the mitigation scenarios. To do this, existing plan and programmes had to be identified and projections developed for the outer years of the analysis period.

4. Estimating the I&FF scenario in the baseline.

In this section of the framework approach the analysis involved:

- Estimates of I&FF annually disaggregated by investment entity and funding source
- Estimates the O&M annually disaggregated by investment entity and funding source
- Estimate annual subsidy costs for each relevant investment type and for IF, FF, and O&M costs, if subsidies are include explicitly in the assessment.

5. Defining potential mitigation scenario

This involved identifying the mitigating interventions for each sub-sector of the energy sector and listing them for each type of

asset.

6. Deriving detailed annual I&FF estimates for the mitigation scenario

This required:

- Estimating annual changes, I&FF and EM required to implement mitigation scenarios.
- Estimating the annual IF, FF, and O&M costs, and subsidy costs, if included, explicitly, for mitigation scenario.
- 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 explicitly in the assessment.

7. Calculate the changes in IF, FF, and O&M costs, and in subsidy costs if included explicitly, needed to implement mitigation.

- 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, consider calculating changes in cumulative and/or in annual subsidies for IF, FF, and O&M for each investment type and all investment types.

8. Assessing policy implications

These highlight the need to:

- Based on the required changes in IF, FF and O&M as determined in step 7, identify the policies and incentives necessary to induce this change.

Integrate climate change in regional projects, regional and national strategy,

- Strengthen the capacities of all stakeholders
- Integrating these options in national reference
- Involve local entities proactively; give responsibility/empowerment to the people
- Develop activities that support the generation of income/revenue

It is expected that this national assessment of I&FF will increase greater awareness and understanding of future investments that address climate change as well as development priorities.

1.8.1 KEY TERMINOLOGY

Scenario: A ‘scenario’ is an internally consistent and plausible characterization of future conditions over some specified time period.

Mitigation Scenario or Climate Change Scenario: The mitigation scenario includes measures to mitigate GHG emissions, that is to say, the mitigation scenario should describe the expected socio-economic developments, technological change (if appropriate), new measures to mitigate GHG emissions and the expected investment in the sector given the implementation of mitigation measures. This can also be referred as target scenario.

Baseline Scenario or Business as Usual (BAU): also known as a non-policy case condition. It reflects a continuation of current policies and plans, i.e., it is a description of what is likely to occur in the absence of new policies to address climate change.

Investment flow (IF): An “investment flow” (IF) is the capital cost of a new physical asset with a life of more than one year, such as the capital cost of a new power plant, a new automobile, a new household appliance or a new agricultural irrigation system. Investment flows are limited to new physical assets because such investments have climate change implications for the duration of the operating lives of the facilities and equipment purchased.

Financial flow (FF): A “financial flow” (FF) is an ongoing expenditure of programmatic measures; financial flows encompass expenditures other than those for expansion or installation of new physical assets. Examples of financial flows include expenditures for an agricultural extension program for farmers, a malaria prevention program to distribute mosquito nets, or the implementation of improved forest management techniques. These expenditures are “operation and maintenance” type costs, e.g., salaries and raw materials.

Operation and Maintenance (O&M) Costs: it is associated with physical assets purchased with investment flows and will have operation and maintenance (O&M) costs associated with them (i.e., ongoing fixed and variable costs such as salaries and raw

materials). Operation and maintenance costs of new assets need to be included in I&FF assessments because these costs can vary considerably among investment flow types and can have a significant effect on the total cost of an investment over its lifetime. For example, O&M costs are a much greater share of total costs (capital costs plus O&M costs) for gas-fired electricity generation than photovoltaic electricity generation. O&M costs include the following categories of costs: Salaries or wages of personnel, Fuel costs such as power and/or fuel for operations, fuel for production, Public utilities such as telephone service, Internet connectivity, etc., Raw materials, Maintenance and/or leasing of equipment, Office supplies and consumables, Advertising, insurance, etc.

Investment Entity: An “investment entity” is the body or thing making the investment in the asset. The sources of the I&FF funds are the origins of the funds invested by the investment entities, e.g., domestic equity, foreign debt, domestic subsidies, foreign aid. These are described below for each investment entity.

Household: Households are individuals or groups of individuals (e.g., families) who act as one unit financially. Households invest in assets, such as homes, farms, vehicles, and facilities for small unincorporated businesses. All of their investment funds, which include equity (savings, remittances by relatives in foreign countries), debt (loans from friends, relatives, or financial institutions), and government support in the form of subsidies (e.g., rebates, tax deductions, or tax credits on purchases), are assumed to be domestic to simplify the assessment of I&FF.

Corporations: Corporations include both financial corporations and non-financial corporations and can be either for profit or not-for-profit.

Governments: Governments are the national, provincial, state, and local governments of a country. Financial and non-financial corporation’s owned wholly or in part by governments, such as public universities and research institutions, and publicly held oil companies, utilities, and water authorities, are included in this category.

Table 1: Taxonomy of investment entities and sources of I&FF funds

Investment Entity	Source of I&FF Funds	
Household	Domestic	Equity and debt
	Domestic	Domestic equity (including internal cash flow) Domestic borrowing (bonds and loans)
Corporations	Foreign	Foreign direct investment (FDI) Foreign borrowing (loans) Foreign aid (ODA) ^A
	Domestic	Domestic funds (budgetary)
	Foreign	Foreign borrowing (bonds and loans) Bilateral foreign aid (bilateral ODA) Multilateral foreign aid (multilateral ODA)
Government		

An official development assistance (ODA) provided to private corporations is primarily foreign aid that is given to nongovernmental organizations (NGOs).

Base Year: The base year is the first year of the assessment period, that is, the first year of mitigation and adaptation. The base year should be a recent year for which information on the I&FF and O&M is available so that the IF, FF and O&M costs for the first year of these scenarios are all historical data.

1.9. Focus for the IFF Report

The IFF assessment reports is based on historical expenditures from 2013 – 2014, trends from 2015 - 2020; forecast 2020-2030 hence presenting a concise guide and plan towards restructuring of budget spending that encourages *low emission development* while growing the economy. It focuses on economic growth, poverty reduction, and expanding access to energy services for the poor, transition away from carbon-intensive fossil fuels, expanding the diversity of energy sources to include the use of renewable energy within the energy mix, improving the efficiency of energy use, and ending gas flaring.

1.9.1 LONG TERM LOW EMISSION DEVELOPMENT PATHWAYS

The FGN has indicated that its 2050 growth pathway would be based on the bio-economy as outlined in the Bio-Economy Strategy for Nigeria. The Long-Term Low Emissions Development pathways would map the non-oil sectors to delineate the role of oil and gas in the long term. While oil has a shorter growth trajectory as demand shifts, gas is a transitory factor towards achieving climate targets.

The challenge for the oil and gas industry is not only to mitigate and adapt to a changing policy and investment landscape, but also to evolve in ways, which support efforts in decarbonizing the energy system. Around the world there is a gradual shift from policies supporting oil and gas production to policies that disincentivize fossil fuels, including carbon pricing and the European Union’s Emission Trading Scheme. In addition to disincentives, many governments including Nigeria are encouraging the use of substitute technology

and fuel, especially renewable energy. Further consideration in the adoption of circular economies, in which materials are reused or recycled instead of disposed of at the end of their service life.

Concerted efforts in research areas of impacts, mitigation, adaptation, and vulnerability on climate change are yet to show a blueprint to define how this new paradigm shift could be implemented in different countries. What is essential is a solid knowledge base to assess costs and benefits of different growth trajectories to pursue green, blue and circular economic growth, which are inherently country-specific^{vi}. This report provides a platform on how 'low carbon growth' (a key factor for green growth) could be mainstreamed into Nigeria's development pathway by 2030 up until 2050 and beyond.

Assuming conventional approaches to oil and gas production; achieving goals in electricity generation and use, transportation and agriculture could imply a doubling of greenhouse gas (GHG) emissions by 2035. Cumulative emissions over this period (2010–30) might add up to 11.6 billion tons of CO₂ to the atmosphere—five times the estimated historical emissions between 1900 and 2005.

A lower carbon path offers not only the global benefits of reducing contributions to climate change, but also net economic benefits to Nigeria, estimated at about 2 percent of GDP. These national benefits include cheaper and more diversified electricity sources, with savings of the order of 7 percent or US\$12 billion; more efficient operation of the oil and gas industry, with discounted net benefits of US\$7.5 billion, more productive and climate resilient agriculture; and better transport services, resulting in fuel savings, reduced costs of production and improved quality, better air quality, and reduced congestion. These domestic benefits would be accompanied by a global benefit of avoiding some 2.3 billion tons of CO₂e (carbon dioxide equivalent) emissions over 25 years. An additional 1.4 billion tons of emission reductions are technically viable but would require extra financial incentives to be economically viable for Nigeria.

Energy Conservation Using Innovative and Cost-Efficient Technologies: Technology policies are one of the strategies employed in the reduction of carbon emissions and the usage of energy^{vii}. In the face of global climate change, energy efficiency and conservation are very essential components of policies for addressing emerging concerns on energy security and the reduction of greenhouse gas emissions^{viii}. The review of Dincer and Acar^{xix} suggested that sustainable energy systems should be equitable and efficient with the ability to meet standards, such as the current and future energy demands of the population, least possible social or environmental impact, lowering net carbon emissions of other greenhouse gases (GHGs), zero depletion of natural resources, zero adverse effects on the future generations and should be able to protect water, land, and air resources. However, adopting sustainable energy systems, which are affordable, secure, and offer low-carbon energy services involves the use of techniques that recognizes the complexities of energy systems from an environmental, economic, and social perspective^{ix}. Similarly, the dissemination of low-carbon technologies may be restricted by institutional, social and behavioural factors but their large-scale global deployment is necessary for the stabilization of global climate^x.

The natural gas reserves in Nigeria have prospects to reduce energy-related costs through increased efficiency^{vi} but gas flaring has been a major cause of environmental pollution due to lack of infrastructure, diversification and utilization of energy resources contributing significantly to GHG emissions, a waste of a significant natural resource, energy source and loss of revenue to the country^{xi}. Globally, the contribution of gas flaring to GHG emissions annually is about 400 million tons of CO₂ which represents 1.5% of global CO₂ emissions^{xii}.

Leakage and emissions of natural gas: Unavoidable natural gas leakage and bulk emissions called "fugitive emissions," take place through gas seals and pipe connections, from gas-actuated process control equipment, during maintenance operations, and from equipment designed to vent small volumes of gas during normal operations. These fugitive emissions can be reduced by: *replacing wet seals on gas compressors, which continuously leak gas through the seal, with dry sealing devices; installing vapor recovery units on glycol pumps and dehydration units; using air rather than gas to actuate process control equipment; installing low-bleed pneumatic control devices; and carrying out enhanced and directed maintenance programs for production and processing facilities, gas compressors, pipelines and meters. More so, gas emissions evolving from oil stored in fixed-roof tanks at oil and gas facilities can be reduced by replacing the fixed roofs with internal floating roofs that minimize the leakage and/or installation of vapor recovery units to collect the gas evolved.*

Decarbonization Strategy: this creates a pathway to reduction of carbon in primary energy over a period. That is the removal or extraction of carbon dioxide from the energy sources. Nigeria has a CCS strategy that is yet to be fully implemented though it is still in view.

Gas based Transport System: Auto-gas would enhance fuel efficiency of vehicles to make road transport cheaper, with better air quality, and reduced congestion. Introduction of electric vehicles to eliminate GHG and reduce Petroleum Motor Spirit (PMS) vehicles in advanced countries would impact on PMS imports and production. PMS blending with synthetic ethanol or bio-ethanol to reduce

emissions by as much as 34% where the emissions savings of the production chain of bioethanol is added to the reduction of emissions by the ethanol blends. The use of gas for farm machineries and equipment as replacement for diesel will reduce emissions and reduce cost of energy for farm processes in agriculture.

Gas based Captive Power: LNG/LPG can be used in power generation to run oil and gas production and other industrial processing operations. Options to reduce emissions from this on-site power generation equipment include: replacement of low-efficiency gas turbines/reciprocating engines with modern, high- efficiency equipment; installing variable speed drives on gas compressors and oil pumps to maximize compressor and pump efficiencies; replacement of the power generation equipment itself with modern higher efficiency equipment, such as combined-cycle units; replacement of equipment with a high demand for power, particularly gas compressors, with modern higher efficiency equipment; installing optimal system control units to reduce the power requirement in the various oil and gas operations; and carbon capture and storage of combustion gases. Gas powered electricity for storage and processing in agriculture is a desired outcome for reducing emissions from diesel, the most ubiquitous industrial fuel currently in use in Nigerian industry.

Net Zero Emissions: This aims at the removal of Carbon dioxide from atmosphere and permanently storing it through reduction measures, to create artificial or natural sinks (e.g., one trillion Trees Initiative, Direct Air Capture with Carbon Storage, "DACCS"), Bio-Energy with Carbon Capture and Storage, "BECCS", Increasing ocean productivity; Nigerian Gas Flare Commercialization Project(NGFCP). Since 2007 this project has failed to meet its target. However, NGFCP has estimated \$3.5bn for commercialization of 178 flare sites. The on-going process is at the request for proposal (RFP) stage and the first bidding process could be concluded in June 2020. It is estimated that the project is on track for 2030 and would produce 1.2mscf LPG at scale.; The National Gas Expansion initiative proposes increase from current 1700million MT LPG to 10M tons LPG by 2030; and an increase of gas cylinders from about current 3-4m cylinders to 52m gas cylinders by 2030.

Just Transition: is a framework to encompass social interventions needed to secure workers' rights and livelihoods when economies are shifting to sustainable production, that avoids climate change and protects biodiversity; This is closely associated with economic growth trajectories outlined in gas to energy projects such as the energy-agric nexuses (e.g. proposed investments to power sustainable cities anchored by Office of the Vice President; national livestock and crops transformation agenda anchored by the Office of the Vice President; and African Development Bank – Special Agro Processing Zones projects starting in June 2020).

Science and Research-based targets provide companies with a clearly defined pathway to assure growth by specifying how much and how quickly they need to reduce their greenhouse gas emissions; (we may not be able to do this estimation due to low level of awareness and lack of policies to target industry use. But this is to be discussed under the Industry sector).

Carbon neutral strategy is where some emissions generated in a location are offset somewhere else making the overall net emissions zero. There is need to outline and forecast of such trajectories within the Nigeria 2050 economic growth Pathway by the Ministry of Finance Budget and National Planning.

1.10. Rationale

As a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, Nigeria has made international commitments to promoting low-carbon development, including meeting its reporting obligations to the UNFCCC, reducing emissions of greenhouse gases consistent with its national circumstances and within the context of economic recovery and growth, sustainable development goals (SDGs) and Low Carbon Emission Development Strategy (LEDS).

The UNFCCC and other international institutions provide directly or support financial incentives to embark on low-carbon projects. These include programmes such as the UNDP NDC Support Program, UNDP sponsored Nigerian Renewable Energy Master Plan, Green Climate Fund (GCF), Clean Development Mechanism and REDD (Reduced Emissions from Deforestation and Degradation). Nigeria's first REDD+ project was approved in October 2011. NDC Support Program includes training of National Experts for the Assessment of Investment and Financial Flows in the NDC Sectors of which this report emanated.

Nigerians also have access to funds and incentives established outside the UNFCCC process, but with the aim of promoting low-carbon development (LCD), including the Clean Technology Fund, of which the World Bank is trustee, as well as the Global Energy Efficiency and Renewable Energy Fund, established by the European Union. At the same time, the Nigerian Policy Framework to support and promote low-carbon development has been evolving, partly in response to international obligations and incentives, and partly due to internal drivers, such as the need to develop more options for power generation.

Aligning investments towards climate friendly operations with an end view of LEDS alone will not transform Nigeria’s oil and gas sector for climate mitigation or support pro-poor development. More traditional economic incentives are required to attract investments into the sector such as; enforce efficiency measures, establish sustainable tariff practices, demonstrate feasibility of gas transitioning, and ensure sustainable use of gas reserve with zero flaring on the long run.

Chapter Two

2.0 Scope, Data Inputs and Scenarios

2.1. Scope of Work

For the IFF report of the Oil & Gas sector, the following areas and mitigation actions in line with the government’s policies and sectoral plan have been identified as the focal actions (mitigation pathways) within the upstream, midstream, and downstream:

- Gas flare reduction and commercialization projects which focus on all actions implemented, on-going or planned to include the National Gas Flare Commercialization programme.
- Gas pipeline projects to increase the gas utilization capacity of the country in line with the government’s policy of a gas-driven energy sector and introduction of Leak Detection and Repair Programme that will check and reduce fugitive methane along the pipeline value chain.
- LNG/LPG/CNG Expansion and Utilization Programme under the fuel switch campaign of the government which is expected to see a switch from high carbon fuel to natural gas utilization for cooking, power generation, and industries and in the auto industry.
- Refinery efficiency and bio-ethanol blending focuses on government program which task the need to ensure optimization of refineries and reduction of losses as well as blending of bioethanol with the petroleum product to ensure consumption of low

carbon Petrol motor spirit and Automotive Gas Oil (AGO also known as diesel), which are the most consumed petroleum product in the country.

2.2 Data Input and Scenarios

2.2.1 ASSESSMENT PERIOD AND COST ACCOUNTING PARAMETERS

The overall assessment period between 2013 – 2030; with two years historical period from 2013 - 2014, a baseline (2015) and a fifteen-year projection of 2016 – 2030.

In the utilization of the currency in the exercise, the Nigerian Naira (NGN) was converted to constant 2015 USD. The central bank policy rate of 9.0 per cent is used to compute the Net Present Value. The average exchange rate of \$1=197.8763NGN i.e. N197.88 approximately taken from the Central Bank of Nigeria Annual Reports. Based on expert understanding of the industry and cross-references with best practices in the industry on a local and international basis, a margin was built to account for the peculiarities in Nigeria’s capex and opex as explained in the Table 2 below:

Table 2: Assumptions on Cost Accounting Parameters for IF, FF and O&M

Measures	Investment Flows	Financial Flows	Operations & Maintenance
Gas Flare Reduction and Commercialization	70-85% of the cost to be spent on gas process and treatment equipment as well as gas pipelines to connect domestic gas grid	1-5% of the cost will be on capacity building, training, awareness programme, bidding and tendering processes and publicity of the gas flare commercialization programme	This is 20 – 25% of the cost spent on operations and maintenance of the facilities. This includes cost on human and material resources.
Gas Pipeline Projects	70-90% of the cost to be spent on right of way, pipelines, gas processing plants, gas treatment equipment as well as gas pipelines that is the main trunk of pipeline transmitting gas inter-state.	2-5% of the cost will be on capacity building and training on activities such as leak detection and repairs, bidding and tendering processes for companies that will implement projects	This is 10 – 25% of the cost shall be spent on operations and maintenance of the facilities. This includes cost on human and material resources.
LPG/LNG/CNG	70-75% of the cost is to be spent on complete set of CNG, LPG and Mini LNG plant equipment for domestic consumption in the country. Except for LPG, others are already in place and it is just for expansion purposes	2-5% of the cost will be on capacity building, training, awareness programme, bidding and tendering processes and publicity of the fuel switch programme of the national government	This is 20 – 25% of the cost spent on operations and maintenance of the facilities. This includes cost on human and material resources inclusive of feedstock for the plants.
Refinery & Blending	70-80% of the cost is to be spent on refineries, ethanol plant and blending facilities. This cost will include efficient modular refineries, blending facility based on 10% blending of ethanol with PMS that should be in place by 2030	2-5% of the cost will be on capacity building, training, awareness programme, bidding and tendering processes and publicity of the gas flare commercialization programme.	This is 20 – 25% of the cost spent on operations and maintenance of the facilities. This includes cost on human and material resources.

2.2.2 ACTUAL DATA COLLECTED FROM ENTITIES - INDIVIDUAL, GOVERNMENT, PRIVATE SECTOR

Capital Expenditure (CAPEX) on total oil and gas production, oil and gas export, petroleum products imports, gas flared, oil spills, penalties for flared gas, gas utilized for enhanced oil recovery (EOR), total number of petrol stations, total number of depots, consumption of petroleum products, consumption of Liquefied Petroleum Gas (LPG), gas utilized by Industries, gas utilized for power generation, LPG production facilities, LPG distribution facilities, refineries, Petrochemical plants, fertilizer plants, etc. Proposed/targeted investments (estimates in dollars) in Refineries, Gas drilling for power generation and industrialization, pipeline

infrastructural development, Gas distribution facilities, LPG Production Facilities, LPG distribution facilities, gas flare-out activities (gas commercialization), Petrochemical plants, fertilizer plants and any mitigated efforts to reduce carbon emissions.

Operation & Maintenance (OPEX) costs include the following categories of costs:

- Salaries or wages of personnel.
- Fuel costs such as power and/or fuel for operations, fuel for production.
- Public utilities such as telephone service, Internet connectivity, etc.
- Raw materials.
- Maintenance and/or leasing of equipment.
- Office supplies and consumables.
- Advertising.
- License or equivalent fees (such as corporation yearly registration fees) imposed by a FGN.
- Real estate expenses, including rent or lease payments, office space, furniture and equipment, property taxes and equivalent assessments.
- Operations fees, such as fees assessed on transportation carriers for use of highways, and production or operation fees, such as subsidence fees imposed on oil wells.
- Insurance
- Damage due to uninsured losses, accident, sabotage, negligence, or terrorism.

2.2.3 APPROACH TO DATA GATHERING AND ANALYSIS

The Nigeria Oil and Gas Industry is one of the key sources of income for the country which makes it easier to cross check some of the data either received directly or indirectly from the Industry experts. The pathway for data collection principally includes use of O&G data based on available public pronouncement from government and private based institutions via their official website or news publications of key industry actors such as the state-owned National Oil Company - NNPC, DPR, IOCs in Nigeria, DOCs, use of estimates based on prior experience working with operators in the industry and available international cost with adjustment by a margin to reflect peculiarity of the oil and gas industry in country.

2.2.4 APPROACH TO MODELING

The model was developed in line with the principal mitigation sources highlighted in the NDC implementation action plan for the oil and gas sector. It should be noted that adaptation is not considered under the Oil & Gas Sector. The cost of implementing projects in Nigeria are usually far higher than what is obtainable in almost all oil producing countries due to the security challenge in the region where predominantly the resources are situated in the country. Albeit the security issue is getting better, the perception has not necessarily changed hence the exorbitant daily rates of the experts in and high costs of deploying equipment and resources. For example, the cost of crude production in some countries is about \$40 - \$50 per barrel though shale oil extraction is much higher from about \$25 per barrel. In the United Kingdom, it costs \$52.50 to produce a barrel of oil; production in Brazil costs nearly \$49 per barrel; Canada is about \$41 a barrel and the USA produces at average of \$36 a barrel. However, in middleeastern countries like Saudi Arabia and UAE production costs of production is between \$4 at \$5 per barrel, whereas in Nigeria cost of production ranges from \$15 - \$17 per barrel.^{xiii} This perspective is expected to guide the appraisal of some of the figures in the IFF data sheet.

Actual investment on assets for mitigation project could span up to the year of project implementation. However, it is often based on the premise that a higher percentage of these investment occurs at early stage of the project. Since a gas project takes an average 18 months to 3 years to execute, this was factored in and used as a benchmark for project whose completion date is known but actual conception and project start date is unknown in the model.

While there is an overlap as to what is to be considered as mitigation action for the oil and gas and other relevant sectors, mitigation activities that are power related, which fall under this category has been included under O&G mitigation activities. For example, power plant built and managed within the project boundary of an oil and gas operator, for the purpose of articulating mitigation activities in the sector.

However, it is imperative to note that while it could be difficult obtaining data on mitigation activities, especially on financials. It could be very challenging in the oil and gas industry due to the non-disclosure agreement most operators have with their respective partners, for the purpose of this study, this gap has been handle using the most relevant and reliable data available in the public

domain. In cases where the values for capital investment is not available, proxy based on our experience working with certain operators was adopted.

2.2.5 HISTORICAL IF, FF, AND O&M DATA AND SUBSIDIES

A two-year historical period (2013-2014) was adopted to show a trend in IF, FF and O&M cost flow from which possible predictable scenarios were assumed. Relevant activities that took place in the previous years were only highlighted for more clarity. Data availabilities remain a major hitch hence while the IF of most of the projects in the model sheet is referenceable, the FF and O&M are mostly based on assumptions except in instances where the values are available.

Subsidies: subsidies were not captured for the selected scopes as this is not applicable for the upstream and midstream activities. The downstream is also not applicable because the subsidy is reflective on the consumer side and as such it is better to capture this under the transport sector. In the downstream, the cost of fuel production at the refinery is fully reflective and the differential cost on production is passed on through the marketers and benefitted by the consumers.

While developing countries like Nigeria are eligible for financial assistance and technology transfer to support national actions for mitigation and adaptation purposes, successful implementation of national mitigation actions in the sector are strongly linked to domestic reform processes, such as gas flaring, power sector reforms, transportation and agricultural policies. So far, several incentives have emerged such as the Convention, the Protocol and other international institutions providing financial resources for low-carbon development projects^{xiv}. Some of these financing mechanisms include:

The Clean Development Mechanism (CDM) is expected to be a source of investment finance for low-carbon development in Nigeria. As of June 2020, among the 11 large and scale projects in Nigeria registered with the CDM Executive Board¹ four are based on the recovery and conversion of associated gas. Should the carbon market had remained at the prices prior to 2010, these projects have the potential to generate significant worth of revenue annually. The CDM covers the additional cost that these low carbon projects may face as a result of technology, policy or market risks. These portfolios of projects could have generated more revenues in the country for lower carbon energy sources such as gas when expanded. While the carbon prices nosedived prior to the Paris agreement, with the NDC in place, new market mechanisms are expected, and the carbon prices are gradually picking up which is expected to drive clean energy project development.

Table 3: Projects in Nigeria registered by the CDM Executive Board (as at June, 2020)

Category	Project	Reductions
Oil field flaring reduction	Recovery of associated gas that would otherwise be flared at Kwale oil-gas processing plant, Nigeria	1,496,934
Oil field flaring reduction	Pan Ocean Gas Utilization project	2,626,735
Energy efficiency in households	Efficient Fuel Wood Stoves for Nigeria	31,309
Oil field flaring reduction	Recovery and Marketing of gas that would otherwise be flared at the Asuokpu/ Umutu Marginal Field	256,793
Land Fill Gas	Municipal Solid Waste (MSW) Composting Project in Ikorodu, Lagos State	281,781
Land Fill Gas	LFG Project in Nigeria	129,932
Energy Efficiency in power sector	Afam Combined Cycle Gas Turbine Power Project	550,234
Fuel switch in Industry	Lafarge WAPCO Partial Substitution of Alternative Fuels in Cement Facilities Project in Nigeria	166,557
Oil field flaring reduction	Recovery and Utilization of Associated Gas from the Obodugwa and neighbouring oil fields in Nigeria	288,147
Energy Efficiency in power sector	Kainji Hydropower Rehabilitation Project, Nigeria	873,474
Energy Efficiency in power sector	OML 58 IPP Gas Fired Generation project	264,994

¹ The executive board is a responsible UN body for the international approval of CDM projects.

Gas-to-Power: A number of independent power projects (IPPs) comprised mostly of foreign firms, were initiated² such as four independent power plants of Energy Company Nigeria Plc (ENCON) - fully operational.^{xv} The plants include a 10MW gas-fired Industrial plant in Ikorodu, a Unipower 6MW gas-fired reciprocating power plant, a 3MW gas-fired inside-the-fence power plant and a 1.32MW gas-fired captive power plant in Ilupeju, all in Lagos. Although Exxon Mobil established a 500MW IPP at Akwa Ibom State,^{xvi} it has reached commercial terms with Qua Iboe Power Plant Limited (QIPPL) for the transfer of ownership of the Qua Iboe power project and the supply of gas from the NNPC/MPN joint venture offshore facilities to the power plant^{xvii}. In addition, the Okpai Power Plant built by Nigerian Agip Oil Company (NAOC) is functioning at full capacity and sends 480MW to the national grid.^{xviii} The Afam Integrated Gas and Power Project by Shell Petroleum Development Company (SPDC) is designed to provide 650MW to the national grid. large-scale gas projects are intended to displace the ubiquitous use of diesel power generation. As part of the SUNGAS project in the Niger Delta, the Living Earth Foundation is partnering with Shell Petroleum Development Corporation (SPDC) to set up a community-based utility delivering power to a community in the Niger Delta using associated gas.^{xix}

Biofuels: The Nigerian government is piloting large-scale biofuel production for use in automobiles, generators, and for bio-gas production. The Nigerian National Petroleum Corporation (NNPC) received a grant of €70,000 from the Renewable Energy and Energy Efficiency Partnership (REEEP) to support a detailed feasibility study into high ethanol-yielding cassava varieties and other biofuel feedstocks for production of two types of automotive fuel: ethanol fuel and palm oil diesel.^{xx} The Corporation has also initiated three sugarcane-to-ethanol projects, two cassava-to-ethanol projects and two oil palm-to-biodiesel projects in addition to five feasibility studies^{xxi}. Tens of millions of dollars have since been spent on Nigeria's biofuels programme led by the NNPC with very little sustainable biofuels produced.

Energy Efficiency: Oando has launched its O-Gas 3kg liquefied petroleum gas (LPG) stoves projects such as "TEEN Can Cook Initiatives", 'Clean Cook Fund Initiatives Limited (CCFL)'^{xxii} among others while exploring possibilities of tapping into the carbon market to bring down the cost of the stoves.^{xxiii} Techno Oil like Oando is carrying out a project tagged 'Going Green Revolution'. The project has so far deployed over 20,000 gas cylinders of 3kg, 5kg and 12.5kg at a discounted price to stimulate local consumption and allow poor families to access liquid petroleum gas (LPG).^{xxiv}

These historical climate and non-climate actions above, though not captured in Table 4 and Table 5 respectively buttresses that these actions have been in place before Nigeria officially signed the Paris Agreement, thereby taking on the responsibility of ensuring the delivery of its National Commitments. So far, Table 4 shows that no investments have been recorded in the household while total investments within gas flare activities is \$757.33 with a financial flow and O&M of \$0.81 and \$340.81. Nigeria flared the associated gas as there were no plans to utilize the gas during oil production.

HKK Demand: Household kerosene has been one of the most demanded fuel after PMS because of its diverse use. In the last 20 years, statistics revealed the increasing demand of this product. However, with the new technology and capacity development which has caused an increase in gas production, demand for HKK began to decline at a geometric rate because subsidies were removed thus pushing many in urban and rural areas to shift to the use of LPG to save costs; as well as being a less hazardous option for in terms of fire outbreak. Therefore, demand of kerosene is reducing at a geometric progression. Arguably, HKK will still be in demand for several reasons, some of which are its use as an alternative fuel, geographical location, and old habits.

Projections have however been made on the above assumptions that in the next 5 years the demand for HKK will decrease noticeably by 18% after which decline in demand will be subtle in proceeding years.

Table 4: BAU Historical IF, FF, and O&M Cost in million 2015USD (2013 -2014)

Annual Total IF, FF, O&M costs by Investment types/entity												
Investment Entity Category	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
Household	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corporations	6.00	0.00	4.00	0.00	0.00	0.00	200.00	4.00	50.00	0.00	0.00	0.00

² IPPs are granted permits by the legislation build their own decentralised power plants; it can be partnerships between the private sector and federal or local government.

Government	4.00	0.00	0.00	550.00	0.00	225.00	0.00	0.00	0.00	858.13	4.00	379.06
Total	10.00	0.00	4.00	550.00	0.00	225.00	200.00	4.00	50.00	858.13	4.00	379.06

Table 5: Climate Friendly Investments for Historical IF, FF, and O&M Cost by Investment types/entities in million 2015USD (2013 - 2014)

<i>Annual Total IF, FF, O&M costs by Investment types/entity</i>												
Investment Entity Category	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
Household	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corporations	77.33	0.81	0.41	0.00	0.00	0.00	200.00	4.00	50.00	0.00	0.00	0.00
Government	680.00	0.00	340.00	550.00	0.00	225.00	0.00	0.00	0.00	858.13	4.00	379.06
Total	757.33	0.81	340.81	550.00	0.00	225.00	200.00	4.00	50.00	858.13	4.00	379.06

Source: Authors' compilation

Table 6: BAU Historical IF, FF, O&M Costs by Investment Types (million 2015USD)

Historical IF, FF, O&M Costs by Investment Types												
Year	GFU			GPP			GSA (LPG, CNG & LNG)			R&B		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2013	5.00	0.00	0.02	450.00	0.00	112.50	100.00	2.00	25.00	758.13	2.00	189.53
2014	5.00	0.00	0.02	100.00	0.00	112.50	100.00	2.00	25.00	100.00	2.00	189.53
Total	10.00	0.00	0.04	550.00	0.00	225.00	200.00	4.00	50.00	858.13	4.00	379.06

Table 7: Annual Climate Friendly Investments for Historical IF, FF, O&M Costs by Investment Types (million 2015USD)

Historical IF, FF, O&M Costs by Investment Types												
Year	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2013	724.18	8.82	170.00	450.00	0.00	112.50	100.00	2.00	25.00	758.13	2.00	189.53
2014	373.15	8.33	170.41	100	0.00	112.50	100.00	2.00	25.00	100.00	2.00	189.53
Total	1097.33	17.04	340.41	550.00	0.00	225.00	200.00	4.00	50.00	858.13	4.00	379.06

2.2.5.1 EXISTING GAS PIPELINE INFRASTRUCTURE

Table 4 showing lower investments in gas pipeline projects and gas utilization of \$550million and \$200million respectively indicates gross inadequacy and capacity of existing gas pipeline infrastructure to meet the current and projected demand growth. While the connectivity between East and West is an on-going project, the inability to get this completed limits the ability to move gas from the east where there is higher gas reserve concentration to the west with higher gas demand concentration. This infrastructure imbalance limits the flexibility of supply. The on-going new and expansion of gas infrastructure projects need to be delivered speedily to enable most of the power plants to run at full capacity especially the newly built NIPP projects.

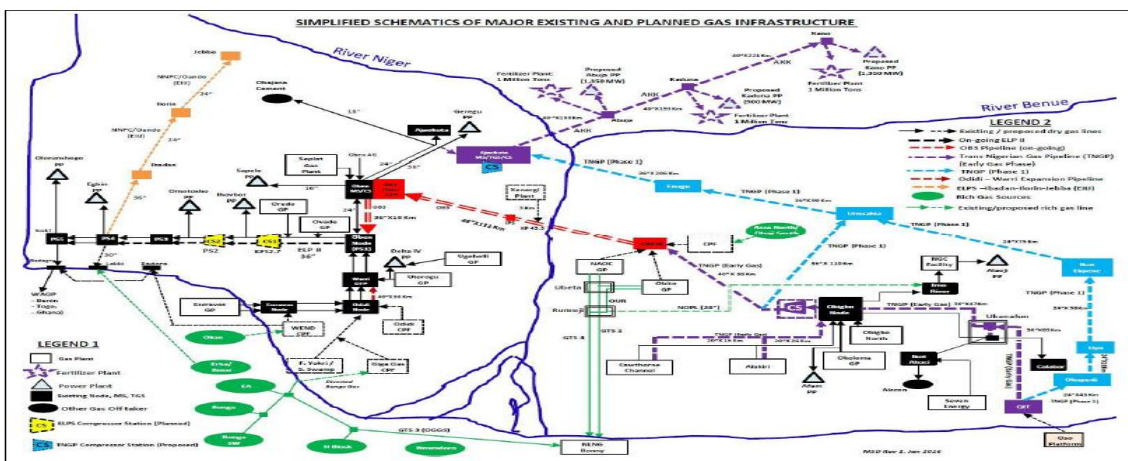
The gas pipeline infrastructure comprises of un-integrated (now in the process of being connected) pipeline networks; Eastern Network Alakiri-Obigbo-Ikot Abasi Pipeline, Western Network Escravos-Lagos Pipeline System (ELPS)^{xxv}, and dedicated pipeline infrastructure

owned by the NLNG and the NNPC/SPDC/Total joint venture (see Figure 2). There are also local distribution companies such as Gaslink Limited (owned by OANDO), Shell Nigeria Gas, Falcon Gaz and few others which distribute natural gas to major industrial areas in the western and eastern parts of Nigeria. Other gas transmission pipelines are privately owned by: Seven Energy (including Eastern Horizon Network (built by OANDO now owned by Seven Energy) and pipelines owned by the IOCs connecting their fields to facilities and pipelines to the Bonny LNG facility and in some cases to specific end-users (see Figure 3).

With 85% of power generation infrastructure running mainly on natural gas, gas infrastructure plays a leading role to achieving energy security in the country. The major stakeholder in pipeline infrastructure development is NNPC's gas subsidiary (NGC). While no longer a monopoly, NGC is responsible for the largest share of gas transmission in Nigeria through a gas pipeline transmission network. It currently operates gas facilities comprising of over 1,250 kilometres of pipelines with an over-all design capacity of more than 2.5 billion standard cubic feet of gas per day, 16 compressor stations and 18 metering stations^{xxvi}.

Other key players include the IOCs, Oando, Seplat and Seven Energy and importantly Dangote is entering this sector.

Figure 2: Gas Pipeline Network in Nigeria



Source: Fichtner, 2017

Eastern Network: The Alakiri - Obigbo – Ikot Abasi Pipeline (the Eastern Network) supplies all power stations in the eastern axis of the country. The Eastern network is supplied by various sources of gas in the Rivers/Bayelsa state region which include Okoloma, Alakiri, Obigbo, Obiafu/Obrikom and Imo river.

Western Network: The ELPS I, a 560km pipeline transports gas from fields in the Niger Delta to Lagos, Nigeria's commercial center, and then spurs at Lagos on to the West African Gas Pipeline (WAGP), which was developed by the NNPC, Chevron, Shell and the governments of Nigeria, Ghana, Togo and Benin. Nigeria began exporting some of its natural gas via the 420-mile West African Gas Pipeline (WAGP) in 2010 to Ghana via Togo and Benin. The Western network is supplied by various sources of gas in the Delta state region which include Utorogu, Oben, Sapele, Ughelli east, Chevron Phase I and II, Panocean and NPDC.

Gas Link and Falcon gas: The current utilized capacity for Gaslink is 68mmscf/d but has the capacity to supply up to 100mmscf/d. Falcon gas with franchise to supply gas around the Ikorodu areas of Lagos state has 25mmscf/d capacity. The gas source to the two gas distributors comes from the ELPS 1.

Seven Energy³ (Accugas Pipeline Network): Seven Energy through its special project company, Accugas has built a pipeline from its Uquo field in Akwa Ibom and connected two power plants (Ibom power at Akwa Ibom and Calabar power plant in Cross Rivers. State. They have also purchased the Oando Eastern Horizon company gas pipeline and now owns a circular grid network covering Akwa Ibom and Cross rivers state.

Figure 3: Seven Energy Infrastructure in the South-southern Region

³ Seven Energy went into insolvency and most of its assets were bought by Savannah Energy. <http://www.sevenenergy.com/media/news-and-announcements/2019/13-02-2019>



Source: Seven Energy^{xxvii}

2.2.5.2 EXISTING GAS SUPPLY

Existing gas supply to the domestic market in the mid-term is basically from the onshore and the near offshore. Gas from the deeper offshore is not yet part of the domestic market. There are four principal categories of companies:

1. **IOCs (JV Partners):** produces the largest quantity of AG and export some of the gas to international markets. It should be stressed that the gas exported far exceeds gas consumed by the domestic market as shown in the Figure 3. Shell, Total, and ENI have access to Bonny LNG. Chevron produces significant gas that is sent through the ELPS for Western domestic consumption and for the West African Gas market. ExxonMobil is basically absent but recently got involved in a gas supply agreement for the planned Qua Iboe IPP and has a share in SNEPCO.
2. **Nigeria LNG Limited** is the most significant arrow-head of the federal government’s quest to eliminate gas flaring and derive value from the country’s 187 trillion cubic feet of proven gas reserves. NLNG has converted about 119 bscm (billion standards cubic metres) or 4.2 Tcf (trillion cubic feet) of AG to exports as LNG and Natural Gas Liquids (NGLs), thus helping to reduce gas flaring by Upstream Companies from over 60% to less than 25%. Operational flares are only permitted to eliminate waste gas that cannot be converted to any further use. Flares also act as safety systems for non-waste gas and are released via pressure relief valves, when required, to ease the strain on equipment.
3. **Domestic Oil Companies (DOCs):** These companies provide part of the gas supply albeit smaller to the IOCs. With more of the onshore fields been taken over by the DOCs, more gas volumes are expected from the DOCs. Some of the DOCs are also JV partners.
4. **NPDC (NNPC):** NPDC represents the interest of government directly in the O&G as a subsidiary of NNPC.
5. **Independents:** These companies are not under domestic gas obligation but for commercial reasons, they also seek to supply gas to the domestic market.

2.2.6 BASELINE SCENARIO OR BUSINESS AS USUAL (BAU) SCENARIO

- a. **Gas Flare Utilization (GFU):** This includes all gas flare reduction projects including the National Gas Flare Commercialization programme. The O&G stakeholders would rather continue to flare as basic infrastructure to reduce the overhead cost of gas utilization projects are either not available or far from oil fields location. However, lack of regulation or policy geared towards flare reduction with incentives for industry players will be a tall order as these players would prefer, hence continue to flare and pay the flare penalty. The data analysis from this approach have only indicated costs for installing flare meters by either new players or replacements of old ones. The flare fines are also captured as part of the costs that would have been incurred and so this is trajectory from the historical trends for some players who had been flaring in the past. It is however assumed that the flaring and associated investments will naturally decline from \$5.5million to \$2.5million within 2021 - 2030 (see Table 3) based on traditional industry practice as it is clear that new players would have been mandated to submit flare utilization plan before operating. This therefore suggests that the old flares would have been the only gas flares.
- b. **Gas Pipeline Projects (GPP):** These are gas pipeline projects which will lead to developing gas fields and production of gas for power generation, industries and for LNG, LPG, and CNG production; an industrial shift from crude oil and derivatives to natural gas utilization. The activities under GPP are the harbinger for the development of the LPG & LNG project in the category below. Some pipelines are currently being built in the country for example the second Escravos – Lagos pipeline system (ELPS - 2) and

the Oben –Obiafu-Obrikom (OB3) pipeline which are both enough to meet the gas requirements to more than double the capacity of power generation currently in the country. Table 9 shows that investments in gas pipeline projects will peak at 2023 as projected at a discounted cost of \$92.09million with a total projected annual cost of about \$906.95 which will improve gas infrastructural development and ease of access to gas for utilization. Although completed and running projects featured under the baseline scenario includes the two projects under implementation before 2015, ELPS-2 and OB-3 with increase gas distribution flow. The new pipelines planned include the Ajaokuta-Kaduna-Kano (AKK) pipeline and the Trans Sahara Gas pipeline which is expected to continue from Kano to North Africa. When all these pipelines are completed, the transmission capacity across the nation is expected to be between 7.5- 10bcfpd.

- c. GAS (LNG/LPG/CNG) Projects: This category is based on FGN’s plan to domesticate a wider use of LPG predominantly for cooking, industries, power generation, automobiles through policies such as the auto gas, LPG programme, distributed generation, micro and off-grid power generation regulations of the government. Under this scenario, it is assumed that it is only the project conceived prior to 2015 would have been implemented regardless. It is important to stress that the traditional trend of consumption of LPG and the Greenville LNG company’s project are those considered under this scenario. Table 8 shows that under BAU, implementation of increased gas utilization shall continue to complete on-going projects such as OB-3 and second ELPS. This is expected to meet the shortfall in consumption in the nearest 5years.
- d. Refining & Blending (R&B): The plan of the government is to achieve self-refining capacity by 2023 using efficient technology, combining both modular and big capacities in the country located in various states in proximity to crude oil or distribution access. This assumes the repair of current refineries, modular refineries and that Dangote refinery would have happened. The emphasis on efficiency of production might not necessarily be the focus. Therefore, all the projects on refineries are considered under this category.

Table 8: Baseline Scenario Cost

Annual total IF, FF, O&M costs by investment types in million 2015 (USD)												
Year	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2015	5	0	0.1	100.00	-	25.00	100.00	2.00	25.00	2,100.00	2.00	689.53
2016	5	0	0.1	100.00	0.00	25.00	100.00	2.00	25.00	2,100.00	2.00	689.53
2017	5	0	0.01	100.00	0.00	25.00	100.00	2.00	25.00	2,100.00	2.00	689.53
2018	5	0	0.01	100.00	0.00	25.00	100.00	2.00	25.00	4,287.00	-	1,189.53
2019	5	0	0.01	100.00	0.00	25.00	100.00	2.00	25.00	6,000.00	-	1,689.53
2020	5	0	0.36	100.00	0.00	26.05	-	-	25.00	-	-	1,389.53
2021	2.5	0	0.33	100.00	0.00	25.34	-	-	25.00	947.66	-	1,436.91
2022	2.5	0	0.31	100.00	0.00	25.79	-	-	25.00	-	-	1,436.91
2023	2.5	0	0.29	200.00	4.00	75.40	-	-	25.00	-	-	836.91
2024	2.5	0	0.28	200.00	4.00	75.88	-	-	25.00	-	-	836.91
2025	2.5	0	0.26	100.00	2.00	50.41	-	-	25.00	947.66	-	536.91
2026	2.5	0	0.25	100.00	0.00	50.68	-	-	25.00	-	-	536.91
2027	2.5	0	0.24	100.00	2.00	50.79	-	-	25.00	-	-	536.91
2028	2.5	0	0.23	100.00	0.00	50.72	-	-	25.00	-	-	300.00

2029	2.5	0	0.22	100.00	0.00	50.75	-	-	25.00	1,137.19	-	584.30
2030	2.5	0	0.21	50.00	0.00	38.18	-	-	25.00	-	-	584.30
Total	55	0	3.21	1750	12	644.99	500	10	400	19,619.51	6	13964.15

Figure 4: Annual Total IF, FF, O&M Cost for individual investment types in million 2015USD

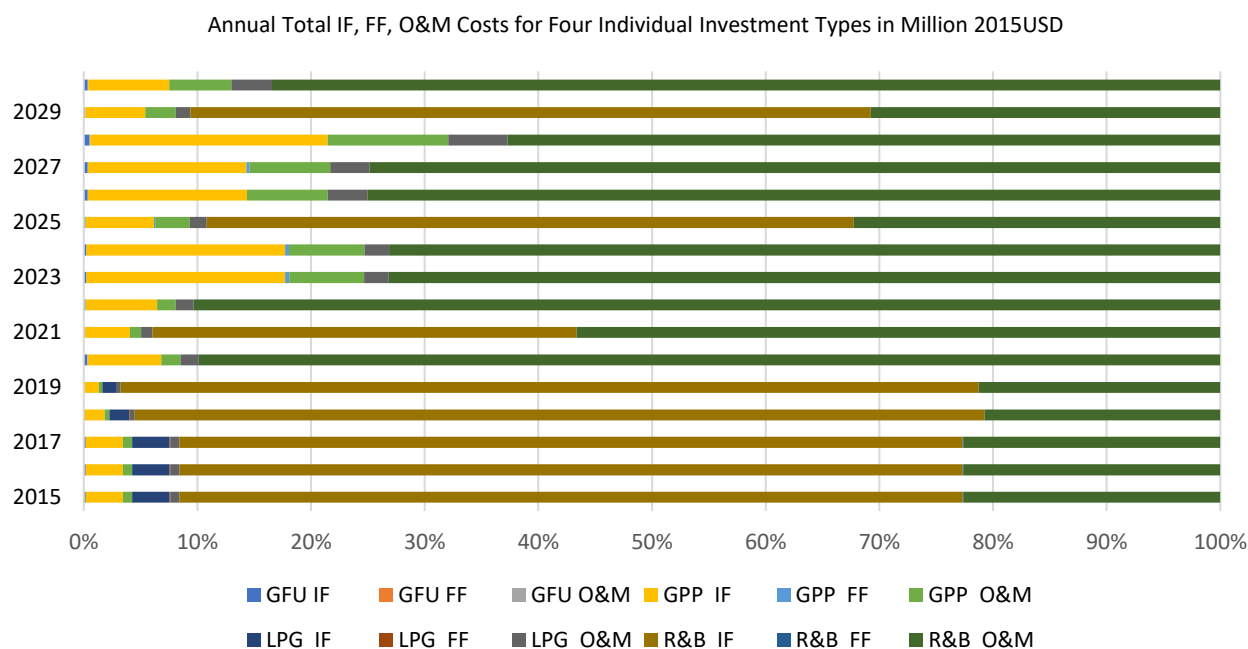


Table 9: BAU Scenario - Discounted Annual Total IF, FF, O&M costs by investment types in million 2015 USD

Year	Discounted Annual Total IF, FF, O&M Costs by Investment Types in million 2015 USD											
	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2015	4.59	0	0.09	91.74	0	22.94	91.74	1.83	22.94	1,926.61	1.83	632.60
2016	4.21	0	0.08	84.17	0	21.04	84.17	1.68	21.04	1,767.53	1.68	580.36
2017	3.86	0	0.01	77.22	0	19.30	77.22	1.54	19.30	1,621.59	1.54	532.44
2018	3.54	0	0.01	70.84	0	17.71	70.84	1.42	17.71	3,037.02	0	842.69
2019	3.25	0	0.01	64.99	0	16.25	64.99	1.30	16.25	3,899.59	0	1098.08
2020	2.98	0	0.21	59.63	0	15.53	0	0	14.91	0.00	0	828.53
2021	1.37	0	0.18	54.70	0	13.86	0	0	13.68	518.40	0	786.04
2022	1.25	0	0.16	50.19	0	12.94	0	0	12.55	0.00	0	721.14
2023	1.15	0	0.13	92.09	1.84	34.72	0	0	11.51	0.00	0	385.34
2024	1.06	0	0.12	84.48	1.69	32.05	0	0	10.56	0.00	0	353.52
2025	0.97	0	0.10	38.75	0.78	19.54	0	0	9.69	367.25	0	208.07
2026	0.89	0	0.09	35.55	0	18.02	0	0	8.89	0.00	0	190.89
2027	0.82	0	0.08	32.62	0.65	16.57	0	0	8.15	0.00	0	175.13
2028	0.75	0	0.07	29.92	0	15.18	0	0	7.48	0.00	0	89.77

2029	0.69	0	0.06	27.45	0	13.93	0	0	6.86	312.20	0	160.41
2030	0.63	0	0.05	12.59	0	9.62	0	0	6.30	0.00	0	147.17
TOTAL	\$32.01	\$0.00	\$1.45	\$906.93	\$4.96	\$299.20	\$388.96	\$7.77	\$207.82	\$13,450.19	\$5.05	\$7,732.18

Total discounted Baseline Scenario Costs (BSC) for IF is \$14,778.1 while accompanying FF and O&M is \$17.8 and \$8240.64

Figure 5: Discounted Annual total IF, FF, O&M costs for four individual investment types in million 2015USD

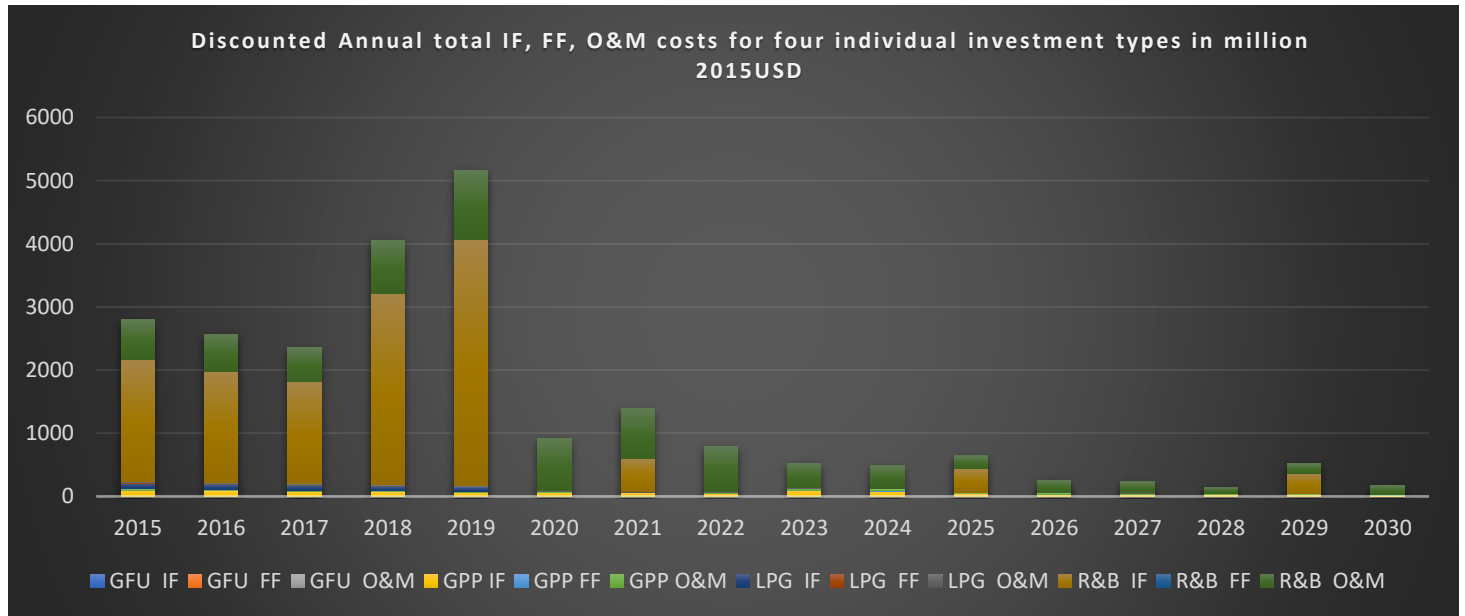


Table 10: BAU Total IF, FF AND O&M Cost by Investment Type/ Entity

BAU Total IF, FF AND O&M Cost by Investment Type/ Entity												
Investment Entity Category	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
Household	0.00	0.00	0.00	0.00	0.00	0.00	32.65	-	25.88	0.00	0.00	0.00
Corporations	1,364.09	43.52	3,995.24	11,000.00	44.00	3,292.50	574.69	5.82	293.54	14,691.38	137.16	25,429.59
Government	525.00	8.00	3,037.90	3,700.00	1.00	3,433.47	719.41	23.58	275.59	4,587.92	6.85	4,866.64
Total	1889.09	51.52	7033.14	14700.00	45.00	6725.97	1326.75	29.4	595.01	19279.3	144.01	30296.23

Table 11: BAU Discounted Total IF, FF AND O&M Cost by Investment Type/ Entity (in million 2015USD)

BAU Discounted Total IF, FF AND O&M Cost by Investment Type/ Entity												
Investment Entity Category	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
	DIF	DFF	DOM	DIF	DFF	DOM	DIF	DFF	DOM	DIF	DFF	DOM
Household	0.00	0.00	0.00	0.00	0.00	0.00	29.95	0.00	23.74	0.00	0.00	0.00
Corporations	1251.46	39.93	3665.36	10091.74	40.37	3020.64	527.24	5.34	269.30	13478.33	125.83	23329.90
Government	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	481.65	7.34	2787.06	3394.50	0.92	3149.97	660.01	21.63	252.83	4209.10	6.28	4464.81

Total	1733.11	47.27	6452.42	13486.24	41.28	6170.61	1217.20	26.97	545.88	17687.43	132.12	27794.71
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Fig 11: BAU Discounted Total IF, FF AND O&M Cost by Investment Type/ Entity (in million 2015USD)

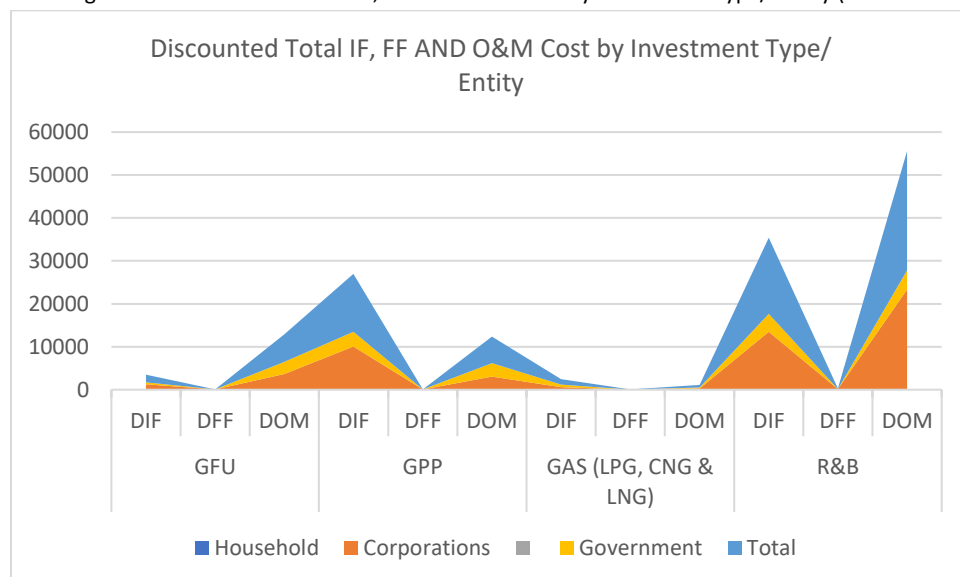


Table 11: 10 YEAR GAS PRODUCTION AND UTILIZATION (bcf)

NNPC Report

YEAR	GAS PRODUCED	GAS USED AS FUEL	GAS SOLD TO THIRD PARTIES	GAS TO NGC	GAS RE-INJECTED	GAS LIFT	FUEL GAS TO EPCL	GAS FOR LPG/NGL/EGTL AS FEEDSTOCK TO EPCL	GAS FOR LNG	TOTAL GAS UTILIZED	GAS FLARED	% FLARED
2009	1,837.28	80.57	440.94	21.02	409.85	55.96	8.09	42.4	269.1	1,327.93	509.35	27.72
2010	2,392.84	72.23	857.23	167.19	21.18	169.06	493.31	5.2	25.87	1,811.27	581.57	24.3
2011	2,400.40	104.54	786.84	101.56	348.33	78.97	9.43	38.61	313.09	1,781.37	619.03	25.79
2012	2,580.17	115.68	875.46	72.17	462.88	72.9	15.37	47.19	329.86	1,991.50	588.67	22.82
2013	2,325.14	128.52	606.54	129.89	638.51	46.9	9.22	56.08	300.88	1,916.53	408.61	17.57
2014	2,485.65	151.14	705.04	178.45	625.59	101.49	11.01	35.81	391.37	2,199.88	285.76	11.5
2015	2,929.85	159.19	1,017.21	133.54	727.46	77.07	10.19	41.91	421.19	2,588.48	341.37	11.65
2016	2,777.79	147.44	431.53	0		747.75		130.69	1,007.91	2,465.32	312.47	11.25
2017	2,901.63	139.44	421.94	0		756.07		106.82	1,119.65	2,543.93	357.7	12.33
2018	2,836.55	134.65	430.21	25.31	760.12			104.76	1,099.42	2,554.47	282.08	9.94
2019	2,950.01	138.55	435.32	30.23	765.16	55.96	8.09	106.8	1,106.52	2,559.50	280.01	9.49

YEAR	GAS PRODUCED	GAS USED AS FUEL	GAS SOLD TO THIRD PARTIES	GAS TO NGC	GAS RE-INJECTED	GAS LIFT	FUEL GAS TO EPCL	GAS FOR LPG/NGL/EGTL AS FEEDSTOCK TO EPCL	GAS FOR LNG	TOTAL GAS UTILIZED	GAS FLARED	% FLARED
2020	3,068.01	140.61	440.25	32.55	770.54	60.25	9.22	108.12	1,115.92	2,563.74	275.22	8.97
2021	3,313.45	145.88	455.94	36.85	775.66	63.28	10.05	110.63	1,120.58	2,755.66	265.55	8.01
2022	3,578.55	150.77	625.96	60.49	800.25	70.35	12.33	120.55	1,130.35	2,802.78	250.47	6.99
2023	3,864.83	155.65	650.33	55.55	815.94	72.55	15.44	125.88	1,138.88	3,150.66	245.24	6.34
2024	4,174.02	160.87	875.46	70.59	825.33	75.24	14.68	126.44	1,145.28	3,555.45	240.44	5.76
2025	4,591.42	170.33	1,255.47	123.87	955.81	136.5	22.55	135.56	1,200.35	3,863.74	235.69	5.13
2026	5,050.56	185.81	1,300.65	135.55	1,000.88	145.77	30.51	145.58	1,255.85	4,356.55	226.44	4.48
2027	5,555.62	190.25	1,350.87	145.55	1,200.22	140.66	42.55	145.55	1,300.33	4,754.69	200.12	3.6
2028	6,111.18	195.55	1,445.38	170.47	1,355.01	150.68	85.66	215.15	1,782.58	5,589.12	200.06	3.27
2029	6,722.29	200.51	1,253.41	168.65	2,557.36	151.85	75.87	200.22	2,284.11	6,288.39	195.35	2.9
2030	7,394.52	225.74	1,280.55	168.8	2,700.25	153.57	76.38	210.85	2,326.54	6,858.21	180.57	2.44

(Considering thread and Government policies; between 2019-2021 projections were made multiplying previous gas production by 1.04, From 2022 - 2025 projection got an increase by 1.08, From 2026- 2030 projection was on increase by 1.1). Source: CLN Analysis.

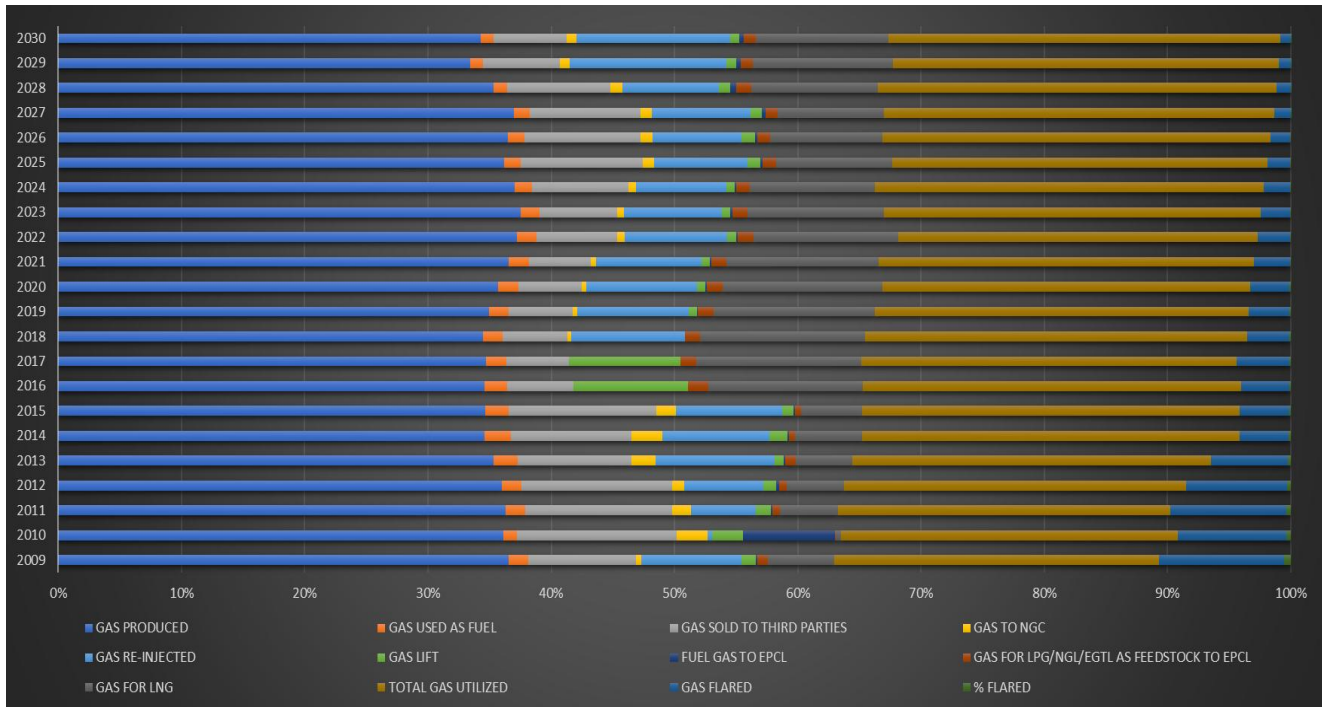


Figure 6: 10 Year Gas Production and Utilization (bcf)

2.2.7 CLIMATE CHANGE SCENARIO OR TARGET SCENARIO

Principal GHG emissions in the sector considered are from gas flaring, fugitive methane emissions, on-site fuel use (upstream and midstream) and on-site fuel use from refineries. The combined contribution of flaring and venting to the environment has been identified to be about 80% of emissions in the sector. The target of reducing flaring down to less than 10% by the year 2020 is obviously not attainable but the prospects of ending it completely by 2030 is a possibility. The sectoral plan noted that eliminating flaring by 2030 could save around 64 million tonnes of CO₂ per year, which also implies large development co-benefits.

Other actions or strategies put in place by the government which is capable of yielding result include the Petroleum Industry Roadmap, Nigeria Gas Masterplan, the '7 Big Wins Roadmap' in the oil and gas sector, the LPG policy and LNG train 7.

- a. Gas Flare Commercialization (GFU): this includes flare utilization projects that were implemented in the past, on-going and those planned. The cost of the projects already implemented and on-going were captured while cost for yet to be implemented projects were captured based on pronouncements by the industry experts under the National Gas Flare Commercialization Programme (NGFCP) or projections based on previously implemented from those known already. This assume that all flare projects will be implemented by 2022 because all the NGFCP projects are to be given to the third-party companies through prequalification process which will imply they need to be implemented quickly as recommended by FMoP & DPR. Gas flaring, which takes place at oil and gas extraction sites (extraction, production, gas processing, and LNG and GTL plants), can be reduced where viable alternative uses for the gas flares can be identified such as the Gas flare commercialization and NLNG projects. Associated Gas could be re- injected either for enhancement of oil recovery or purely for disposal/storage; used for heating on-site operations; power generation either for large scale with electricity delivered to the national grid or on a small-scale electricity to local communities; supplies to LNG and GTL plants; supplies to domestic industry; and also export via the West Africa Gas Pipeline. Extraction of natural gas liquids (LPGs) for sale can be deployed to reduce gas volumes flared, even where no viable use for the dry gas is available. Although bulk of gas flaring can be reduced by using the gas as described above, some flaring will always continue primarily for safety reasons. These smaller but significant emissions can be reduced by redesigning the flare itself to remove the need for pilot flames and to improve combustion efficiency.
- b. Gas Pipeline Projects (GPP): The country has an aggressive ambition to drive the economy using a cleaner form of energy--gas. Several pipeline projects are being initiated to drive the supply of gas throughout the nation. Prominent among these projects are; the Ajaokuta-Kano-Kaduna (AKK) pipeline, Trans Sahara gas (TSGP) pipeline that will further move it beyond Kano to some other northern states before it is extended beyond Nigeria to North Africa and beyond as well as the East-West Offshore Gas Gathering System (EWOGGOS) pipeline network which is expected to double the capacity of gas supply to the western region when completed. These are the pipelines considered under this category.
- c. Liquefied Petroleum Gas Projects (LPG/CNG/LNG): The use of LNG internally in the country especially in areas where there is no gas pipelines or gas capacity of pipelines is not sufficient to meet demand especially in locations like Lagos, Port Harcourt, Ogun, Kaduna, Kano, Sokoto, Gombe etc. The goal is such that the LNG project of Greenville and proposed LPG project that will see the

country consume annually 5 million tonnes in the next 5 years. This is projected further to 7.5 million tonnes by 2030 and industry price of similar project was used to estimate the cost for a capacity expected of Nigeria by 2030.

- d. Refining & Blending (R&B): This focused majorly on the government's policy to reduce the carbon content of fossil fuel consumed by automobiles which is the driver for the blending of fossil fuel with bioethanol. Under this category, the pronouncement of need for a 30 billion litres per annum capacity of bioethanol by 2030 is therefore considered.
- e. Other mitigation activities not included directly is the methane emission reduction activities which is expected to be addressed in all the categories particularly where methane emissions are susceptible. Methane emissions are variable and depends largely on so many factors which include maintenance practices, age of equipment and operational practices. The cost is therefore subsumed in the best practices' operations expected under the climate actions stated above. The emission reductions are however stated under the GPP where about 80% of the emissions are likely to occur.

Table 123: CCS Scenario - Annual Total IF, FF and O&M Cost by Investment Type and Carbon Equivalent Reduced (million 2015USD)

Year	GFU			CO ₂ (t CO ₂ e)	GPP			CO ₂ (t CO ₂ e)	GAS (LPG, CNG & LNG)			CO ₂ (t CO ₂ e)	R&B			CO ₂ (t CO ₂ e)
	IF	FF	O&M		IF	FF	O&M		IF	FF	O&M		IF	FF	O&M	
2015	423.80	-	171.66	2.07	100.00	-	112.50	-	100.00	0.00	25.00		100.00	2.00	189.53	
2016	283.50	-	171.66	2.66	100.00	-	112.50	-	100.00	0.00	25.00		100.00	2.00	189.53	
2017	273.40	11.72	11.72	3.06	100.00	-	25.00	-	100.00	2.00	25.00		2,100.00	22.00	689.53	
2018	234.40	11.72	11.72	3.06	100.00	-	25.00	-	100.00	2.00	25.00		4,287.00	40.00	1,236.28	
2019	137.77	5.86	5.86	6.58	100.00	-	26.05	-	100.00	2.00	25.00	0.03	6,000.00	60.00	1,689.53	
2020	116.22	0.00	0.00	6.31	450.00	5.00	112.84	-	52.94	-	38.24	0.23	-	-	3,189.53	
2021	420.00	0.00	0.00	8.80	950.00	2.00	263.29	8.96	94.12	-	48.53	0.36	1,131.66	-	3,282.91	
2022	0.00	0.00	0.00	8.80	1,900.00	2.00	500.40	13.38	58.82	2.94	39.71	0.51	655.25	5.63	3,400.73	4.25
2023	0.00	0.00	0.00	8.80	1,900.00	2.00	500.88	16.53	58.82	2.94	39.71	0.64	468.25	5.63	1,853.98	4.34
2024	0.00	0.00	0.00	8.80	1,850.00	7.00	787.91	24.80	117.65	5.88	54.41	0.78	1,489.66	4.50	1,872.41	4.38
2025	0.00	0.00	0.00	8.80	1,850.00	7.00	788.48	26.87	117.65	5.88	25.00	0.85	1,152.16	2.25	1,038.04	4.43
2026	0.00	0.00	0.00	12.37	1,850.00	2.00	788.29	33.07	58.82	2.94	39.71	0.85	-	-	2,386.91	4.47
2027	0.00	0.00	0.00	12.37	1,550.00	6.00	713.22	33.07	58.82	2.94	39.71	0.92	-	-	2,386.91	4.43
2028	0.00	0.00	0.00	11.58	800.00	6.00	713.25	35.82	58.82	2.94	39.71	0.92	-	-	2,296.80	4.38
2029	0.00	0.00	0.00	11.58	800.00	3.00	713.18	42.52	58.82	2.94	39.71	0.92	1,137.19	-	2,296.80	4.34
2030	0.00	0.00	0.00	11.58	300.00	3.00	543.63	46.06	58.82	2.94	39.71	0.95	-	-	2,296.80	4.29
Total	1889.09	29.3	372.62	122	14700	45.00	6726.40	281	1294.10	38.40	569.10	8	18621.2	144.0	30296.2	39

Figure 7: Annual Total IF, FF and O&M Cost by Investment Type

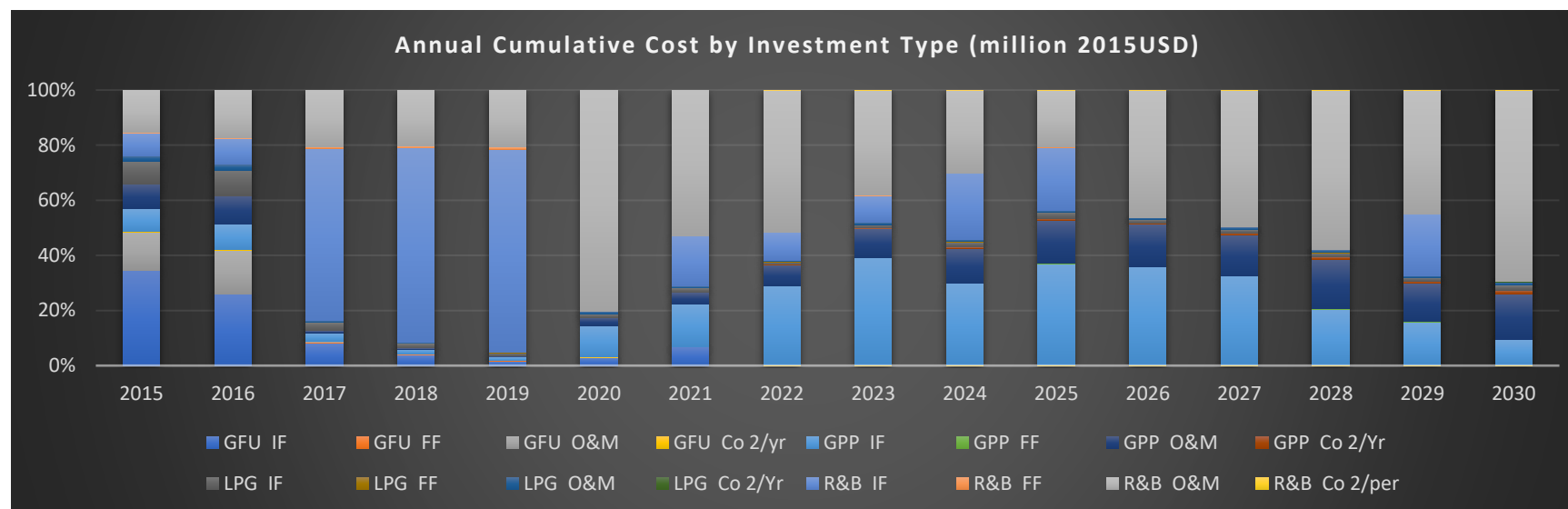


Table 134: CCS - Cumulative Annual Total IF, FF & O&M Estimates by Investment Type and Entity (in million 2015USD)

Investment Entity Category	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
Household	-	-	-	-	-	-	53.97	53.97	55.96	-	-	-
Corporation	4,983.81	4,560.01	4,920.36	14,116.00	14,119.00	14,336.50	862.15	762.15	774.06	38,305.85	40,258.13	40,258.13
Government	2,550.00	2,550.00	2,720.00	6,808.79	6,708.79	7,034.92	684.91	684.91	712.71	7,321.56	7,566.08	7,564.08
Total Funding Sources	7533.81	7110.01	7640.36	20924.00	20827.79	21371.42	1601.03	1501.03	1542.73	45627.41	47824.21	47822.21

Figure 8: Total IF, FF & O&M by Investment Type

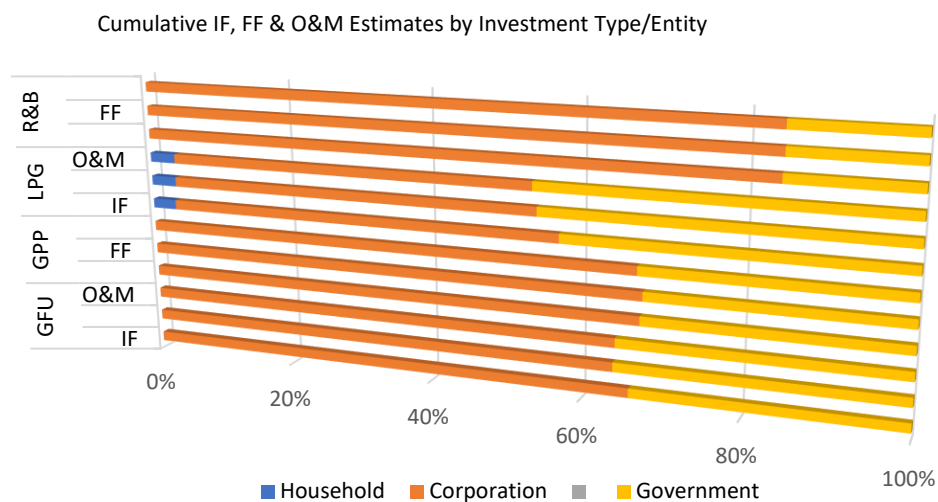


Table 145: CCS - Cumulative Annual Total Discounted IF, FF & O&M Estimates by Investment Type and Entity (in million 2015USD)

Investment Entity Category	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
Household	0.00	0.00	0.00	0.00	0.00	0.00	49.51	49.51	51.34	0.00	0.00	0.00
Corporation	4572.30	4183.50	4514.09	12950.46	12953.21	13152.75	790.96	699.22	710.15	35142.98	36934.06	36934.06
Government	2339.45	2339.45	2495.41	6246.60	6154.85	6454.06	628.36	628.36	653.86	6717.03	6941.36	6939.52
Total Funding Sources	6911.75	6522.94	7009.50	19196.33	19108.06	19606.81	1468.83	1377.09	1415.35	41860.01	43875.42	43873.59

Figure 9: CCS - Cumulative Annual Total Discounted IF, FF & O&M Estimates by Investment Type and Entity (in million 2015USD)

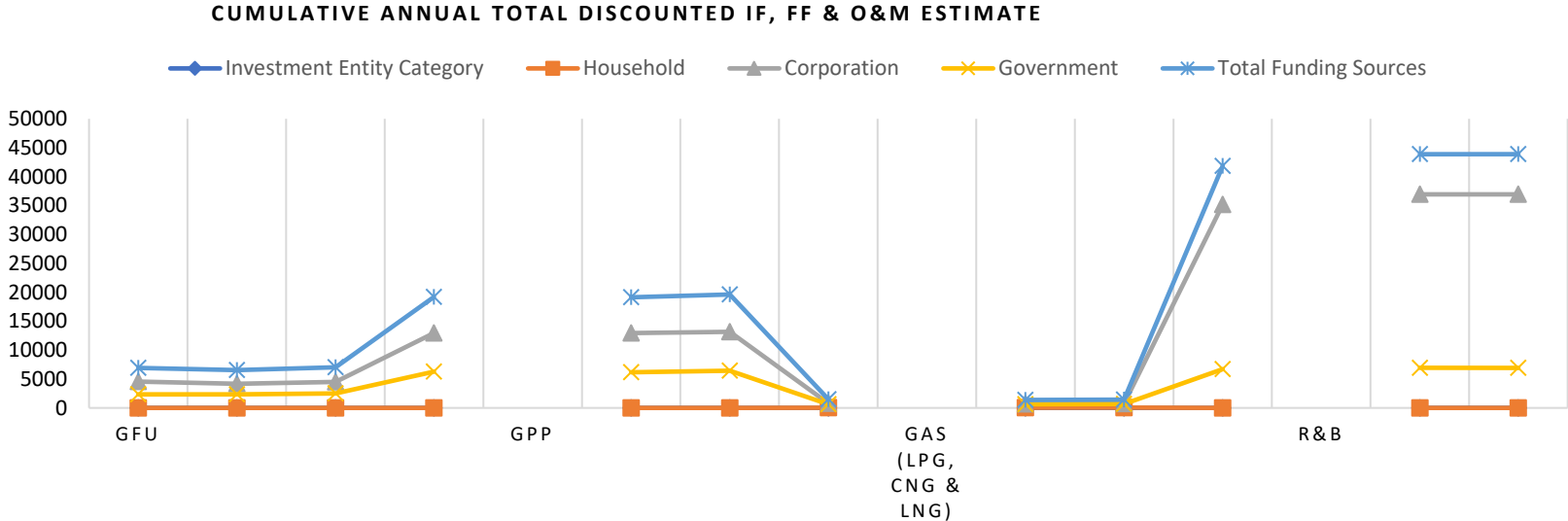


Table 16: CCS - Annual Total Discounted IF, FF & O&M Estimates BY Investment Types (million 2015USD)

Year	Discounted Annual total IF, FF, O&M Estimated Cost by Investment Types.											
	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2015	388.81	0	157.49	91.74	0	103.21	91.74	0	22.94	91.74	1.83	173.88
2016	238.62	0	144.48	84.17	0	94.69	84.17	0	21.04	84.17	1.68	159.52
2017	211.11	9.05	9.05	77.22	0	19.30	77.22	1.54	19.30	1621.55	16.99	532.44
2018	166.05	8.30	8.30	70.84	0	17.71	70.84	1.41	17.71	3037.02	28.34	875.81
2019	89.54	3.81	3.81	64.99	0	16.93	64.99	1.30	16.25	3899.59	38.10	1098.08
2020	69.30	0	0	268.32	2.98	67.28	31.57	0	22.80	0	0	1901.81
2021	229.75	0	0	519.68	1.09	144.03	51.49	0	26.55	619.06	0	1795.86
2022	0	0	0	0	1.00	251.13	29.52	1.48	19.93	328.85	2.83	1706.71
2023	0	0	0	874.81	0.92	230.62	27.08	1.35	18.28	215.60	2.59	853.62
2024	0	0	0	781.46	2.96	332.82	49.70	2.48	22.98	629.25	1.90	790.93
2025	0	0	0	716.94	2.71	305.56	45.59	2.28	9.69	446.50	0.87	402.27
2026	0	0	0	657.74	0.71	280.26	20.91	1.045	14.12	0	0	848.63
2027	0	0	0	505.58	1.96	232.64	19.19	0.96	12.95	0	0	778.56
2028	0	0	0	239.40	1.80	213.44	17.60	0.88	11.88	0	0	687.31
2029	0	0	0	219.63	0.82	195.80	16.15	0.81	10.90	312.20	0	630.56
2030	0	0	0	75.56	0.76	136.92	14.81	0.74	10.00	0	0	578.49
Total	1393.18	21.16	323.13	5248.08	17.71	2642.34	712.57	16.28	277.32	11285.53	95.13	13814.48

Figure 10: Annual Discounted Total IF, FF and O&M Estimates by Investment Types (million 2015USD)

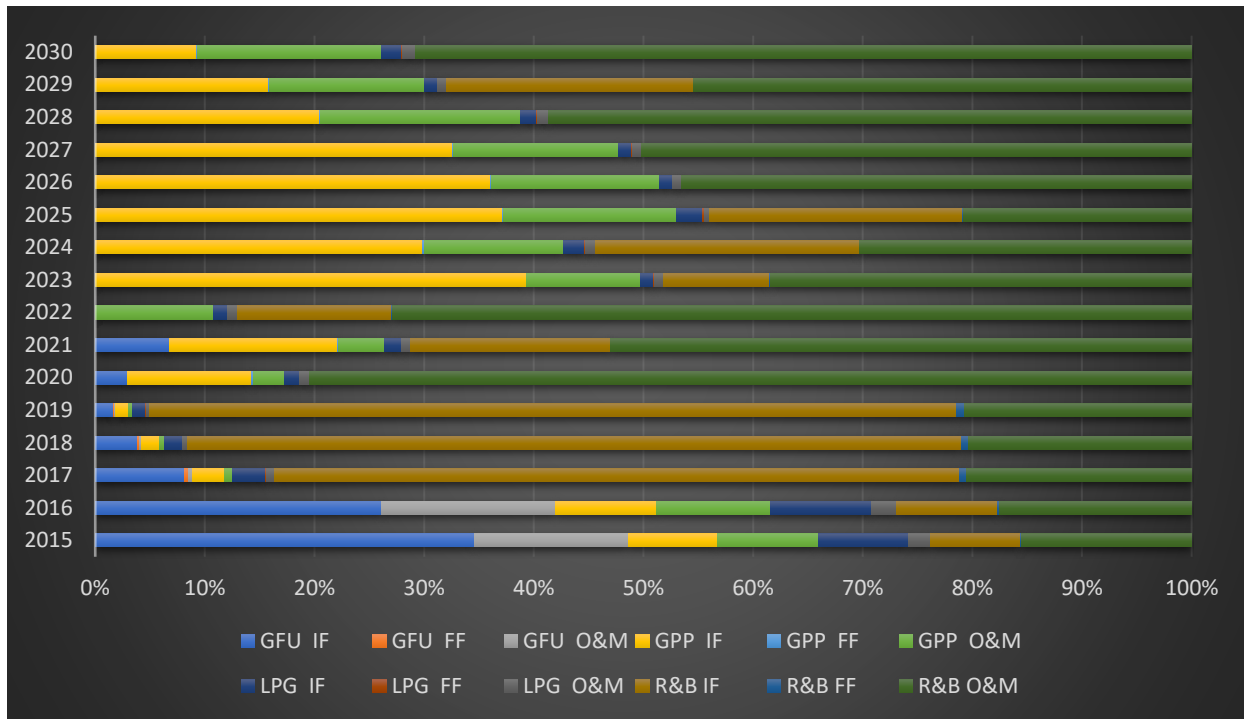
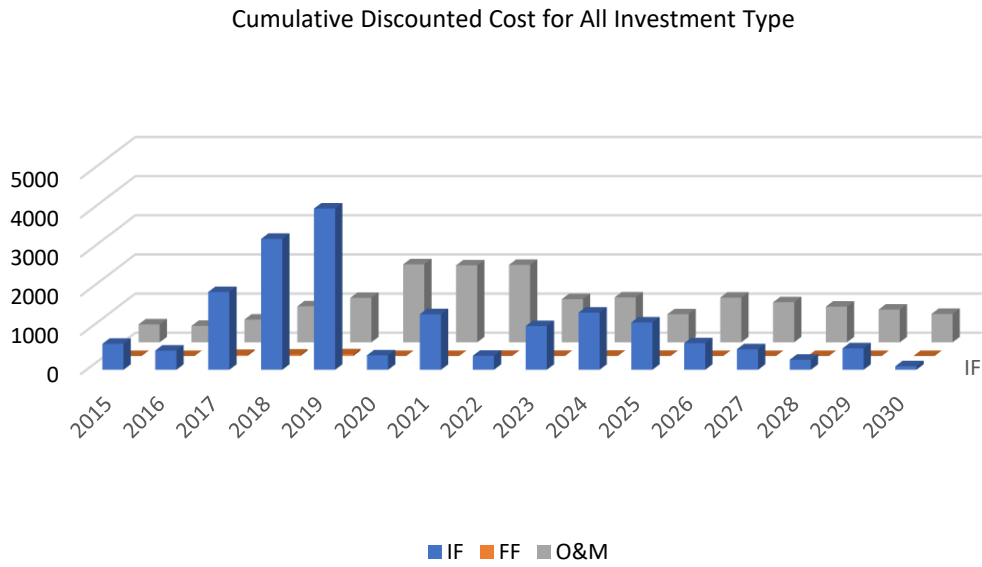


Table 157: Cumulative Discounted IF, FF and O&M Cost for All Investment Types

YEAR	Σ IF	Σ FF	Σ O&M
2015	664.03	1.83	457.52
2016	491.13	1.68	419.73
2017	1987.1	27.58	580.09
2018	3344.75	38.05	919.53
2019	4119.11	43.21	1135.07
2020	369.19	2.98	1991.89
2021	1419.98	1.09	1966.44
2022	358.37	5.31	1977.77
2023	1117.49	4.86	1102.52
2024	1460.41	7.34	1146.73
2025	1209.03	5.86	717.52
2026	678.65	1.755	1143.01
2027	524.77	2.92	1024.15
2028	257	2.68	912.63
2029	547.98	1.63	837.26
2030	90.37	1.5	725.41
Total	18639.36	150.275	17057.27

Figure 11: Cumulative Discounted IF, FF and O&M Cost for All Investment Types



Chapter Three

3.0 Results, Analysis and Findings - Calculation of the IFF

3.1. Incremental Changes in IF, FF and O&M Cost

Table 168: Incremental Annual Total IF, FF, O&M costs by Investment Types.

Year	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
	ΔIF	ΔFF	ΔO&M	ΔIF	ΔFF	ΔO&M	ΔIF	ΔFF	ΔO&M	ΔIF	ΔFF	ΔO&M
2015	418.80	8.04	277.59	-	0	-	-	2.00	-	-	-	-
2016	278.50	14.18	242.52	-	-	-	-	2.00	-	-	-	-
2017	268.40	11.72	242.10	-	-	-	-	-	-	-	20.00	-
2018	229.40	11.72	288.00	-	-	-	-	-	-	-	40.00	46.75
2019	132.77	5.86	258.70	-	-	1.05	-	-	-	-	60.00	-
2020	111.22	0.00	452.77	350.00	5.00	86.78	52.94	-	13.24	-	-	1,800.00
2021	417.50	0.00	530.03	850.00	2.00	237.95	94.12	-	23.53	184.00	-	1,846.00
2022	-2.50	0.00	661.30	1,800.00	2.00	474.60	58.82	2.94	14.71	655.25	5.63	1,963.81
2023	-2.50	0.00	628.81	1,700.00	2.00	425.49	58.82	2.94	14.71	468.25	5.63	1,017.06
2024	-2.50	0.00	661.33	1,650.00	3.00	712.03	117.65	5.88	29.41	1,489.66	4.50	1,035.50
2025	-2.50	0.00	661.34	1,750.00	5.00	738.06	117.65	5.88	-	204.50	2.25	501.13
2026	-2.50	0.00	661.35	1,750.00	2.00	737.61	58.82	2.94	14.71	-	-	1,850.00
2027	-2.50	0.00	661.37	1,450.00	4.00	662.42	58.82	2.94	14.71	-	-	1,850.00
2028	-2.50	0.00	661.38	700.00	6.00	662.54	58.82	2.94	14.71	-	-	1,996.80
2029	-2.50	0.00	661.39	700.00	3.00	662.42	58.82	2.94	14.71	0.00	-	1,712.50
2030	-2.50	0.00	661.40	250.00	3.00	505.45	58.82	2.94	14.71	-	-	1,712.50
Total	1136.8	29.3	7691.3	12950.0	33.0	5906.4	794.1	32.4	169.1	3001.7	138.0	17332.0

Note: negative sign means no capital invested is expected under the climate scenario from 2022 if the NGFCP is fully implemented except for operational and maintenance costs.

Figure 12: Cumulative Incremental Annual Total IF, FF and O&M Cost by Investment Types

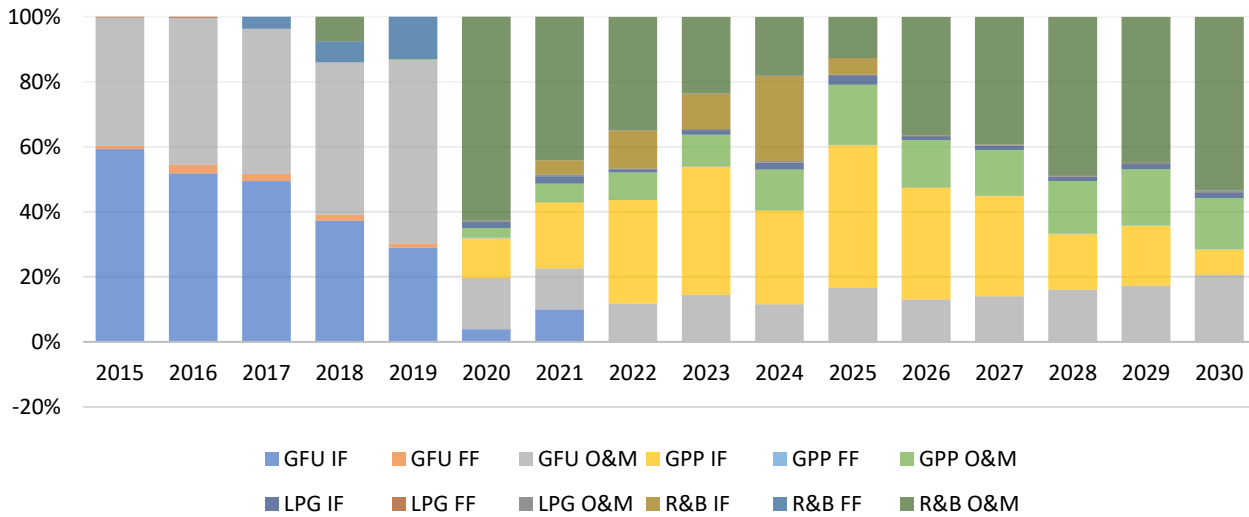


Table 179: Discounted Cumulative Incremental Annual IF, FF & O&M Cost for Investment Types

Year	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
	ΔIF	ΔFF	ΔO&M	ΔIF	ΔFF	ΔO&M	ΔIF	ΔFF	ΔO&M	ΔIF	ΔFF	ΔO&M
2015	384.22	7.38	254.67	0.00	0	0	0	1.83	0.00	0.00	0.00	0.00
2016	234.41	11.94	204.12	0.00	0	0	0	1.68	0.00	0.00	0.00	0.00
2017	207.25	9.05	186.95	0.00	0	0	0	0.00	0.00	0.00	15.44	0.00
2018	162.51	8.30	204.03	0.00	0	0	0	0.00	0.00	0.00	28.34	33.12
2019	86.29	3.81	168.14	0.00	0	0.68	0	0.00	0.00	0.00	39.00	0.00
2020	66.32	0.00	269.97	208.69	2.98	51.74	31.57	0.00	7.89	0.00	0.00	1073.28
2021	228.39	0.00	289.94	464.98	1.09	130.17	51.49	0.00	12.87	100.65	0.00	1009.83
2022	-1.25	0.00	331.88	903.36	1.00	238.19	29.52	1.48	7.38	328.85	2.83	985.57
2023	-1.15	0.00	289.52	782.73	0.92	195.91	27.08	1.35	6.77	215.60	2.59	468.28
2024	-1.06	0.00	279.35	696.98	1.27	300.77	49.70	2.48	12.42	629.25	1.90	437.41
2025	-0.97	0.00	256.29	678.18	1.94	286.02	45.59	2.28	0.00	79.25	0.87	194.20
2026	-0.89	0.00	235.13	622.19	0.71	262.25	20.91	1.05	5.23	0.00	0.00	657.74
2027	-0.82	0.00	215.72	472.96	1.30	216.07	19.19	0.96	4.80	0.00	0.00	603.43
2028	-0.75	0.00	197.92	209.47	1.80	198.26	17.60	0.88	4.40	0.00	0.00	597.54
2029	-0.69	0.00	181.58	192.18	0.82	181.86	16.15	0.81	4.04	0.00	0.00	470.15
2030	-0.63	0.00	166.59	62.97	0.76	127.31	14.81	0.74	3.71	0.00	0.00	431.33
Total	1361.19	40.47	3731.81	5294.68	14.60	2189.22	323.61	15.54	22.17	1353.60	90.97	6961.87

Table 20: Cumulative Annual Non-Discounted and Discounted Incremental IF, FF and O&M Cost for all Investment Types

Year	Non-Discounted			Discounted		
	Δ IF	Δ FF	Δ O&M	Δ IF	Δ FF	Δ O&M
2015	418.8	10.04	277.59	384.22	9.21	254.67
2016	278.5	16.18	242.52	234.41	13.62	204.12
2017	268.4	31.72	242.1	207.25	24.49	186.95
2018	229.4	51.72	334.75	162.51	36.64	237.15
2019	132.77	65.86	259.75	86.29	42.81	168.82
2020	514.16	5	2352.79	306.58	2.98	1402.88
2021	1545.62	2	2637.51	845.51	1.09	1442.81
2022	2511.57	10.57	3114.42	1260.48	5.31	1563.02
2023	2224.57	10.57	2086.07	1024.26	4.86	960.48
2024	3254.81	13.38	2438.27	1374.87	5.65	1029.95
2025	2069.65	13.13	1900.53	802.05	5.09	736.51
2026	1806.32	4.94	3263.67	642.21	1.76	1160.35
2027	1506.32	6.94	3188.5	491.33	2.26	1040.02
2028	756.32	8.94	3335.43	226.32	2.68	998.12
2029	756.32	5.94	3051.02	207.64	1.63	837.63
2030	306.32	5.94	2894.06	77.15	1.5	728.94
Total	17882.6	232.7	31098.8	8333.08	161.58	12905.07

Figure 13: Cumulative Annual Non-Discounted and Discounted Incremental IF, FF and O&M Cost for All Investment Types

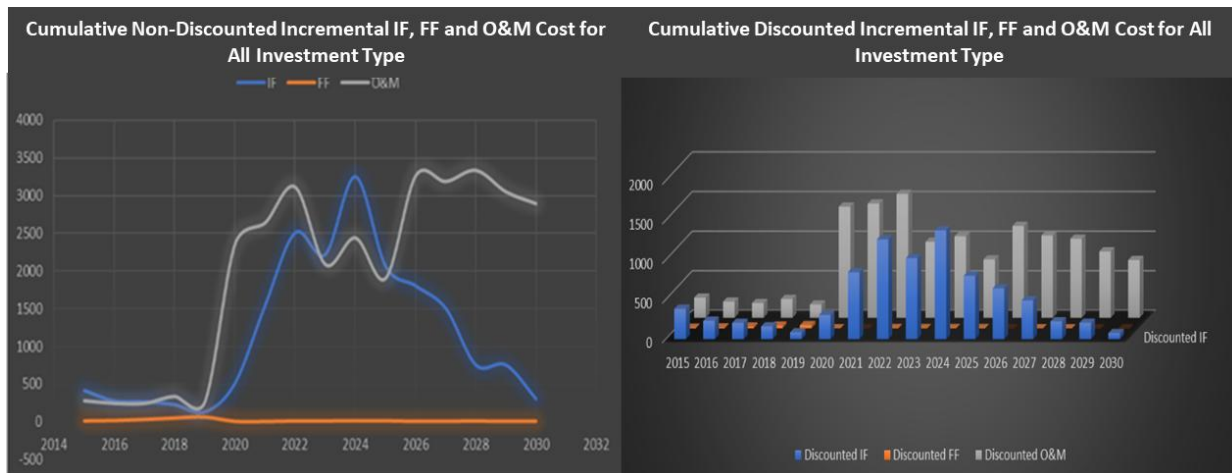


Table 21: Incremental Annual Total IF, FF, O&M costs by Investment types/entity (million 2015USD)

Incremental Annual Total IF, FF, O&M costs by Investment types/entity												
	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
Investment Entity Category	Δ IF	Δ FF	Δ O&M	Δ IF	Δ FF	Δ O&M	Δ IF	Δ FF	Δ O&M	Δ IF	Δ FF	Δ O&M
Household	0.00	0.00	0.00	0.00	0.00	0.00	21.32	53.97	30.08	0.00	0.00	0.00
Corporations	3,619.72	4,516.49	925.12	3,116.00	14,075.00	11,044.00	287.46	756.,33	480.52	23,614.47	40,120.97	14,828.54
Government	2,025.00	2,542.00	-317.90	3,108.79	6,707.79	3,601.45	-34.,50	661.33	437.12	2,733.64	7,549.23	2,697.44
Total	5,644.72	7,058.49	607.22	6,224.79	20,782.79	14,645.45	274.28	1,471.63	947.,72	26,348.11	47,670.20	17,525.98

Fig 14: Incremental Annual Total IF, FF, O&M costs by Investment types/entity (million 2015USD)

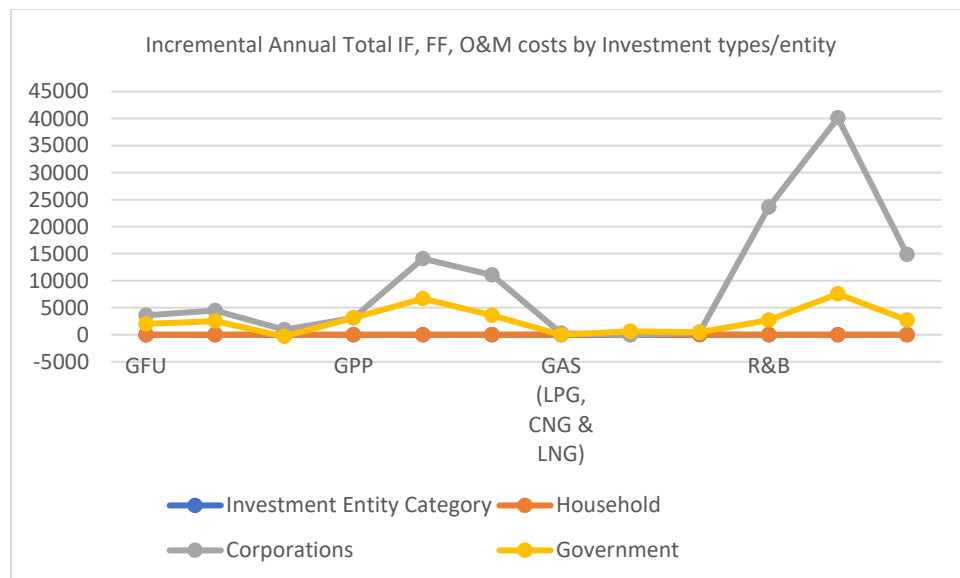


Table 22: Discounted Incremental Annual Total IF, FF, O&M costs by Investment types/entity (million 2015USD)

Discounted Incremental Annual Total IF, FF, O&M costs by Investment types/entity												
	GFU			GPP			GAS (LPG, CNG & LNG)			R&B		
Investment Entity Category	Δ IF	Δ FF	Δ O&M	Δ IF	Δ FF	Δ O&M	Δ IF	Δ FF	Δ O&M	Δ IF	Δ FF	Δ O&M
Household	0.00	0.00	0.000	0.00	0.00	0.00	19.56	49.51	27.60	0.00	0.00	0.00
Corporations	3320.84	4143.57	848.734	2858.72	12912.84	10132.11	263.72	693.88	440.84	21664.65	36808.23	13604.17
Government	1857.80	2332.11	-291.651	2852.10	6153.94	3304.08	-31.65	606.72	401.03	2507.93	6925.90	2474.72
Total	5178.64	6475.68	557.083	5710.82	19066.78	13436.19	251.63	1350.12	869.47	24172.58	43734.13	16078.88

Figure 14: Discounted Cumulative Incremental Annual Total IF, FF, O&M costs by Investment types/entity (million 2015USD)

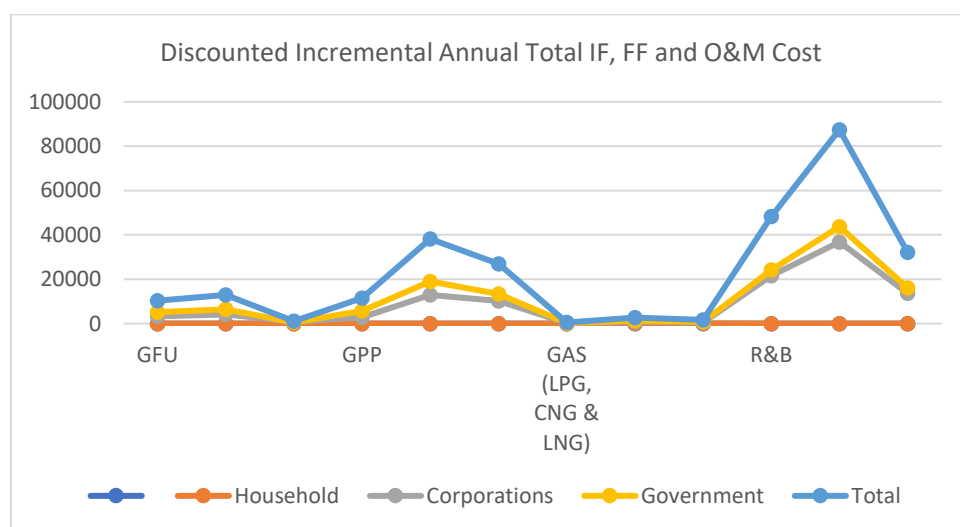


Table 18: Discounted Cumulative Incremental Total IF, FF, O&M costs by Investment types/entity (million 2015USD)

Investment Entity Category	IF	FF	O&M
Household	8.22	0	6.52
Corporations	3841.24	55.48	5888.82
Government	1617.42	10.79	1863.17
Total	5466.88	66.27	7758.51

3.2 Demand and Supply Side

3.2.1 GAS DEMAND SCENARIO

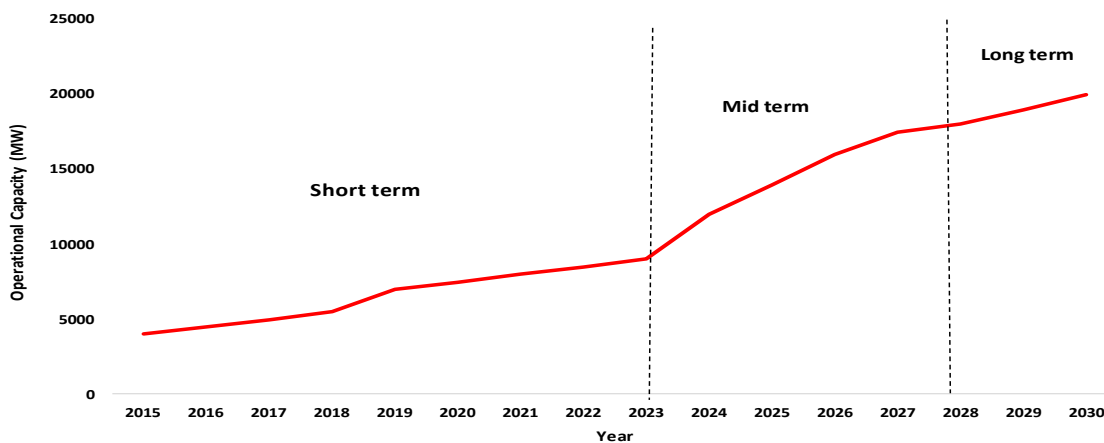
Domestic Gas demand is growing annually by 2-3% - a relatively low rate for a developing country of Nigeria's size with vast economic potential. This development is anticipated to reduce global demand for PMS as gas is now dominating the market. In Nigeria it is noticeable based on the previous oil demand statistics that this shift has begun but at a relatively slow rate because most cars in the country are still fuelled with petrol or diesel given transportation as a major oil demand driver. Projecting into the future of oil demand, the shift in the transportation sector to the use of efficient and electric cars will begin to have a reducing effect on oil demand come 2030. Power generation accounts for 68% of gas consumed domestically while industrial gas demand include consumption from fertilizer and petrochemical industries, cement industry, steel and aluminium smelting industry (the last category is largely dormant)⁴ accounts for about 32%. Due to lack of gas infrastructure, most potential gas users in the manufacturing sector in several states cannot access gas. While this is changing gradually, there is a huge unmet gas demand by the power sector and manufacturing industries. Lagos and Ogun states dominate national gas demand, and this is likely to even grow in the future.

Over the last several years, the fiscal, commercial, legal and regulatory environment for the gas investments has improved which has brought significant private investment into the gas sector. These investments have been largely related to improved transport infrastructure – traditional pipelines, but also domestic LNG (notably Greenville) and CNG. While the expansion of the gas sector and gas demand has been hindered by the on-going financial crisis in the electricity sector that both depresses gas demand and causes long delays in payments for gas supplies, right policy framework and open market of the electricity industry is expected to expand capacity and increase demand for gas. Future gas demand and pricing in Nigeria is fundamentally tied to the economically sustainable growth of the electricity sector.

3.2.2 GAS DEMAND – ELECTRICAL SECTOR

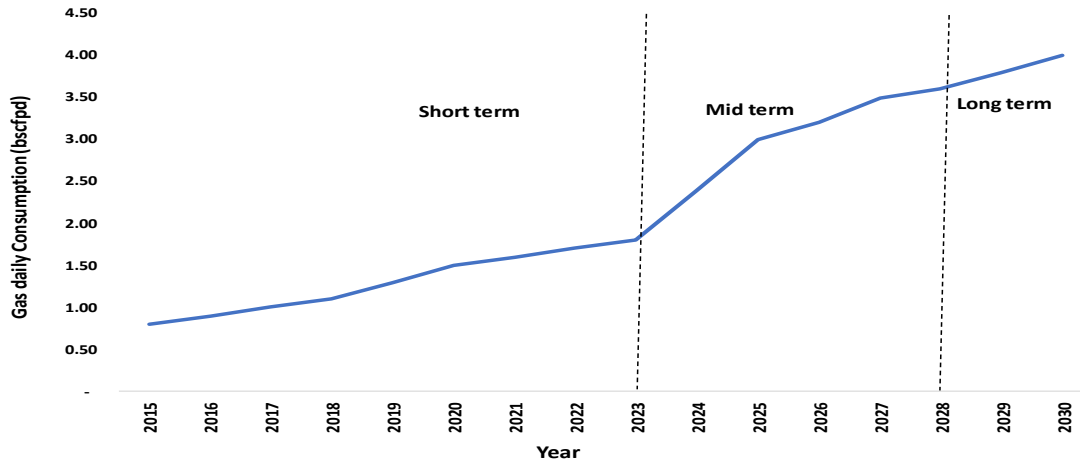
In 2013, the generation and distribution companies were partially privatized with the state owned IPPs sold to private owners with the FGN retaining a minority stake. Despite this change of ownership, expected level of improvement and capacity increase within the power sector has not been realized principally due to paucity of funds and lack of modern-day knowledge of electricity management by the new owners. However, operational capacity has improved compared to pre-privatization era – largely driven by the completion of IPPs that begun before the privatization process. Some fully private IPPs have also been implemented. Except for hydro, all large-scale power plants in Nigeria are fuelled by gas. For the foreseeable future, gas demand for power will increasingly dominate the domestic market (70-80% of gas demand).

Figure 15: Electrical Power Capacity Projection



⁴ It should be noted that most of the steel industries that are active in Nigeria are the scrap metal recycling companies. Most of these companies use liquid oil (diesel or LPFO) for their furnaces.

Figure 16: Gas Demand Projection in the Electricity Industry



Source: CLN Analysis, 2019

In projecting into gas demand by the electricity industry in the future, we have considered the growth pattern based on three term regimes as shown in Figure 15 and Figure 16:

- Short term (1-4 years): depending on the focus of the government to be formed after the recent elections, it is expected that new efforts will lead to improving operational issues largely resolved as load factor of operating IPPs nearing full capacity and bringing on built and non or below capacity operating IPPs (due to gas shortages, connections, or other technical factors). The total installed capacity of grid connected generators in Nigeria is 12,500MW while the available capacity is about 5000MW.
- Mid-term (4 – 8 years): As the electricity market stabilizes and with good financial standing to attract the right magnitude of capital, there is the possibility of regional grids springing up in some states, which would imply new IPPs being built including the Lagos IPPs and new technologies employed. The gas demand to meet this capacity increase is expected to be in the range of 1.8bcsf/d – 3.6bcsf/d.
- Long term: (above 8 years): Depending on the overall domestic economic growth, the demand for the use of fossil fuel for electricity generation could begin to peak (perhaps decline slowly) and more roles for the role of renewables particularly solar and hydro technologies. For example, Nigeria signed power purchase agreement with about 14 companies and there are two large scale hydro plant at various levels of construction works. More renewable projects especially solar as the technology continues to get better and more affordable. This may limit the expected increase in demand for gas. Gas demand at the long term is expected to rise above 3.6bcsf/d. For this type of demand to be realized, gas consumption will need to move beyond demand in the electrical power to more into Industries (especially manufacturing industries).

3.2.3 GAS DEMAND – OTHER INDUSTRIES

Over the last ten years, the cement industry has grown tremendously in capacity. Fertilizer and petrochemical industries have also grown considering higher demand for fertilizers with the various agricultural reforms of the government. Most manufacturing industries would prefer to run on gas powered captive energy especially with the perpetual challenge of the electricity industry. Gas demand in the steel and aluminium industries has not changed due to old erratic nature of its operations (now largely dormant) and any restructuring is unlikely. Therefore, while demand in the manufacturing industries could be seen to be increasing, demand from cement, petrochemicals, fertilizers, steel, and aluminium industry is likely to be modest over the short to medium term.

The cement industry has seen the largest industrial growth sector in the country with the two major players (Dangote and Lafarge) having between them 39.75 million metric tonnes per annum^{xxviii}^{xxix}. The industry has significant gas demands both for

heating the kilns and on-site power. Non-gas fired cement is not cost competitive because this relies on relatively expensive, often unreliable liquid fuel supplies due to poor transportation infrastructure. Low gas infrastructure and challenges related to security of supply of the liquid fuels, some of the cement industries are utilizing biomass in their kilns to supplement diesel and charcoal sources.

Apart from cement industries in Lagos, Ogun, Edo and Cross rivers states, other cement producing companies due to their distant location from the gas grid such as Ashaka Cement in Gombe, Benue Cement of Gboko, Sokoto Cement and others are not connected to gas for their kiln and electric power operations. The plan to connect the eastern gas pipeline to the northern part of the country will ultimately have the gas transmission grid go through (or close to) Benue state to the northern region. This is a long-term project, when implemented, there could be major increase in demand for gas in cement industries considering Dangote and Lafarge Cement plants in Benue, Sokoto and Gombe states in the northern region of the country. However, considering the challenges in developing gas transmission line couple with the bureaucratic processes related to various statutory approvals, it would be difficult to expect it to be completed before 2025. As shown in Figure 16, with the country tending towards having excess capacity in domestic cement there should be moderate expectation in terms of gas demand growth in the cement industry except for the existing industries that may need to switch fuel from coal/LPFO/Diesel to natural gas/CNG. Thus, a continuous reduction of about 5 - 10% in demand of AGO and decline will be at an increasing rate towards 2030 as demand for cleaner fuel continue to rise. It is therefore expected that demand will begin to decrease at a 2% rate and 5 years from now, there will be a huge demand decrease of about 7% and by 2030 decrease will be about 9 percent.

It should also be noted that the largest proportion of gas demand for cement is for kiln heat, which can be substituted for by other, lower-cost fuels. For example, Lafarge is moving to use biomass for up to 30% of their heat demand. They are also looking at using waste as a kiln fuel as well. These are economically viable in-situ options vis-à-vis diesel and gas, but not at the moment as outputs are not enough to fully drive operations therefore gas would remain a competitive option.

Demand for other products: Other fuel products will reduce in demand as a result of the world technology drifting towards a clean and efficient fuel use. By 2031, the reduction rate in demand will be as high as 10% reduction in sales especially because there are alternative fuels which are clean, efficient and less costly.

3.2.4 FERTILIZER & PETROCHEMICAL INDUSTRIES

There are two major fertilizer and petrochemical industries in Nigeria. Gas demand in these industries is directly proportional to production output and potentially, expansion into new production lines. Gas is a major feedstock of the petrochemical industry with Notore Chemical Industries (formerly known as NAFCON) and Indorama Eleme Petrochemicals Limited (formerly Eleme Petrochemicals a subsidiary of NNPC). Eleme Petrochemicals owned by Indorama group has expanded its capacity adding a urea plant facility in 2016^{xxx}. There is a short-term plan by Notore to build a 50MW gas-fired power plant and sell power in excess of the Notore's requirement to the national grid through the Nigerian Bulk Electricity Trading Plc (NBET) and a mid-term plan to increase the capacity of the plant to its original design of 1500 metric tonnes capacity plant^{xxxi}. The threat to these industries is the proposed Dangote petrochemical industry in Lagos which could stunt the growth of other petrochemical industries. However, should these projects be implemented as planned, the gas demand is expected to increase in the next few years. The gas demand growth in the industry could be with the short to midterm horizon. It should be noted that both facilities have dedicated gas supplies and transmission lines from gas supplies under long-term contracts.

3.2.5 OTHER GAS USERS (OFF GRID - SMALL & MID-SCALE POWER PLANTS)

Most of the industries in Nigeria are concentrated in the commercial capital of the country, Lagos and increasingly in Ogun state. These industries due to poor and unreliability of power supply from the grid, run on captive generators with fuel of choice fuel for most of these captive generators being diesel (AGO). Albeit, for the past 10 – 15 years, companies are gradually switching to natural gas. Nigerian Gas Company (NGC) has constructed a pipeline to the city gate both in Lagos and Ogun. Gaslink, a company owned by Oando Plc is one of the leading indigenous energy companies in the country with franchise to supply natural gas through its 100 km pipeline in Lagos to cover Ikeja and the Greater Lagos area. At present, the distribution network has the combined capacity to deliver 101 million standard cubic meters per month^{xxxii}. Shell Nigeria Gas (SNG) has a western gas distribution network of about 100 million standard cubic feet of gas per day (MMscf/d) in Agbara/Ota axis,

including the Ogun-Guangdong Free Trade Zone and some parts of Lagos state^{xxxiii}. Other franchise companies in Lagos and Ogun state axis are Falcon gaz (Ikorodu area) and Gas land (VI/Lekki/Epe areas).

Currently, there are about 160 customers serviced by Gaslink in Lagos and Ogun state that rely on gas supply from Gaslink, Shell, and Falcon Gaz to power their captive power plants and other operations. There are several applications also submitted to Nigeria Gas Company and some of the franchise companies to power captive power plants for the use of residential estates, industrial estates, and corporate offices. With expansion projects of manufacturing plants taking place such as new plants owned by PZ Plc, Nestle Plc and more small-medium size industries around Ogun state^{xxxiv}; as shown in the Figure 16 , the demand for gas is expected to be on the increase.

Lagos state government in partnership with other private companies are planning to build small/medium capacity gas power plants to meet residential, industrial and public utility needs in Lagos state^{xxxv}. Most of these power plants will use gas and will rely on pipeline for gas distribution within greater Lagos environment. Should this therefore be implemented successfully in Lagos, it is expected that other states such as Ogun, Rivers, Abia and Anambra with industrial clusters could also adopt this approach to solve their power needs.

3.2.6 GAS DEMAND - TRANSPORT

With technologies such as distributed power generation and captive power generation becoming more popular as transmission of electricity over long distances are now considered to be too expensive and challenging, there is significant high chances that Nigeria, despite challenges with the grid could join the league of countries using EVS as it is anticipated that new model vehicle owners will prefer to retrofit their cars or company trucks in order to save fuel cost and maintenance and this will cause a gradual reduction in oil demand which will be huge eventually. But most certain is the adoption of Autogas for heavy duty and light weight cars. From 2030 and beyond, most car manufacturers will only be producing fuel efficient and electric cars it is therefore projected that the rate of decrease in PMS use will double to about 4% after 2030. Suffice to say that there will be a decrease in the use of oil in Nigeria, but the rate of decrease will be a subtle and gradual one.

3.3 Supply Side

3.3.1 PLANNED GAS SUPPLY

Low levels of domestic gas consumption particularly feedstock supply to the thermal power plants in the country has remained an issue leading to fewer thermal plants being operational and those operational, not at full capacity. Currently there are four major applications for gas supplies in Nigeria: export, domestic sales/use, reinjection and flare.

3.3.2 OVERVIEW OF ONGOING AND PLANNED GAS SUPPLY PROJECTS

As part of planned projects, NNPC has identified some gas projects tagged the Seven Critical Gas Development Projects (7CGDP) that will deliver about 3.4billion standard cubic feet of gas per day to meet a projected medium-term supply gap by 2020 (see Table 24).

Table 24: Planned Gas Supply Projects

Source of Gas Supply	Gas Reserve Capacity	Remarks
Assa North		
Ohaji South field	4.3 TCF	
Unitized Gas fields (Samabri-Biseni, Akri-Oguta, Ubie-Oshi and Afuo-Ogbainbri)	6.4 TCF	
NPDC's OML 26, 30 & 42.	7TCF	
Shell Petroleum Development Company, (SPDC) development of JV	2.2 TCF	Gas Supply to Brass Fertilizer Company
OML 13	5 TCF	To support the expansion of Seven Energy Uquo Gas Plant
Okpokunou/Tuomo West (OML 35& 62)	10 TCF	

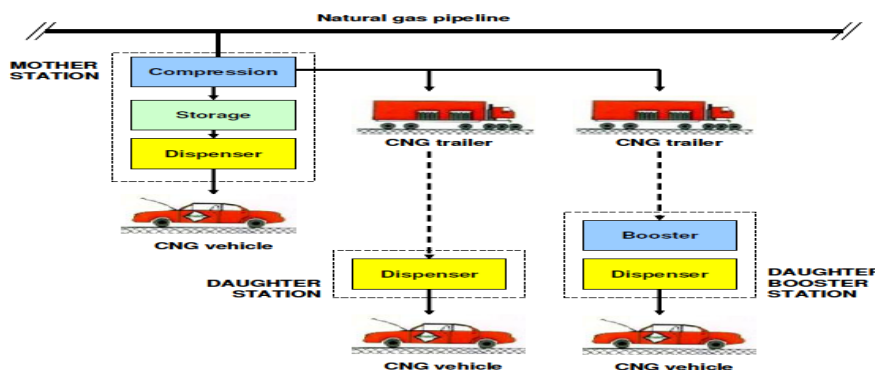
Chevron Nigeria Limited have also recently signed a Gas Sale and Aggregation Agreement (GSAA) with Dangote Fertilizer Limited (DFL) and Gas Aggregation Company of Nigeria Limited (GACN) as the 'aggregator'. CNL is obligated to supply 70 million standard cubic feet per day (Scf/d) of natural gas to DFL to enable start-up and operation of the newly built fertilizer plant^{xxxvi}.

Other relevant gas infrastructure (Virtual Pipelines)

Virtual Pipeline technology (VPT) is becoming popular in Nigeria as it helps to facilitate the delivering of gas to remotely located industries or plants in locations with no gas pipelines. The VPT is a high-cost technology and thus suitable for customers who do not have access to gas and must rely on diesel or LFO. The size of this market is limited. The common VPT in Nigeria are:

- *Compressed Natural Gas (CNG)*: CNG technology involve natural gas been passed through a drying appliance where moisture is removed with a molecular screen and purified through filtration equipment. Then the gas is compressed to about 25 - 30 MPa according to the type of compressor. The process requires the typical mother and daughter station as shown in Figure 17. The pressured gas is delivered in supply bottles or directly into the filling equipment (stand). The gas may be delivered to the pressure tank of a vehicle using filling hose. The filling process automatically stops after reaching a pressure of 20 to 21 MPa^{xxxvii}.
- *Liquefied Natural Gas (LNG)*: The LNG technologies involve liquefaction, shipping, regasification, and delivery into the pipeline grid or directly for utilization by facility. When natural gas, mainly methane, is cooled and liquefied through cryogenic processes at a temperature of approximately -260°F (-162°C), liquefied natural gas (LNG) is formed. As a result of this, natural gas volume is reduced to one six-hundredth (1/600), allowing for transportation of significant gas volumes by specialized LNG tanker ships over long distances. LNG is generally a more economic form of natural gas transportation than other options for very long distances and is employed to move gas from reserves in distant or stranded fields to developed world markets^{xxxviii} -- albeit these are almost exclusively large-scale LNG facilities and with sea links.

Figure 17: CNG Distribution Line



Source: Mott McDonald Report, 2012

Some of the companies involved in the virtual pipeline technologies in Nigeria are:

- **NIPCO (CNG)**: NIPCO formed a joint venture agreement with Nigerian Gas Company (NGC), a subsidiary of NNPC and formed Green Gas Limited (GGL) for implementation of CNG project. NIPCO have in place stations in Ibafo, Ogun state, Benin City, Edo State and in Warri, Delta State^{xxxix}.
- **Powergas (CNG)**: the company operates four compression plants (Ogun, Lagos, Abia and Rivers state) in Nigeria, delivering clean and cost-effective energy to several states both in the western and eastern regions of the nation^{xl}.
- **Greenville (LNG)**: the company has completed the first phase of its \$50million Mini-LNG plant in Rumuji, Port Harcourt, Rivers state. It has signed a gas supply contract with Total Exploration and Production Nigeria Limited (TEPNG) to deliver 74 million standard cubic feet (scf/d) of gas from its OML58 fields^{xli}. Greenville is setting up adequate number of strategically located LNG & CNG refuelling stations to cater to vehicles fuelled by LNG across the country especially in locations with no gas pipeline network.

Despite the advantages of the VPT, it should be mentioned that aside the cost of the equipment itself, there are added costs of compression and/or regasification (as in the case of mini-Liquefied Natural Gas), security, logistics etc. In Nigeria, there are limitations as to where and how efficiently and plausible to deploy VPT considering the state of our current road network and building patterns, and other challenges we face in the environment.

3.3.3 PLANNED GAS PIPELINE INFRASTRUCTURE

Table 25: Existing, On-going and Proposed Gas Infrastructure

Existing Gas Infrastructure			On going/ Proposed Gas Infrastructure		
Pipeline	Current Capacity	Supplies	Pipeline	Capacity	Expected Operation
ELPS I (560km)	1,100mmscfd	Power Plant, Petrochemicals, Industries	ELPS II (342km)	1,100mmscfd	2019
Alakiri - Obigbo – Ikot Abasi	800mmscfd	power plants, Fertilizer, Aluminium & Steel industries	OB3 (130km)	2,000mmscfd	Q2 2019
AccuGas (260km)	600mmscfd	Power plants, Cements	Dangote-EWOGGS (550km)	1,500mmscfd	Phase 1: 2019 Phase 2: 2025
Gas Link (100km)	68mmscfd	Ikeja, Apapa & Environs	TNGP-AKK (614km)	3,500mmscfd	2020
Falcon Gas (50km)	25mmscfd	Ikorodu (Lagos)			

Source: CLN Analysis, 2019

In addition to those above, other gas infrastructures and those proposed are as shown in Table 25. Other key players in the gas market include those planned or currently supplying gas to dedicated facilities or industries as well as those supplying gas using the virtual pipeline network systems (See Table 19).

Table 19: Examples of Operators in Supplying Non-Grid Connected Customers

Company	Client	Type	Capacity
Greenville	Small & Mid-Size Industries	LNG	110mmscfd
PowerGas	Small & Mid-Size Industries	CNG	25mmscfd
Seplat	Azura IPP	Pipeline	116mmscfd
Chevron	Dangote	Pipeline	70mmscfd
Shell Natural Gas	Small & Mid-Size Industries	Pipeline	100mmscfd

Source: CLN Analysis, 2019

3.3.4 ON-GOING GAS PIPELINE INFRASTRUCTURE

Currently, there are two on-going expansion projects apart from other pipeline projects by various O&G companies to tie into either NGC line or supply consumer directly.

- **Expansion Project on ELPS:** The 342km looping expansion of Escravos-Lagos Gas Pipeline system is an on-going project which is nearing completion^{xliii}.
- **East – West pipeline project:** The 127km east -west gas pipeline joins the western and eastern gas pipeline network from Oben to Obiafu/Obrikum (OBB). This would integrate the ELPS and the eastern network and these projects should be completed soon. Oben –Obiafu-Obrikom (OB3) pipeline is Nigeria’s largest gas transmission pipeline and its completion will create the first semblance of a gas grid in the country. The pipeline, being constructed by the Nigerian government is estimated at a cost of \$400M, will have the capacity to pump Two Billion standard cubic feet of gas a day.

3.3.5 PLANNED GAS PIPELINE PROJECTS

- **Ajaokuta – Kaduna – Kano Pipeline network (AKK)^{xliiii}:** This is a 40” X 614km pipeline expected to take gas to the northern part of the country. This project is expected to cost \$2.8billion with 85% of it to be funded through loan from banks in China such as China National Petroleum Corporation and the remaining to be funded by the Nigerian consortium of contractors. The pipeline which is estimated at a cost of \$2.8bn currently scheduled for commissioning in 2020 is expected to transport 3,500 million metric standard cubic feet per day (Mmscfd) of dehydrated wet gas from several gas gathering projects located in southern Nigeria.
- **East-West Offshore Gas Gathering System (EWOGGS)^{xliv}:** Dangote in partnership with First Exploration & Petroleum Development Company is embarking on the EWOGGS project. The project is expected to connect gas resources in the East with the domestic gas demand in the West. The system will consist of two 38-in, 550km pipelines, each with a capacity of 1.5 Bcf/day, an offshore gas pipeline system. It is one of the world’s largest pipeline infrastructure estimated at \$3billion. The pipeline at completion has the capacity to deliver three billion standard cubic feet of gas per day.

Figure 18: Map showing built, planned and proposed oil and gas pipelines.



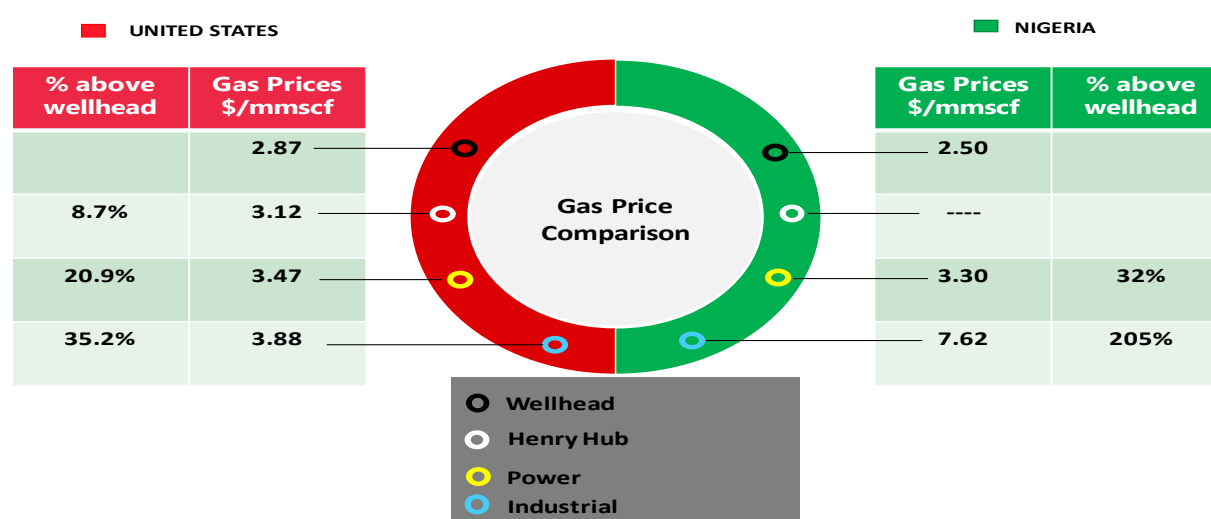
Source: Petroleum Economist

3.4 Gas Value Chain

3.4.1 COMPARING THE VALUE OF GAS: US AND NIGERIAN MARKET

Understanding the value of natural gas in Nigeria can be aligned to its value in the US. As the US has emerged as a major LNG supplier in the Atlantic Basin, it directly competes with Nigerian gas. While LNG was traditionally sold through long-term, fixed price contracts; this has changed with new suppliers like the US going to market based pricing. In the US, the price of natural gas is directly linked to the wellhead price of gas delivered to a sales hub, Henry Hub being the most important. Therefore, in a very important way, the price of gas in the US both at the wellhead and at final use in power and industrial sectors is linked to that of Nigeria. Thus, the value of Nigerian gas can be illuminated by the prices in the US (See Figure 19). Yet it should always be remembered that the US economy is far greater and provides more value to gas than the Nigerian. It therefore implies that, theoretically the price of gas in Nigeria should sell a discount to that in the US if it intends to export value-added products and to support domestic economic growth.

Figure 19: Comparing US and Nigerian Gas Prices



Source: CLN Analysis, 2019

Wellhead Price: The spot wellhead price in the US is set by the sales price at Henry Hub, minus pipeline transport. If Permian basin gas is connected through pipeline to a Gulf Coast hub, the transport price can be in the 0.25 USD level. However if it is not connected the cost can easily exceed 1/mmscf or more. Thus it is interesting that the wellhead price for connected gas in Nigeria is essentially the same as in the US.

Power Sector Price: the average US price in the power sector is the same in Nigeria. Yet Nigerian power sector is fundamentally less profitable than in the US. In the US, the electrical sector has a return on equity of 10%, while in Nigeria the sector operates at a loss. Indeed the Nigeria sector is in a major liquidity crisis. The implication being that the gas prices to the Nigerian power sector needs to be either dramatically lowered or the regulatory rates dramatically increased as well as collections as gas is over-priced.

Industrial and Commercial Sector: A major economic paradox in Nigeria is that traditionally, low value commodity products such as cement pay high gas prices – fundamentally retarding economic growth. Additionally, manufactures and commercial facilities pay extremely high prices +7 USD /mmscf. These prices are only due to the fundamental barriers that have made LFO the competitive fuel in industry and diesel in the commercial sector. Gas prices in the cement industry are under pressure as biomass and increasing gas supplies undermine the monopoly pricing of the State gas company. Commercial customers have increasing sources to replace diesel: gas via CNG, LNG, LPG or private gas suppliers and market prices are underpressure. Further the market for gas at Nigerian prices is small a few hundred mmscfpd and declining. The Nigerian commercial gas price is almost double that of the US and clearly unsustainable.

Most carbon mitigation options generate revenues from sale of natural gas, LNG, LPG and electricity. Considerable uncertainty about the future prices of these products is inevitable. For base and low gas price scenarios, projections from the U.S. Department of Energy Annual Energy Outlook^{xlv} have been used, consistent with analysis of low-carbon options for the Nigerian power sector. The high gas price scenario is based on the United Kingdom Department of Energy and Climate Change (DECC 2011) high gas price scenario, which is notably higher until 2026 than Annual Energy Outlook^{xlv} high-scenario (see Table 27).

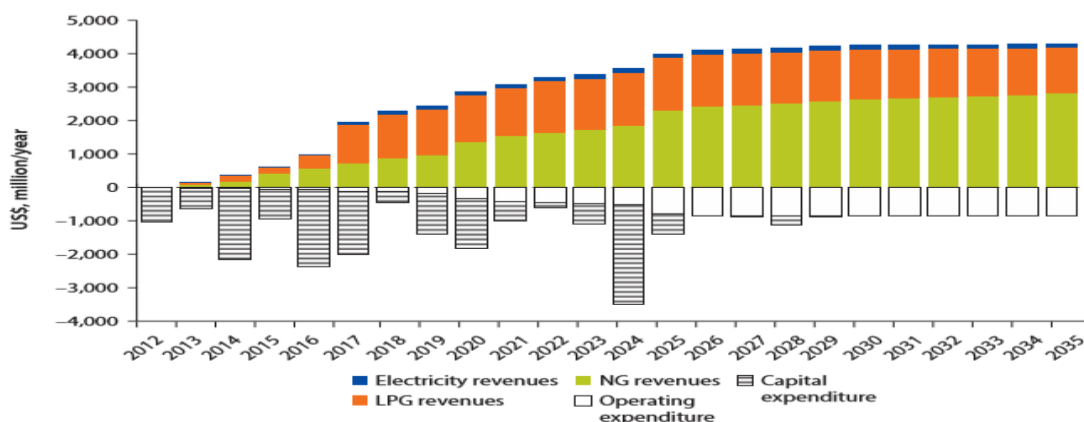
Table 27: Low-, Mid- and High Product Price Scenarios, 2012 - 2035

Year	2012	2015	2020	2025	2030	2035
Natural gas (\$/millionBtu)						
Low	4.41	4.55	4.78	5.02	5.28	5.55
Mid	4.50	4.71	5.07	5.46	5.89	6.34
High	8.34	9.23	10.71	11.45	11.45	11.45
LPG (\$/tonne)						
Low	316	315	323	317	335	319
Mid	404	427	488	516	531	539
High	532	597	681	732	760	772
Electricity (\$/MWh)						
Low	55	60	61	63	65	67
Mid	57	63	65	68	71	75
High	87	99	104	104	104	104

Source: DECC 2011; USDOE 2011

Natural gas supplied to LNG plants is calculated at the value of LNG exports to Europe, less \$1.67 for marginal production cost, \$1.33 for shipping, and \$0.37 for regasification, for a total netback reduction of \$3.37/million Btu from the price of LNG to estimate the value of gas. For gas sold domestically, the price in 2012 is assumed to be at current low gas prices, with an increase to export parity by 2015 in accordance with the assumptions used in the power sector analysis. Revenues for large-scale LPG volumes are estimated at gross primary productivity (GPP) plant outlet at \$400/ton, based on a Rotterdam price of \$800/ton, less shipping and transportation. For small-scale domestic LPG sales near the wellhead, net revenue is estimated at \$150/ton. LPG prices are projected to increase over time indexed to the price of oil, using base, low, and high scenarios. The revenues from the sale of electricity generated from gas utilized by low carbon options are estimated to be the same as the generation cost for grid connected gas turbines used in the analysis of the Nigerian power sector, at \$52/megawatt-hour (MWh) in 2010, increasing to \$63/MWh in 2015, as gas price approaches export parity. Using the mid-prices, Figure 20 shows the costs and revenues for the low carbon scenario. The largest capital costs occur in the early years. Revenues are dominated by gas sales, with significant contributions from LPG. As the graph shows, the early low-carbon options generate sufficient revenue to fund further implementation after 2016.

Figure 20: Revenues and Costs for the Low Carbon Scenario



Source: Energy Redefined, 2012

3.5 Structural Shifts Affecting the Gas Sector

There are some major events that are known to have the potential of impacting on the gas outlook in the 2020-30 period.

3.5.1 DANGOTE REFINERY AND INDUSTRIAL COMPLEX

Dangote is constructing an integrated refinery and petrochemical complex in the Lekki Free Zone near Lagos, Nigeria. The refinery upon completion will produce Euro-V quality gasoline and diesel, as well as jet fuel and polypropylene. It will feature infrastructure facilities such as crude oil and 3bcf carrying capacity associated gas pipeline system. The refinery complex will also include a fertilizer plant, which will utilize the by-products from the refinery as raw materials. The Dangote refinery will have an annual refining capacity of 10.4 million tonnes (Mt) of gasoline, in addition to 4.6Mt of diesel and 4Mt of jet fuel. It will also produce 0.69Mt of polypropylene, 0.24Mt of propane, 32,000t of Sulphur and 0.5Mt of carbon black feed.

The Dangote refinery in Lagos will transform Nigeria and create a shift in Nigeria from oil product importer to exporter of refined products. This will likely significantly disrupt the entire supply and price structure in Nigerian product market and alter the pricing of diesel and fuel oils that are the principal competing fuels for gas in the industrial and commercial markets. It could then imply that the major drive from economics standpoint for utilization of natural gas in industrial facilities could swing in favour of diesel as its price declines in domestic market, reducing price premium for gas in the industrial market.

The result of these developments could force government out of the supply side as there will be no need to import refined products hence interest in the NNPC refineries decline. With Dangote a private company in the picture, gasoline market moves to deregulation which causes price increase, but better and more dependable supply. The ending of product imports will therefore be major financial gain for the Federal Government.

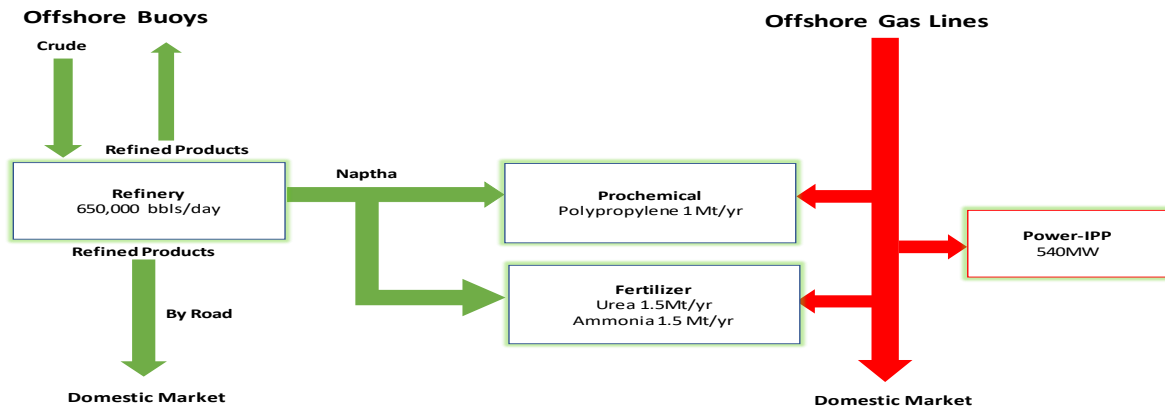
3.5.2 EAST-WEST OFFSHORE GAS GATHERING SYSTEM (EWOGGS)

Dangote in partnership with First Exploration & Petroleum Development Company is embarking on the EWOGGS project. The project is expected to connect gas resources in the East with the domestic gas demand in the West. The system will consist of two 38-in, 550km pipelines, each with a capacity of 1.5 Bcf/day, an offshore gas pipeline system. The EWOGGS gas pipeline system is planned to have provisions for seven offshore gas injection connection points and two offshore gas discharge connection points. This is expected to be an alternative to the NGC gas system now being connected between the Eastern and Western network. When completed, the infrastructure will allow stranded assets along its trajectory to be developed as a gas monetization route will become available.

While there are strong doubts as to the realization of this project activity^{xlvi}, should it be implemented, it signals a complete shift to gas pricing as this could introduce gas-to-gas competition in the Lagos market, which would have widespread gas price implications. This dramatically increase both gas supply and demand, but gas supply is expected to be greater than own demand.

The combination of the two projects by Dangote (see Figure 21) can influence the entire O&G structure in the domestic market especially in the downstream operations and gas industry.

Figure 21: Dangote Industrial and Energy Complex Schematic



Source: CLN Analysis of the Industry, 2019

3.5.3 INCREASING GAS-TO-GAS COMPETITION

Current developments in the Nigeria gas industry suggests that there is going to be a shift from focus on access to transport infrastructure to competition increasingly on gas end-users as new major gas suppliers dramatically increased supply options. The concept of premium gas price in industrial markets may come under pressure with increasing numbers of higher-cost providers (LNG, CNG) targeting same clients. Major gas producers move increasingly into downstream markets with longer-term contracts (either alone or linking with customers).

3.6 Other Assumptions from the Study:

The 70% of domestic gas demand is in the electricity sector and this percentage should increase over the next ten years with the expected growth in electricity supply due to 60% increase in investment for LPG and GPP see

- Figure 12.
 - ∧ More than 6000 MW of capacity has been built but not operational due to various operational and financial barriers.
 - ∧ The electricity sector has severe financial and liquidity problems, unless solved, gas demand growth will be subdued.
 - ∧ The industrial sector is unlikely to grow substantially as the cement sector is mature and there is a lack of other major industries (e.g. steel and aluminium).
 - ∧ The commercial sector should grow rapidly, but this comes from SMEs and MSMEs, and requires significant infrastructure expansion.
- Gas supply infrastructure is growing significantly, but still faces many barriers.
 - ∧ Lagos/Ogun state will have significantly more gas supply in the short and mid-term.

- ^ Increasing amounts of infrastructure is provided by private operators.
- In the near future, gas price competition will move from just the wellhead (due to shortage of pipeline transport) to include the end-user who will have access to more traditional gas supplies and expanding supplies of CNG, LNG, LPG, renewables.

Dangote refinery and industrial complex could be the game changer disrupting the entire supply and price structure in the Nigerian product market and alter the pricing of the principal competing fuels for gas in the industrial and commercial markets. The gas market will also be affected by the new gas infrastructure and gas volumes that will enter Lagos.

3.7 Key Uncertainties and Methodological Limitations

Assessing investment and financial flows in relation to GHG emission has been limited to mitigation actions due to the nature of the industry. Data availability was a huge barrier, hence the estimate for data on investment, O&M and FF.

Breakdown of Investment Entity:

The sources of funding for projects in the O&G sector can easily be referenced due to government's involvement, size and type of the players in the industry. It should be stressed that while the exact ratio is not usually stated but the industry practices guiding joint venture partnerships, profit sharing contract (PSC), marginal field and independent operators are guide used in categorization and ratios. For example, most of the joint venture operations in the industry are 60:40 ratio of government to the operators except in few cases. However, considering the various sub-divisions under Households, Corporation and Government, the application was based on expert judgement with discretion but cross checked with Subject Matter Experts (SMEs) in the industry. Hence, various ratios were used as appropriate for the costs within the investment entities. As it is difficult to know the breakdown of domestic/foreign borrowing, ODA, FDI etc. as expected in the template which in most cases are kept discrete in the country, reasonable ratios for the investment types were applied in the excel sheets vis:

Table 28: Breakdown of Investment Entity

<i>Investment type/entity</i>	<i>GFU (%)</i>	<i>GPP (%)</i>	<i>Gas (LPG, CNG and LNG) (%)</i>	<i>R&B</i>
Household				
<i>Domestic Equity & Debt</i>			5	
Corporations (JV Partners)				
<i>Domestic</i>				
<i>Domestic equity</i>	40	30	10	
<i>Domestic borrowing</i>	15	20	20	
<i>Total Domestic Sources</i>				
<i>Foreign</i>				
<i>FDI</i>	30	20	10	
<i>Foreign borrowing</i>	10	20	0	
<i>ODA</i>	5	10	5	
<i>Total Foreign Sources</i>				
<i>Total Corporation Funds</i>				
Government				

<i>Domestic</i>		
<i>Domestic funds</i>	60	20
<i>Foreign</i>		
<i>Foreign borrowing</i>	20	10
<i>Bilateral ODA</i>	5	5
<i>Multilateral ODA</i>	15	15

Chapter Four

4.0 Conclusion, Recommendations & Challenges

4.1 Conclusion

The impacts and implications of trends in the gas industry is important. Future LCD strategy will focus on gas production and domestic consumption such as to make the country sufficient.

With the shift in gas pricing likely to be experienced by Nigeria gas industry in the nearest future, the electrical sector remains the biggest market considering the increase in government –private sector participation. Most of the gas currently flared are planned to be captured and utilized. The utilization is most likely to be in the electricity and transport sector while other sectors such as agro-allied industries (such as tanneries, textile, etc.) housing – building codes etc will fully adopt LPG as we move into the future. The cost of financing the taking out of this flare completely has been estimated by ministry of petroleum resources to be about US\$ 2-3 billion higher than projected investment flow of GFU at an incremental discounted rate of US\$1361.19 (see Table 17). This among other funds required for O&G mitigation activities can be sourced from domestic, private, public-private partnership, international climate finance/carbon credits from offsets. Depending on the project to be implemented, best approach would be based on various factors and this could be screened based on the financing variables such as the capex, socio-economic impacts, carbon footprints to be reduced, etc.

4.2. Policy Implications

The Federal Government and various states have over the years developed a number of policy documents to promote key elements of climate compatible development, enabling policies, emerging investments, existing local level implementation efforts, and the role of international partnerships. These policies alone will not transform Nigeria’s oil and gas sector towards climate mitigation. To incentivize the flow of international finance to mitigation projects in Nigeria, domestic policies and institutions must be properly aligned with more traditional economic incentives to attract investments, enforce efficiency measures, establish sustainable tariff practices for just transition, demonstrate the feasibility of modern technologies, and ensure responsible use of gas resources. Adequate governance, accountability and transparency are key values that will drive this to fruition.

Therefore, report of Investment and Financial Flows assessment will help guide stakeholders and readers through historical trends while comparing its projections with alignment to NDC strategies to promote investments. The analysis may be utilized for the various NDC strategies e.g., Long Term Low Emissions Development, Decarbonization approaches and others as outlined in Chapter 1.

While possible and economically attractive, low-carbon development is by no means easy in Nigeria or anywhere in the world. A combination of better knowledge, expanded human capacity, reformed policies, and suitable financing is needed to overcome the barriers to adopting low-carbon development options. The FGN can play a catalytic role in getting the transition under way as there is little or no time to waste: once locked into the country’s economic fabric, higher carbon technologies are costly and impractical to reverse.

4.2.1 CHALLENGES IN THE EXISTING POLICY

Nigeria has developed a lot of policies prior to the Paris Agreement 2015 though it was not borne out of climate change actions but resources maximization. Below are briefs on each policy.

The National Biofuels Policy was developed in 2007 to establish a thriving bio-fuel industry and improve the quality of automotive fossil-based fuels in Nigeria via agric-energy nexus, stipulating a blending of up to 10 per cent of fuel ethanol with gasoline to achieve a blend to be known as E-10, and a blending of 20 per cent of biodiesel with conventional diesel by 2020. Despite significant investments in developing the carbon assets of this programme and funding pilot projects by NNPC, this project has not resulted in tangible results.^{xiv}

The National Gas Master Plan (NNPC undated) 2008 focuses on three critical elements which were identified as barriers to natural gas development: gas pricing policy, domestic gas supply obligation and gas infrastructure blueprint. It aims to grow the Nigerian economy through gas by pursuing three key strategies – stimulating the multiplier effect of gas in the domestic

economy, repositioning Nigeria competitively in high value export markets, and guaranteeing the long-term energy security of Nigeria.^{xlvii} FGN has approved a new market-reflective pricing regime for gas. Although gas supply obligation is currently an official policy, it remains to be seen to what extent the international oil companies will comply. Expanding gas processing facilities and transmission pipelines remains a daunting prospect for the Federal Government. This is compounded by the lack of an effective regulator for the gas mid- and downstream.

These climate compatible policies or programmes lack capacity or political will for implement the above outlined policies and programmes. In fact, some of the policy documents like the REMP and the National Energy Policy are yet to receive legislative attention or presidential endorsement. Even the Electric Power Sector Reform Act passed in 2005 has not been fully implemented. It is highly recommended that government should maintain and improve on their sole role of developing and regulating private sector friendly policies that will spur economic activities that will increase Nigeria's GDP per capita with socio-economic benefits.

There is no nationally recognized institutional framework or champion for the implementation of low carbon development in Nigeria. Although the National Assembly has passed a bill to establish a National Climate Change Commission, this has not been signed into law. However, other agencies of government such as the Energy Commission of Nigeria, Federal Ministry of Environment, Federal Ministry of Power, and the Renewable Energy Department of the Nigeria National Petroleum Corporation (NNPC), have a number of isolated activities seeking to promote low-carbon energy development in the country.

4.2.2 PRIVATE SECTOR PARTICIPATION IN DELIVERING LOW CARBON INVESTMENTS AND DEVELOPMENT

Private sector-led participation in the sector has been impeded by unsupportive policy frameworks. Lack of political will to fully implement policies and programmes stymie efforts to expand investments in the sector. Without the full liberalisation of the sector and the emergence of better fiscal policies such as tax holidays, duty-free waivers, cost-reflective tariffs, gas projects are unlikely to increase significantly. Monetary policies as well needs to reflect the better incentives to encourage investors. As no clear guarantees for a good return on invested capital exist, very few companies and financial institutions embark on these projects.

Energy projects, especially gas-to-power projects, have drawn the attention of some financial institutions. Recently, a \$25 million IPP gas plant generating 12.5MW of electricity was financed by Fidelity Bank in partnership with Lagos State Government.^{xlviii} First Bank of Nigeria recently signed an MOU with a Chinese firm to build a 3,000MW gas turbine power plant estimated to cost \$2.4 billion (First Bank Nigeria undated). United Bank for Africa Plc has financed a number of low-carbon energy projects in recent years including Ibom gas power plant.^{xlix}

Second, one of the important barriers to the growth of greener electricity supply has been the monolithic government-controlled power sector. Current power sector reform processes will lead to cost-reflective tariffs, providing incentives for increased gas supply to existing and new power plants. Associated and non-associated gas will increasingly replace the predominantly diesel-generating sets ubiquitous in companies and homes. As gas prices rise and regulation improves, more of the currently flared natural gas will find its way into power production. Flaring of natural gas and other energy related emissions represent about one-quarter of total Nigerian emissions of greenhouse gases. Over the years, Nigeria has set several deadlines for ending gas flaring – none of which has been kept.

Private sector led implementation though it may be profit oriented will ensure sustainability and diversification with favourable policies.

4.2.3 POLICY RECOMENDATION

- Establish a Joint Government-Industry Group: The FGN may need to set up a joint government-industry group to develop a low-carbon strategy and action plan for the oil and gas sector.
- Fund Mitigation Projects: This is to ensure that NNPC's annual budget includes sufficient funding for implementation of the high-priority mitigation options. It is imperative to consider implementing a "fast-track" budget approval process for mitigation options.
- Improve Collection and Availability of Data for GHG emission: Data Integrity is paramount for strategical and productive policy implementation as assumptions with regard to the oil and gas facilities in Nigeria and their condition needs to be

discontinued. In order to develop better and more detailed emission estimates that can form the basis of a detailed plan for their mitigation, it is recommended that the FGN promotes the following:

- ✓ The creation of a sector-wide inventory of emission sources. Apart from information on current GHG emissions, the inventory should include the status of each source—for example, age, condition, emission reduction actions already taken—and identified potential emission reduction options.
- ✓ Application of the Tier 1 or Tier 2 estimation methodology of the Intergovernmental Panel for Climate Change (IPCC) to establish the current level of emissions. (these methodologies are described in the API Compendium, 2009).⁵
- **Gas Flaring Reduction:** Flaring reduction should be the highest priority action, not only to reduce the direct emissions from the flaring, but also to extract maximum benefit from conserving gas through implementation of other mitigation measures. Because of the high cost of installing gas gathering and processing facilities at small flare sites, it is recommended that consideration should be given to collecting the small volumes of AG in clusters for processing and export of the dry gas and LPGs.
- **Improve Energy Efficiency:** Consider replacement of older and/or smaller on-site power plants with new equipment and improved use of variable-speed drives on pumps and compressors to improve efficiency.
- **Ensure inclusion and Jobs Creation:** ensuring level playing field, access to financial services, technology upskilling and capacity building.
- **Deliver competitiveness and market access:** e.g., competitive power tariffs, pricing, quality, market entry and incentivizing transiting climate friendly technology and infrastructures for example removal of import tariff on LPG equipment, etc.; applying FGN protocols to support markets e.g. the Ease of Doing Business and better monetary policies. Government can incentivise more investments by offering equity investments, guarantee schemes, low interest funding, tax incentives, concessions or private or community management of publicly owned assets. By incentivising private sector investments, several projects that would otherwise have been challenging for private or public institutions could be realised. This will further drive down prices and make low-carbon energy technologies more affordable to the poor.

4.2.4 OTHER RECOMMENDATIONS FOR REDUCING EMISSIONS:

- Since some flaring will still occur (for example, for safety), consider improvement of the combustion efficiency of remaining flares.
- Replacing fixed roof tanks with floating roof tanks with gathering systems for the liberated gas.
- Gradual implementing of enhanced and directed inspection and maintenance programs for efficient and sustainable reducing emissions in other oil and gas ventures.
- In alignment with digital economy, protection and utilization of assets is critical as the industry is very asset intensive. Industrial Internet of Things (IIoT) can be beneficial within the oil and gas value chains in the following ways:
 - ^ Large amounts of reservoir data can be integrated with real-time field data to plan well placement and flow rates.
 - ^ IIoT could be used to help reduce Non-productive Time (NPT) events by using real-time data to predict breakdowns and schedule preventative maintenance.
 - ^ Connecting pipeline, ships, railroad, road tanker networks, sensors, leak detection, alarms, and emergency shutdowns to interact seamlessly and to be available for analysis and interpretation in real time would significantly reduce some of the major risks in the sector.
 - ^ With the use of IIoT, refineries and natural gas fields can plan shutdowns and schedules, minimize downtime and improve safety.

⁵ API (American Petroleum Institute). 2009. Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry. Washington, DC.

- ^ Asset tracking, supply chain optimization (from filling to delivery), closing the gap with end customer, smart gas metering.

4.2.5 LONG TERM RECOMMENDATION:

Several technologies may become economically attractive to implement in the longer term, including alternative energy sources such as wave power to replace on-site gas/diesel combustion and carbon capture and storage. The cost trend for these technologies should be monitored and, when they appear to be viable, their potential for implementation in Nigeria should be considered.

- Build strategies for low carbon business models that minimize carbon use while remaining profitable, and articulate these strategies clearly to markets and other stakeholders.
- Support the development of Environmental Social Governance (ESG) metrics that are transparent, objective, and accessible to investors.
- Invest in the promising concepts of net zero emissions and the circular economy while adhering to the nationally determined contributions model of the Paris Agreement.
- Encourage the growth of international carbon markets through Article 6 of the Paris Agreement, and expand the possibilities for joint cross-border projects for emissions reduction.
- Develop a workforce strategy that leverages the above into restoring oil and gas as an attractive destination for younger talent concerned about the ESG footprint and stranded asset risk of the industry.

4.3 Challenges

However, it is imperative to note that obtaining data directly from operators on mitigation activities especially as it relates to financial investment on asset poses a major issue, which may be attributed but not limited to the non-disclosure agreement operators may have with their respective partners.

Annex

Annex 1: List of projects considered under the baseline scenario Implemented Projects

SN	Operator	Project Name	CAPEX (USD million)	Source
1	NPDC	Oredo Integrated Gas Handling Facility (IGHF) project	680	https://www.naturalgasintel.com/articles/99808-oneok-to-invest-480-680m-on-gas-processing-plants . Price estimated based on cost of a processing plant in the US.
2	TOTAL	Ofon Phase 2 Project	6.63	Based on https://allafrica.com/stories/201405190771.html
3	SPDC	Otumara/Saghara Associated Gas (AG) Project	101	Based on https://www.shell.com.ng/media/2011-media-releases/pipeline-contract.html
4	NAOC	Akri & Kwale Gas Plant Flare Down Project	130	https://www.eni.com/en_NG/health-safety-environment/environment/gas-management.page

Annex 2: List of projects considered under the baseline scenario Ongoing Projects

5	Platform	Asuokpu/Umutu field, OML 38	16.97	Based on knowledge of industry. Investment is only attributed to the cost of equipment for gas recovery and transport the domestic pipeline
6	Xenergi	Obodogwu/Ebendo Field	14.82	Based on knowledge of industry. Investment is only attributed to the cost of equipment for gas recovery and transport the domestic pipeline
7	SPDC	Forcados Yokri Integrated Project (FYIP)	212	https://www.alcon-nig.com/under-execution/fyip-phase-ii
8	SPDC	Southern Swamp Associated Gas Gathering Project	960	Based on a prior knowledge of the project. As the field contains the possibility of NAG, the project cost takes into cognizance the cost of recovery AG only

Annex 3: List of projects considered under the baseline scenario Planned Projects

9	NGFCP	Third Party	525	Based on the government pronouncement that at least 80 per cent of gas from flare locations can be viably utilized; and about \$ 3.5 billion worth of inward investments by third party investors. Flare from 178 flare sites identified collectively flare about 330 billion cubic feet (bscf). Obtaining financing for gas projects could be very challenging based on prior experience from operators in the country.
10	NGFCP	Third Party	525	Despite the current ambition, under the baseline scenario it is assumed that only about 30% of the flare volume will be achieved between the year 2022 and 2025, Hence, IF was conservatively assumed to be about 30% of the anticipated project cost.

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