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GAS PRODUCTION AND UTILIZATION IN NIGERIA: A LONG-TERM PERSPECTIVE

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Abstract:

The study reviewed the gas production and utilization in Nigeria and outlines strategies for long term development. There is weak gas resource management system in Nigerian that has resulted to gas production being at 8.0bscf/d with utilization of 39% (2.9 bscf/d) on NLNG, 31% (2.3 bscf/d) on reinjection and other operational usage, 15% (1.1 bscf/d) on gas flaring and 16% (1.2bscf/d) on domestic gas consumption. The study shows a 41% daily average domestic gas supply obligation performance. Extensive review of related literatures was used to obtain relevant data and information on gas production and utilization in Nigeria. The study revealed inconsistencies and low gas production and utilization in Nigeria with respect to the Nigerian Gas Master plan that was not fully implemented, relatively low gas flare penalty and insufficient domestic gas utilization projects. The compressed natural gas utilization in Nigeria has only been used in Benin-City for cars, Nestle Shagamu factory and Power gas Africa. The proposed strategy for the long-term gas production and utilization in Nigeria includes sustainable management structure, sustainable governance and regulatory structure and sustainable financing structure.

Keywords: Gas Production and Utilization; Gas Infrastructure; Domestic Gas Obligation; Sustainable Management Structure; Sustainable Governance Structure; Sustainable Financing Structure.

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1. Introduction

There has never been a deliberate attempt to exploit the gas resource as a means to boost the Nigerian economy or means for sustainable economic development since the discovery of crude oil in 1956 at Oloibiri in the present Bayelsa State and a significant proportion of the Nigeria's gas was discovered accidentally during exploration for oil (National Gas Policy, 2017), while According to BP Statistics (2017), Nigeria ranks 23rd position in the global gas production and with the biggest share of production coming from Associated Gas (AG) and there has been little or no concerted effort to develop the Non-Associated Gas (NAG) fields in Nigeria. Natural gas is the most dominant natural resource in Nigeria with a proven gas reserves of 199.090 trillion cubic feet (tcf) of gas comprising of 96.36 trillion cubic feet (tcf) occurring as Associated Gas (AG) and 102.730 trillion cubic feet (tcf) occurring as Non-Associated Gas (NAG) and with this, Nigeria

ranks as the ninth (9th) largest gas reserve in the world and it is evident, that Nigeria has more gas reserve than oil (Department of Petroleum Resources Annual Reports, 2017).There has always been a shortfall in meeting up with the domestic gas obligation in Nigeria and this has affected the economic activities that would have been triggered, in the form of gas based industrialization (Department of Petroleum Resource Annual, 2016). According to National Gas Policy (2017), Nigeria domestic gas obligation performance is currently at 38.18 percent and the economic recovery and growth plan (2017 – 2020) developed by the federal government of Nigeria, that was framed to strengthen the economy within the short term economic growth framework, did not capture gas exploitation and development as a means or driver for economic growth in the short term framework.

However, according to Ugbo (2013), it is envisaged that the Nigeria gas proven reserves will increase gradually to 250 trillion cubic feet (tcf) by year 2020 and the primary natural gas resource development strategies is centered on reducing the cost of extracting unconventional gas and building integrated chain for commercializing stranded gas resources that are far from market through liquefied natural gas (LNG) and gas to liquid (GTL) technologies as well as through long distance pipelines.

Okon (2014), explained that gas utilization under the Company Income Tax Act (CITA) is defined as: "the marketing and distribution of natural gas for commercial purpose and it includes : power plant, liquefied natural gas, gas to liquid plant, fertilizer plant, gas transmission and distribution pipelines". However, there is increasing utilization of gas in Nigeria for power generation, fertilizer, petrochemical and manufacturing; But there is lack in the gas feedstock for a number of industries, with inefficiency in gas resource management and Okafor (2016), posits that the pace at which gas resource and its associated infrastructure are developed in Nigeria is unimpressively slow and Odunuga (2016), stated that Nigeria has about 400 trillion cubic feet (tcf) to 600 trillion cubic feet (tcf) of natural gas that is yet to be discovered, which is about 7.7 percent to 11.5 percent of the total global quantity of natural gas that is yet to be discovered and this is a huge economic gain with respect to economic development in Nigeria through gas based industrialization; however, the gap therein is the lack of gas resource management plan for structured economic development.

While, Nigeria with an average daily gas production of approximately 8.0 bscf/d with 39 percent (2.9 bscf/d) LNG (NLNG with six trains and expansion into the seventh train) utilization, 31 percent (2.3bscf/d) reinjection / other operation usage, Gas flaring at 15 percent (1.1 bscf/d) and domestic gas consumption at 16 percent (1.2 bscf/d) is clear indication that meeting the domestic gas obligation is still a challenge in Nigeria, as a result of lack of gas infrastructures to support the demand (DPR, 2016).

Gas production and utilization has been struggling to meet with domestic gas supply obligation due to lack of critical gas infrastructure, which is the pipeline and presently, there is a daily average domestic gas supply performance of 41% resulting from 1065.58 MMscfd supplied to the domestic market by eleven companies(DPR,2017).

Natural gas is one of the non-renewable fossil fuel that is formed from the remains of sea animals and plants that died 300 to 400 million years ago ; it comprises of a mixture of hydrocarbon and

non hydrocarbons in the gaseous phase or in solution with oil in underground reservoirs at reservoirs conditions (OPEC, 2017).

Bismuke (2014) states that natural gas exist as wet, dry, sweet or sour gas; and the economics associated with the processing and transportation with each of them varies.

According to Onyekonwu (2016), natural gas is produced from reservoir rock and it is a mixture of light hydrocarbon gases, impurities and liquid hydrocarbons. Natural gas is found below the earth's surface in three principal forms:
1) **Associated gas** usually occurs in oil reservoirs and dissolved in the crude oil, or combined with the crude oil and the gas is produced along with crude oil from oil wells is separated from the oil at the head of the well. While, according to PFC Energy (2007), associated gas includes the gas cap (gas residing above oil in a reservoir).
2) **Non-associated gas** occurs naturally in reservoirs that do not contain crude oil and the production process and technology is mainly for the gas
3) **Gas Condensate** is usually termed as natural gas liquids and the density is high with no surface boundary.

According to Lin Z et al (2003), forecasting the future gas production is essential for efficient management and utilization of natural gas and conventionally, the decline curve is used with the following assumptions:
1) Production has to be stable over the period with constant choke size/constant wellhead pressure
2) Should reflect the reservoir productivity and not be as a result of external causes

Inkpen and Moffett (2011), states that gas production usually starts much later, when compared to crude oil production and it is usually produced at 2% or 3% of the total reserve at a constant rate over a long period and this is produced at a constant rate over a very long period of time.

This study outlines a long term perspective to gas production and utilization in Nigeria.

This study is significant because, effective management of gas production and utilization is a means to boost the economy through increase in revenue accruing to the government and stakeholders; The typical example of gas based economy is the Qatar Gas with a proven gas reserve of 896 tcf and fourteen (14) LNG trains contributes about 57.8% to the Gross Domestic Product (http://www.qatargas.com/english), while the Nigerian Liquefied Natural Gas (NLNG) contributes about 4% to GDP (NLNG, 2013).

The study is also significant, as it would support the domestic gas utilization in the form of Liquefied Petroleum Gas (LPG) that is obtained from the natural gas processing. Oluwabunmi (2014), posits that there is a large market for Liquefied Petroleum Gas (LPG) in Nigeria; While, about 20,000 tons of Liquefied Petroleum Gas (LPG) out of a total estimated market demand of 200,000 tons per year (tpy) is imported. With the increasing average domestic gas demand in Nigeria resulting to about 600 mm cubic feet per day (cfpd), While there is a projection for average domestic gas consumption to increase to over 4,800 mm cfpd by 2020. Hence, there is increase in the demand for domestic Liquefied Petroleum Gas (LPG) market in Nigeria is and this would lead

to the high tendency to displace other fuels used for cooking. Interestingly, as Nigeria experiences a significant increase in population, it is expected that progress in economic development will occur at a pace that can support her population growth and natural gas is considered critical to the process of a long term economic development.

The study is significant, because it is a means of economic development through gas based industrialization; natural gas is used in petrochemical and manufacturing industries, while 60 mm cfpd is estimated gas demand for these industries, the optimal utilization of the gas resources by these industries shall form a framework for industrialization in Nigeria with anticipated economic multiplier effect and this would be in line with the Sustainable Development Goal nine (9) with the objective of promoting inclusive and sustainable industrialization by building resilient infrastructure that will foster innovation.

In terms of sustaining economic growth in the long term in Nigeria, this study is very important as it is in line with Sustainable Development Goal Seven (7) with the objective of ensuring modern energy to all that is affordable, reliable and sustainable.

The significance of this study is premised on the basis that the Nigerian strategic aspiration as enshrined in the Gas Master Plan (GMP) of year 2008, was aimed and geared at growing the economy using natural gas and this is further enunciated in the National Gas Policy of year 2017. Furthermore, the Nigerian government through the petroleum ministry and related agencies has not come up with any long term economic plan for the natural gas industry and pipeline infrastructure development; The recent initiative of the Nigerian petroleum ministry is the short and medium term priorities to grow the gas industry, which has a time frame of four years (2015-2019). The question is what happens after 2019 or what is the plan after 2019 ? The economic recovery and growth plan aims to restore sustained economic growth in Nigeria, but did not capture gas development as a means of industrialization in its medium term framework.

Hence, this study provides a long term perspective to managing the natural gas production and utilization in Nigeria.

2. Materials and Methods

The study adopts extensive literature review and analytical framework model to determine the strategies necessary for long term gas production and utilization development in Nigeria and these include the following steps:
1) Extensive review of the gas industry in Nigeria
2) Review of the gas production and utilization in Nigeria

The analytical framework involve extensive review and research deductions. The analytical framework steps includes the following:
- Analysis of the gas industry in Nigeria
- Analysis of gas production and utilization in Nigeria

The major sources of data in this study include the following:
1) Department of Petroleum Resource Annual Reports

2) Gas Aggregation Company of Nigeria (www.gacn.com)
3) Nigerian National Gas Policy (2017)

3. Results and Discussions

3.1. The Nigerian Gas Company

The Nigerian Gas Company Limited (NGC) was formed in 1988, as one of the eleven (11) entities of the Nigerian National Petroleum Corporation (NNPC) with the objective to develop an effective gas sector in Nigeria that would support the industrial sector through an integrated gas pipeline network and export natural gas to the neighboring countries (West African Sub-region).(http://ngc.nnpcgroup.com/).

There is about 2,000km of gas pipelines all over the country and it is the responsibility of the Nigerian Gas Company to manage these pipelines; some of the key pipeline projects of major economic benefit to Nigeria includes the following:
1) Escravos Lagos Pipeline
2) Obiafu-Obrikom-Oben (OB3) pipeline
3) Ajaokuta-Kaduna-Kano (AKK) gas pipeline

Recently, the Nigerian Gas Company (NGC) has been split into, Nigerian Gas Processing and Transmission Company (NGPTC) and Nigerian Gas Marketing Company (NGMC) (www.africaoilgasreport.com).

3.1.1. Nigerian Gas Master Plan

The Federal government of Nigeria approved the implementation of the Gas Master Plan (GMP) in 2008 based on the fact of establishing Nigeria, as a leading gas based industrialized economy through the export of Liquefied Natural Gas and a full blown domestic market by 2015 and the plan has not delivered on all its set target. For instance, Nigeria still lacks critical gas pipeline infrastructure and has continued to fall short of domestic gas supply obligations (National Gas Policy, 2017).

The blue print for the Gas Master Plan (GMP), which set out the gas infrastructures necessary to the western and eastern parts of the country and building new gas pipelines from the south to Ajaokuta, to Abuja and to the northern part of Nigeria. The first part of the infrastructure required the construction of Central Processing Facilities (CPFs) in the Niger Delta region to process wet gas supply to onshore gas transportation networks and industrial plants and further to the Gas Master Plan, about 590km of gas pipelines have been completed and commissioned and these pipelines include the following :
1) Oben – Geregu (196km)
2) Expansion of Escravos -Warri-Oben (110km)
3) Emuren-Itoki (50km)
4) Itoki – Olorunshogo (31km)
5) Imo River – Alaoji (24km)
6) Ukanafun-Calabar (128km)

7) NOPL (50km)

With these projects, it is expected that all the available power projects in Nigeria are connected to permanent gas supply pipelines (www.nnpc.com).

The domestic gas supply was introduced to address challenges in the domestic market and provide a pricing path for wholesale gas supply to downstream offtakers. The domestic supply obligation is broken down to an annual delivery obligation (i.e delivery to the nearest gas transmission infrastructure) on all gas producers with total obligations equaling the planned domestic need for gas (National Gas Policy, 2017).

The National Domestic Gas Supply and Pricing Regulations of year 2008, proposed different gas prices for different consumer groups. While, the Gas Aggregation Company of Nigeria, (GACN) was established as a strategic aggregator, to manage the implementation of the domestic supply obligation and aggregate price (National Gas Policy, 2017).

3.1.2. Gas flaring in Nigeria

According to NGFCP (2016), the National Gas Flare Commercialization Program was instituted by the Nigerian government in December, 2016 through the petroleum ministry and its regulatory agency (i.e Department of Petroleum Resources) to reduce gas flaring, obtain economic benefit and social benefit from the program. Gas flaring causes environmental and health issues which includes; unwanted emissions to the atmosphere and respiratory ailments. While 70 % has been achieved in the flare gas utilization program, there is target of zero flare by year 2020 that need to be met.

With effective implementation of the flare gas utilization project, the host communities would derive a huge economic and social benefit arriving from better environment for agricultural activities in the form farming and fishing and the four ways geared towards this achievement of the zero gas flare by year 2020 are as follows:
1) Improving the market and licensing process
2) Better financing option with incentives
3) Better implementation and monitoring process
4) Improving the Nigerian capabilities with engagement of other stakeholders.

Moreover, to achieve a viable and licensing system, it shall involve the following:
1) **Develop contracting framework:** Develop a flexible and transparent system that balances licensees' needs and operators' concerns
2) **Pricing scheme**: There is need to provide incentives for operators support the gas flare utilization projects.
3) **Off-takers:** To ensure that they readily available offtakers that are financially and technically viable to receive the gas and pay for it.
4) **Make data available**: The operators should routinely provide data on their location, and other relevant data to the government agency that requires them.
5) **Implementation of licensing process**: There is need to have temporary waivers for those whose operation has commenced.

3.1.3. Issues with Gas Flaring

According to NGFCP (2016), the penalty for gas flaring is relatively very low relative to other countries, while this rate has been upgrade to meet up with the prevailing economic indices over a long period. However, the penalty for gas flaring has passed through the following stages in Nigeria:

1) **1998**, gas flare penalty was at 10 Naira (approximately $0.50) per mscf.
2) **The gas flare penalties** are paid by oil operators and are usually tax deductible
3) **There was** an attempt in the year 2008, to shore up the penalty for gas flaring to $3.50 (approximately 420 Naira) per mscf, but this actualized due the resistance by the stakeholders in the oil and gas industry in Nigeria.
4) **In 2015,** Department of Petroleum Resource waived ¼ of the N3 billion assessed gas flare penalty.
5) **25% gas flare penalty** are waived and defaulted in Nigeria, while the current penalty is; at 0.03 USD/ mscf in Nigeria, Norway is 3.40 USD/mscf, and Russia is 0.65 USD/ mscf.

3.2. Gas Utilization in Nigeria

According to Strategic Gas Plan for Nigeria (2004), natural gas utilization options in Nigeria are streamed into the following:

1) Gas to Power
2) Gas to LNG Plants
3) Gas to GTL
4) Gas to pipelines for export
5) Gas to chemicals, refineries, and other users in the domestic, commercial and industrial sectors of the economy.

While according to www.napims.com, the gas utilization projects include the following:

- Liquefied Natural Gas
- Independent Power Plant
- Gas to Liquid Conversion
- Natural Gas Liquids
- Methanol
- Gas supply to local industries

According to DPR (2017), the average daily gas utilized in Nigeria for 2017 is 7.09BCFD,While according to NGPTC (2017), there slightly over 1,800km of gas pipeline in Nigeria (varying diameters, up to 36") delivering gas to western, eastern and northern regions and the major gas projects development projects includes the following :

1) NLNG Project
2) Brass LNG ($3.5bn)
3) OKLNG (US$.7bn)
4) WAGP – West African Gas Pipeline
5) NPDC for domestic gas obligation
6) Oredo Intergrated Gas Handling Facility -65mscf/d
7) 120km East – West Gas Pipeline

8) Calabar – Ajaokuta – Abuja -Kano Pipeline (1000km)

3.2.1. Natural Gas Utilization Projects in Nigeria

According to www.naipems.com, the various gas utilization projects in Nigeria under auspices the Nigerian National Petroleum Corporation and they are as follows:

3.2.1.1. Escravos gas project

The Escravos gas project the plant is located in the southwestern part of Nigeria and it is target is for export of Liquefied Petroleum Gas (LPG), which is the main product.

3.2.1.2. Oso NGL Project

This project is NNPC/Mobil Joint Venture (JV) and the Natural Gas Liquid (NGL) plant is located at OSO field in the south Eastern part of Nigeria and Its production for export came on stream during the third quarter of 1998.

3.2.1.3. Liquefied Natural Gas Project

The liquefied natural gas has been major source revenue to Nigeria and stakeholders (TOTAL, AGIP and SHELL). The plant currently has six trains and it is been expanded to accommodate the seventh train (detailed engineering to commence within the last quarter of 2019) and this increase the production as well earnings to country and stakeholders.

3.2.1.4. Ekpe Gas Compression Project

The Ekpe gas compression project is geared towards gas lifting and gas re-injection with the overall objective of reducing gas flaring.

3.2.1.5. Oso 2Y2 Project

The Oso 2Y2 project is to increase the produced capacity of the Natural Gas Liquids and maintain condensate production.

3.2.1.6. Belema Gas Injection Project

The Belema gas utilization is estimated at 80mmscf/d spread into re-injecting, gas lifting, used as fuel by local industries and backing out non associated gas that was used to meet various existing contractual obligations.

3.2.1.7. Odigbo Node Gas Project

The Odigbo node gas project is for gas lifting and to supply gas to Aluminum Smelting Company of Nigeria (ALSCON) and the total gas utilization is 113mmscf/d. The Odigbo node gas is from an associated gas field.

3.2.1.8. Odidi AGG project

The Odidi gas project is to gather gas and inject into the Escravos to Lagos Pipeline, which will and then to the West African Gas Pipeline that will supply gas to some West African Countries.

3.2.1.9. Cawthorne Channel Gas Injection Project

The cawthorne channel gas injection is currently operated by EROTON exploration and production company and gather the gas that is flared for re-injection and process to have Liquefied Petroleum Gas (LPG).

3.2.1.10. The West African Gas Pipeline Project

The west african gas pipeline project comprises the governments of Nigeria, Ghana, Benin and Togo signed an agreement in 1995 with the objective supply gas, in line with article 48 of the Economic Community of West African States (ECOWAS).

3.2.1.11. Greenfield LNG project in Port Harcourt

Presently, a mini-Liquefied Natural Gas facility project in Port Harcourt (at Rumuji area), with three trains and is projected and proposed to commence with a capacity of 2,200 metric tonnes with a total cost outlay of $850 million. The first phase cost outlay is $500 million and would be increased to $850 million subsequently. This project is fully on equity financing without any bank financing. The product market design has the capacity to transport the products up to 1000km with special trucks (http://sweetcrudereports.com).

3.2.2. Compressed Natural Gas Utilization in Nigeria

According to Dami (2008), compressed natural gas is seen as the solution to stranded gas flare sites and it requires little pre-treatment as compared to Liquefied Natural Gas (LNG) and more easily adaptable and adequate for small flares. The compression ratio is than that of LNG and it is more suitable for short distances.

Benin city NIPCO's CNG cars
In 2007, NIPCO (i.e now 11plc) launched in joint venture with Nigerian Gas Company, a CNG programme in Benin-city to convert cars and build CNG stations for refueling.

Nestles Sagamu Factory
Nestle Sagamu plant installed G.E Jenbacher gas engines to produce electricity on its production site. Gas is transported with CNG trucks. Volumes of gas and supplier are unknown.

Power Gas Africa
Power Gas has three CNG facilities with total production of 25mmscf per day supplying industries with gas to power. Customers are mainly from the agri-food industry. Compressing facilities are located in Lagos, Ibadan and Port Harcourt.

4. Conclusion and Recommendation

4.1. Strategies for Gas Production and Utilization Development

In order, to achieve an efficient gas production and utilization development with long term benefit in Nigeria, the following strategies should be considered and implemented:

4.1.1. Sustainable Management Structure

For economic development to thrive from gas production and utilization in Nigeria there is need to have sustainable management structure of gas infrastructures and this can achieved by full divestment of the current gas pipeline operating companies (i.e NGPTC and NGMC). The private participation will bring in full competition in this sector and breakdown the monopoly of the federal government of Nigeria, The sustainable management shall consist of a select International Oil Companies as a joint venture to operates gas infrastructures; the model shall be similar to the Nigerian Liquefied Natural Gas company model, but shall exclude the NNPC from the joint venture or consortium.

4.1.2. Sustainable Governance and Regulatory Structure

In order to achieve long term economic development from gas infrastructures, there is need to have a single regulatory agency with a gas act that would set the modalities for investors to participate in the sector.

4.1.3. Sustainable Financing Structure

There is need to have a sustainable financing structure for the gas pipeline development, because it requires huge investment and the strategy is set up Energy Bank in Nigeria, whose sole responsibility is to interface with international finance houses and firms on long term low interest loans for gas pipeline development in Nigeria.

5. Appendices

Appendix A: Table 1.0: Major gas project in Nigeria

S/N	Company	Project Title / Location	Expected Completion Date	Expected Production / Processing Capacity(Mmscfd)	Petrochemicals Product Output (Mtpa/Mtpd)
1	Chevron Nigeria Ltd	Abiteye NAG Development Compression Station project Abiteye in Delta State	2019	40	N/A
2	Chevron Nigeria Ltd	Okan and Meji Debottlenecking Projects	2019	340	N/A
3	Dangote Fertilizer Limited	DANGOTE Urea Fertilizer Plant Lekki Free Trade Zone, Lagos	2018	N/A	2.5 million TPA urea
4	Green Energy Int. Ltd.	LPE Extraction Plant Otakikpo Marginal Field, Rivers State	2019	N/A	
5	Greenville Oil & Gas Co. Ltd.	Mini LNG Plant Rumiji (Emohua LGA) Rivers State	2018	N/A	0.25 MTPA LNG
6	Niger Delta Petr. Resources Ltd.	Ogbele Gas Plant Expansion/Enhancement Works Ogbele, PH	2018	300	• 40mmscfd C1 • LPG • C5
7	Nigerian Petroleum Dev. Co. (NPDC)	UTOROGU NAG 2 PROJECT Utorogu, Warri, Delta State	2018	150	
8	Nigerian Petroleum Dev. Co. (NPDC)	Egbgema West NAG Project		50	N/A
9	NLNG - Nig. LNG Ltd.	Train 7 Project		N/A	7MTPA LNG
10	Pan Ocean	Gas Proc. Plant Ph. 2 (GPPP2) (Ovade-Ogharefe Gas Plant)	2019	200	N/A
11	Seplat Petroleum Development Co. Plc.	Assa North/Ohaji South (ANOH) Midstream Project (NAPIMS) AssaN./Ohaji S., Imo	2019	300	N/A
12	Seplat Petroleum Development Co. Plc.	Oben Gas Plant Expansion project	2018	225	N/A
13	Shell Petroleum Dev. Co.	Southern Swamp Associated Gas Solutions Plus Project	2018	100	N/A
14	Shell Petroleum Dev. Co.	Assa North/Ohaji South (Anoh) Gas Plant Project, Ohaji North & Ohaji South fields, Imo State	2019	300	N/A
15	Shell Petroleum Dev. Co.	Focados Yokri Integrated Project (FYIP), Focados Yokri Area	2019	150	N/A
16	Shell Petroleum Dev. Co.	Soku NAG Compression Project, Rivers State	2019	1 Tscf of gas recovery	N/A
17	Shell Petroleum Dev. Co.	Domgas and AG Solution Project - - Agbada NAG Solution Project, Rivers State	2019	80	N/A

Source: Department of Petroleum Resource (2017).

Appendix B

Table 1.1: Gas reserves and resources in place and ownership type

2P GAS RESERVES / RESOURCES IN PLACE							
S/N	Ownership Type of Gas	Gas Reserves (TCF)					
		AG		NAG		TOTAL	
		Proved (2P)	Resources in Place	Proved (2P)	Resources in Place	Proved (2P)	Resources in Place
1	NPDC	0.33	1.13	1.64	2.60	1.98	3.73
2	NPDC JV	8.12	22.82	5.67	10.80	13.80	33.62
3	NNPC JV	74.44	187.87	60.43	100.41	134.87	288.29
4	PSC	13.01	43.71	17.03	14.60	30.04	58.32
5	Sole Risk/Independents	1.41	3.88	9.89	8.46	11.30	12.34
TOTAL		97.31	259.41	94.66	136.87	191.99	396.3

Source: National Gas Policy (2017)

Appendix C

Figure 1.0: Gas Production and Utilization Profile in Nigeria
Source: Department of Petroleum Resource (2017)

Appendix D

Table 1.3: Nigerian associated and non-associated gas production

Year	Associated Gas (AG) bscf	Non- Associated Gas (NAG)	Total Production, bscf
2006	1,542	748	2,290
2007	1,599	1,008	2,607
2008	1,594	987	2,580
2009	1,582	646	2,228
2010	1,865	955	2,820
2011	1,839	1,127	2,967
2012	1,872	1,123	2,996
2013	1,787	1,025	2,812
2014	1,880	1,168	3,049
2015	1,740	1,262	3,003

Source: National Gas Policy (2017)

Appendix E

Table 1.4: Nigeria Gas Reserves

	Natural Gas Reserves (TCF)		
	Associated Gas, AG	Non Associated Gas, NAG	Total Gas
2010	92.945	89.872	182.817
2011	92.904	90.530	183.434
2012	89.729	92.529	182.258
2013	89.652	92.298	181.950
2014	90.094	97.904	187.998

2015	97.208	94.857	192.065
2016	97.253	101.485	198.738
2017	96.36	102.730	199.090

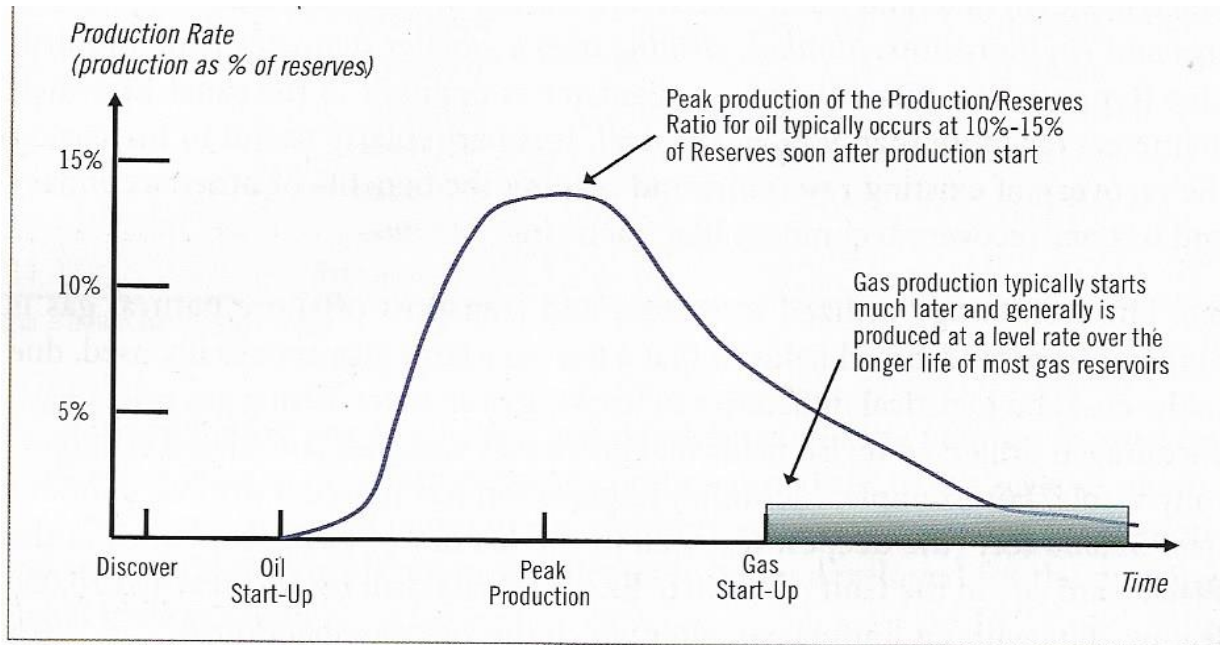Source: Department of Petroleum Resource (2017)

Appendix F

Figure 1.2: Typical Gas Production Profile Versus Oil Production Profile
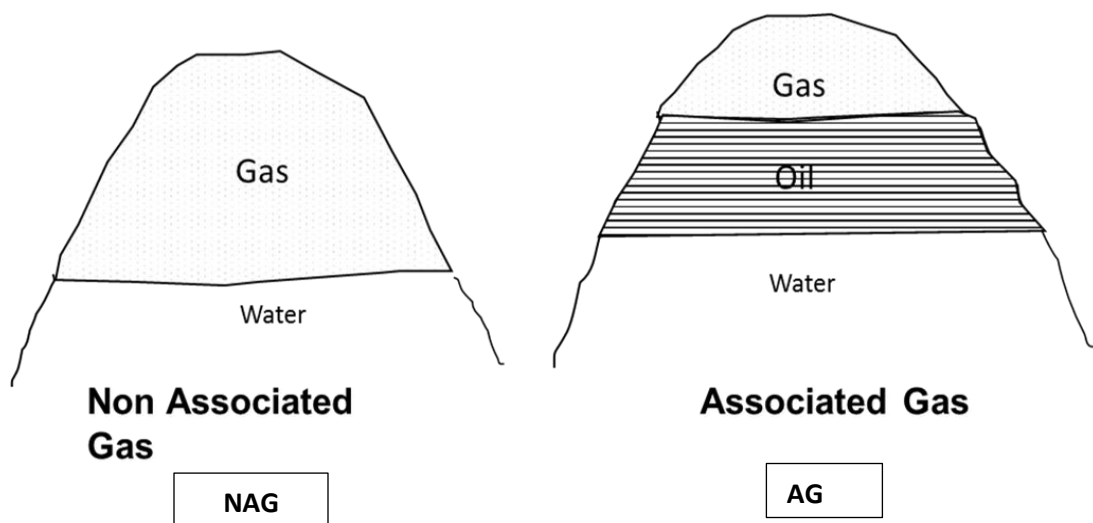Source: Inkpen and Moffett (2011)

Figure 1.3: Associated gas and Non – Associated Gas Reservoir
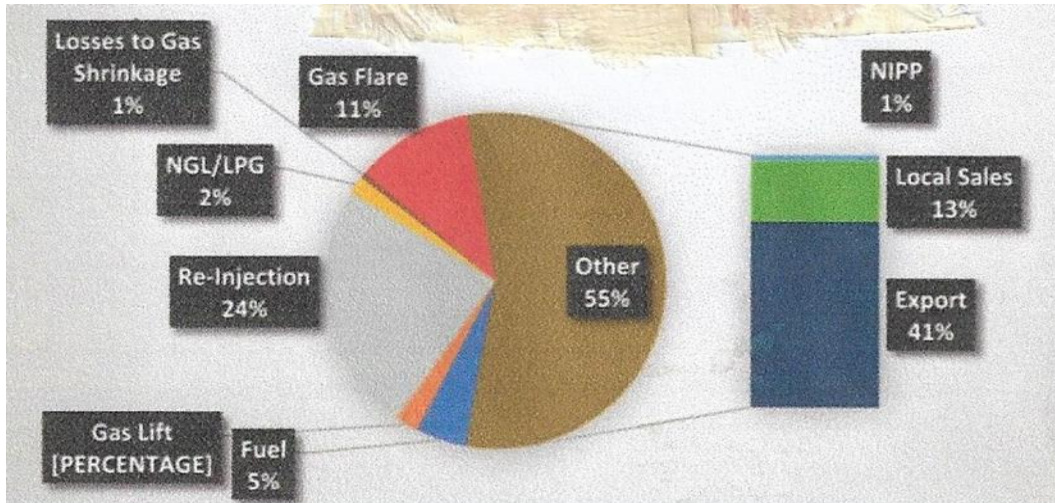Source: Onyekonwu (2016)

Figure 1.4: Nigerian Gas Utilization Breakdown
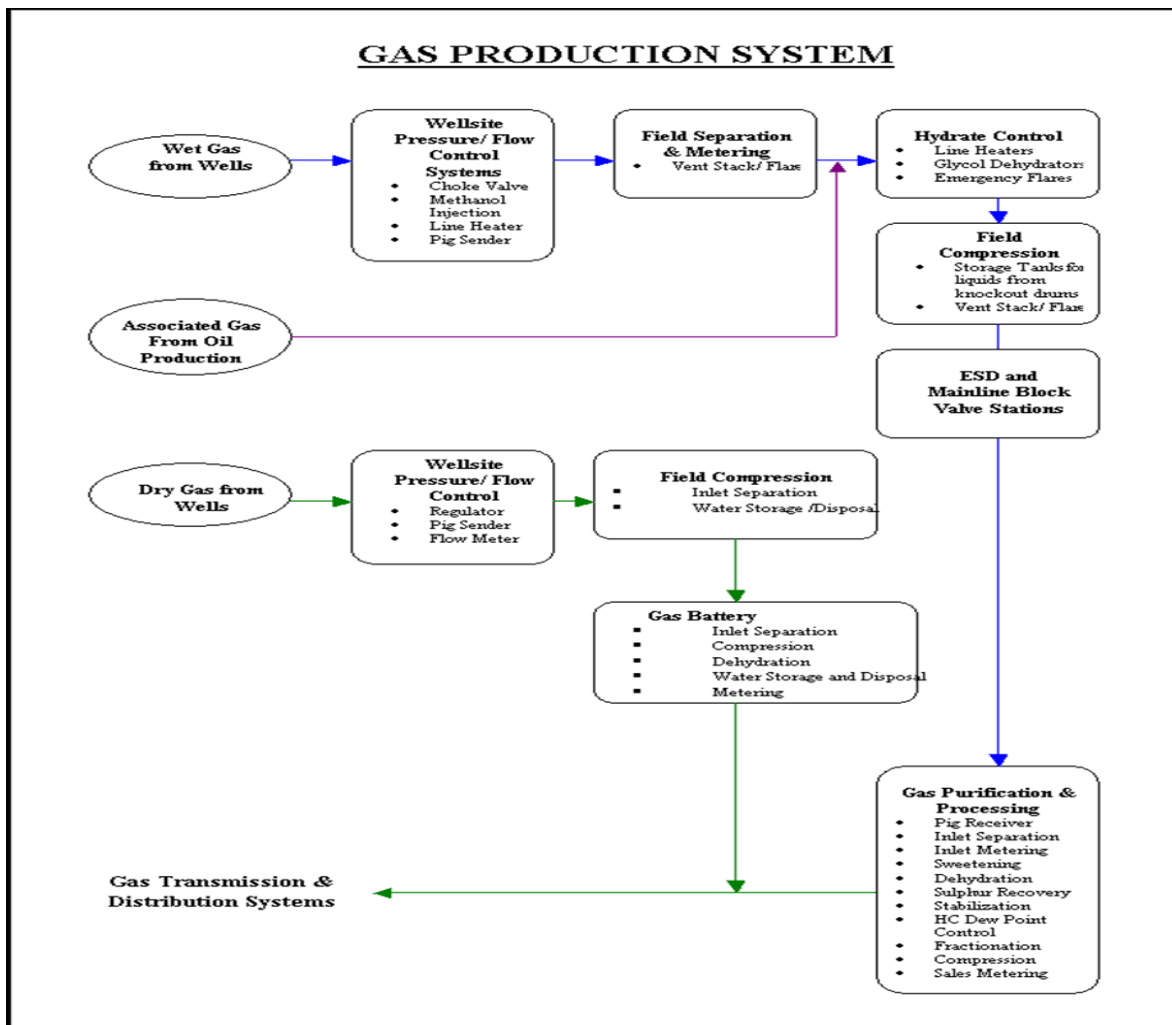Source: Department of Petroleum Resource (2017)

Figure 1.5: Gas Production System
Source: Bismuke (2014)

References

[1]   Ugbo F.The Gulf of Guinea : The Gas Master Plan and Opportunities for Development of Gas Infrastructures (2013), 5-20
[2]   Inkpen A. and Moffett M.H, The Global Oil and Gas Industry (2011), 303-433
[3]   Nigeria Gas Competance Serminar, National Gas Flare Commercialization Program (2016), 1-25
[4]   Maduekwe N.C, The Nigerian Natural Gas Industry: Critical Policies and Legal Issues (2015), 1-5
[5]   Nigerian National Gas Policy (2017), 1-8
[6]   Nigerian National Petroleum Fiscal Policy (2016), 77
[7]   Department of Petroleum Resources Annual Report (2017),78-96
[8]   Odunuga J., Green and Brown Field Development (2016)1-33
[9]   Gas Aggregation Company of Nigeria /www. gacn.com (2017)
[10]   www.nnpc.com [accessed on 20th October, 2018]
[11]   www.thenationonlineng.net [accessed on 20th April, 2019]
[12]   www.napims.com[accessed 24th April, 2019]
[13]   www.gidb.org/gas-introduction [accessed 7th May, 2019].

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