ISSN: 2634 - 8853

Journal of Engineering and Applied Sciences Technology

SCIENTIFIC Research and Community

Review Article

Open Access

Gas Production, Utilization, Flaring and Processing: The Nexus of Modern Energy Landscape and Evolving Lower Carbon Environment, Nigeria

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ABSTRACT

Nigeria is more of a gas than an oil province. Clean and reliable energy is inevitable to grow its economy. Moreso, there is a global shift to gas and renewable to power lower carbon industrial growth. With a 210 TCF gas reserve deposit and a life index of 94 years, the country can play a major role in this energy security for the Africa continent and international community. The study thus assessed the gas potential for the modern energy landscape. Collected data were interpreted to evaluate the feasibility and viability to enhance its economic development. Gas production stood at 7.59bcf/Day as at July 2025 with 6.91bscf/Day and 6.99 bscf/Day recorded in 2023 and 2024 respectively. A total of 2.511,345 TCF of Associated and Non-Associated Gas recorded in 2024 with 7.64% flared. This represents a slight increase of about 0.53% compared to year 2023. Utilization ranges from in-house gas consumption fuel, re-injection for reservoir pressure enhancement and sales to domestic and export markets through Nigerian Liquefied Natural Gas. Out of 2.511 TCF of gas produced in 2025, a total of 0.1918 TCF was flared. This represents 0.28% difference compared with the 7.36% flaring recorded in 2014. In 2014 alone, about 295 bscf of natural gas was flared leading to a massive loss of about $1billion in revenue. 2024 flare rate has shown a significant reduction with 191.834.6 mmscf of flared natural gas with a revenue loss of $133.716 million. In essence, 2014 to 2024 has revealed $877 million saved from gas flaring including drastic reduction in health hazards and environmental destruction of ecosystems. Domestic Gas Delivery Obligation performance record delivered 72.5% in July, up from 71.8% in June. 72.2% in January rose to 73.5% in February, dipped slightly to 70.8% in March, before climbing to 73.7% and 73.0% in April and May respectively all of 2025. Current major processing of natural gas is to produce CNG through the Presidential Compressed Natural Gas Initiative (PCNGI). 27 mother stations (compression hubs), 63 daughter stations (refueling outlets) and 242 certified vehicle CNG conversion centers achieved in 2025. Nigeria is thus gradually shifting to an eco-friendly economy to ensure low and net zero carbon target of 2030 and 2060 for a cleaner and egalitarian society.

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Received: February 25, 2026; **Accepted:** March 09, 2026; **Published:** March 12, 2026

Keywords: TCF is Trillion Cubic Feet, Reservoir Pressure, Bscf/Day is Billion Standard Cubic Feet Per Day, CNG is Compressed Natural Gas

Background Knowledge

Natural gas is estimated to be the fastest growing fossil fuel in the world and is projected to overtake coal by 2030, as the second largest source of energy after oil despite decades of coal mining as energy source before widespread gas utilization. Globally, 64% of the top 10 global petroleum discoveries in 2018 till 2023 was natural gas. According to the International Energy Agency (IEA), global demand for natural gas grew by 4.6% in 2018 alone, driven by strong economic growth and the transition from coal-fired electric power plants globally to gas, a condition traced to climate change mitigative strategy among others [1]. Gas accounted for nearly half of the world's growth in energy demand, with China, India and the United States leading the consumption trend across the world. Nigeria's gas reserves of about 210 tcf is primarily located in the Niger Delta Basin area (Figure 1) which consists of 75,000 square kilometers of onshore swamp and extends offshore into shallow water and finally into deep and ultra deep-water terrains. Research is currently ongoing across other sedimentary basins through the Frontier Exploration Fund to diversify and discover new oil and gas sources. This has yielded tremendous results with the discovery of gas deposit in south-eastern Nigeria.

This is important to use hydrocarbon wealth unite the people of Nigeria to have a common developmental inclusive agenda [1]. With oil reserves of approximately 37.5 billion barrels and natural gas reserves of almost 210 trillion cubic feet, Nigeria

has a significant place in the global energy market, if sincerely harnessed.

Despite massive hydrocarbon wealth, the country's domestic gas consumption is still a challenging one due to complex diverse Geological and environmental terrains across her landscape. With ongoing new reforms, International financial institutions (IMF and World Bank 2025) are already projecting an economic growth rate between 4.2%-4.5% as the country enters post-subsidy period, new tax regime, single exchange rate window, massive external reserve, more vibrant stock market and banking recapitalization era among other several economic reforms to tackle the challenges. The World bank-IMF meeting 2025 has also predicted a slight drop in world economic growth from 3,2% to 3.1% in 2026, but this study forecasts a big leap of Nigeria's economy growth from 4.2% in 2025 to 4.79%-4.96% by ending of 2026 due to the several aforementioned economic reforms that will obviously yield more tangible results in 2026.

Methodology Adopted for the Study

This study has adopted data from past and present studies, viable reports of government and non- government bodies like Nigerian Bureau of Statistics, Nigerian Upstream Petroleum Regulatory Commission, Nigerian National Petroleum Company Limited, Central Bank of Nigeria, Nigerian Midstream Downstream Petroleum Regulatory Authority etc and existing published literatures. The study also relied on data obtained from International agencies like African Forbes, World Bank, United Nations Environmental Protection Programme reports, Amnesty International reports, International Monetary Fund, PwC etc. Published books, Conference and Seminar Papers, Journals were also consulted to get robust data on the subject matter [2].

Gas Exploration and Production

Majority of gas exploration and production activities is geared towards associated gas, even though Nigeria holds more reserves in non-associated gas. This is due to dearth of investment needed to pursue exploration of non-associated gas sites. Nigeria hydrocarbon reserve stood at 37.50 billion bbls for Oil and Condensate, 210 trillion scf for associated and non-associated gas.

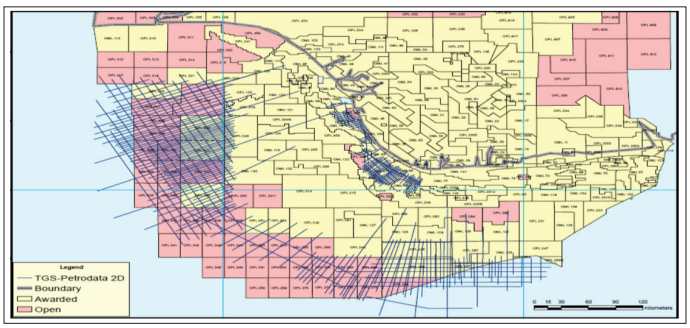

Figure 1: Geologic Map of Niger Delta Area Showing Some Oil and Gas Awarded Blocks

Gas Reserves status as of January 1, 2024 was about 209.26 TCF representing a moderate net increase of 0.21% over January 1, 2023 position of 208.83 TCF (NUPRC report 2024). The total volume of crude produced for 2024 is 578,521,740 barrels (482,819,991 barrels of Oil and 95,701,748 barrels of Condensate). The daily average production figure was about 1,580,369 million barrels per day (1,318,939 barrels of Oil per day and 261,430 barrels of Condensate per day). The Nigerian daily average Associated and Non-Associated Gas production stood at 3.924 BCF/D and 2.938 BCF/D representing 57.2% and 42.8% respectively. A total of 2.511TCF of Associated and Non-Associated Gas was produced in 2024. This represents a slight increase of about 0.53% compared to year 2023. A total of 2.317TCF (92.26%) was utilized, 0.193TCF (7.64%) was flared and 0.003TCF (0.10%) was reported as shrinkage. More recent statistical data has revealed that Nigeria's gas production output as at June 2025 has risen by 0.09% to 185.432 billion standard cubic feet compared to 185,259 billion SCF in the preceding month of May 2025 (NNPCL monthly report). This can be interpreted that within the period of time interval, 6.181 BSCF of gas was produced per day. However, out of the total gas produced in the period under review, 176.396 billion SCF of such was utilized and this represent 94.4% utilization rate, while 5.6 billion SCF of gas was flared ie 0.56%.

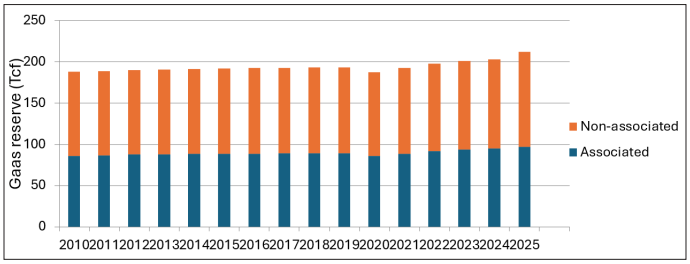

Figure 2: Nigeria's Gas Reserve (Associated and Non-Associated) (Tcf)

The hydrocarbon exploration exercise has been on a steady increase from the year 2010 with more discovery of new hydrocarbon and gas reserve base till date (Figure 2). The 1,532,228 barrels produced received a boost in recent time with July 2025 production that recorded 1,720,733 barrels. But unfortunately, data released afterwards (NUPRC, 2025) has shown a massive reduction to just 1,432,000 in August same year, a condition that was traced to major maintenance work across major oil and gas production platforms. More importantly, the country's gas reserve has witnessed a tremendous increase from 2010 till date revealing a reserve deposit base of 210.634 tcf (Figure 3) as at 2025. Energy transition pathways relayed low CO2 emissions, Sustainable Production and Consumption of this gas over oil [3].

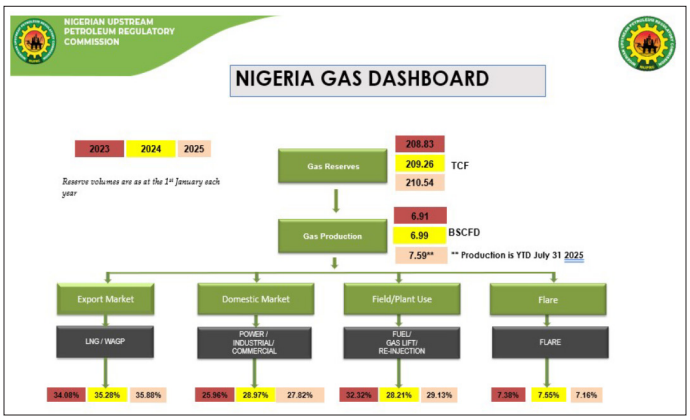

Figure 3: Gas Production Flowchart and Utilization Mode for the Year 2023 to 2025. Source: NUPRC, 2025

Recent published production data (NUPRC 2025) has shown a significant increase of gas production for the year 2025, which stood at 7.59bscf/D as at July 2025 compared to that of 2023 and 2024 that recorded 6.91 bscf/D and 6.99 bscf/D of gas production respectively (Figure 3). A total of 2.511TCF of Associated and Non-Associated Gas was thus recorded in 2024. This represents a slight increase of about 0.53% compared to year 2023. It is

important to note that a total of 2.511Tcf of Gas produced during year 2024 entailed Joint Venture (JV) companies contributed 1.489 Bcf (59.30%), Production Sharing Contract companies produced a total of 0.660 Bcf (26.29%), Sole Risk (SR) companies produced 0.255 Bcf (10.17%), while Marginal Fields (MF) produced a total of 0.106 BSCF (4.24%).

From the international perspective and based on available statistical data, global gas production also grew over the past two decades at an average of 3.1% per annum from 217.3 billion cubic feet (bcf) per day in 1998 to about 386 bcf per day in 2019 and has been traced to significant economic growth in Asia, Africa and the Middle East. While gas production accounted for 23% of the total energy production in 2019, analysts predicted that by 2030, the figure is expected to account for more than 45%. The United States, Russia and Iran are the biggest gas producers worldwide (Figure 5), accounting for nearly half (46%) of total global production of about 390 bcf per day in 2019 and afterward. Nigeria is. conspicuously absent on the top ten list of largest producers, despite holding the largest gas reserves in Africa and the tenth (10th) largest in the world a situation that has been largely traced to low investment especially in the up, mid and downstream gas infrastructural development (Figures 3 and 6). Moreover, CNG utilization is just coming up after the removal of fuel subsidy in the Nigerian economy and today just only 0.4 to about 0.6% utilization rate has been recorded. This offers a big investment opportunity to oil and gas operators and allied companies including reputable banks to improve on the development of the economy with a robust investment return. The global community witnessed significant growth with demand for gas which rose by about 62% between 2013 to 2025 and this was bolstered by its use in production processes and as feedstock in chemicals, petrochemical companies, transportation fuel and electricity generation globally. The world's current most modern 650,000 crude oil processing capacity refinery ie Dangote Refinery located in Ibeju lekki, Lagos state, South-western Nigeria still utilize very high volume of such gas to operate the plant for the production of LPG, refined products and feedstock for the world economic growth. More importantly, current ongoing capacity expansion of the refinery to 1.4 million crude oil processing capacity will obviously position the plant to effectively and efficiently serve the Africa and World market as the largest refinery in the world.

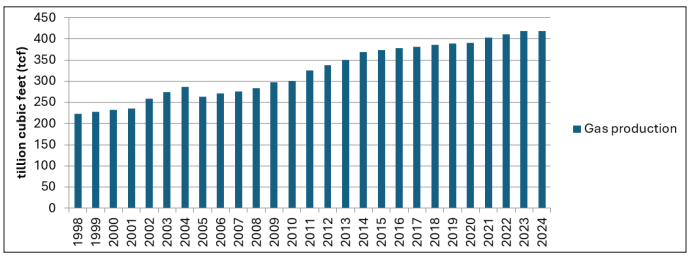

Figure 4: Global Gas Production Trend (Tcf). Source: BP Statistical Review, PwC Analysis

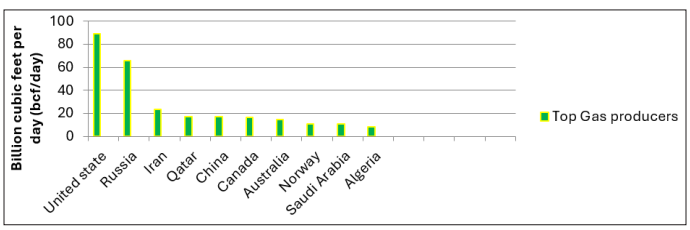

Figure 5: Top Ten Natural Gas Producers in the World (Bcf/Day)

Nigeria's natural gas reserve (Figures. 3 and 6) estimated at about 210 trillion cubic feet represent about 33% and 3% of African and world reserve respectively. It has also been established that the country's reserve has a life index of 94% (NUPRC report). Nigeria's gas value chain cuts across the three core segments of the gas sector (upstream, midstream and downstream). Various players operating along the value chain range from oil companies that extract gas during oil production to natural gas producers, petrochemical firms, power generation companies, regulatory agencies as well as industrial and household consumers. Nigeria's potential as a major global gas supply and utilization hub is high for its economic and world economic development. Investment will have to be focused on Foreign Direct Investment and Global stock markets like London and Nigerian stock exchange. This will enable maximal harnessing the full potential of the reserve base for economic development. Prior to any investment drive, the fiscal, regulatory and environmental conditions will have to be water-tight with strong judicial, legislative and executive approach to such oil and gas investments, moreso that the global community is currently seeing the successes recorded by indigenous investors (Dangote refinery) in the sector. Furthermore, European countries are currently, seriously on the lookout for such stable gas market.

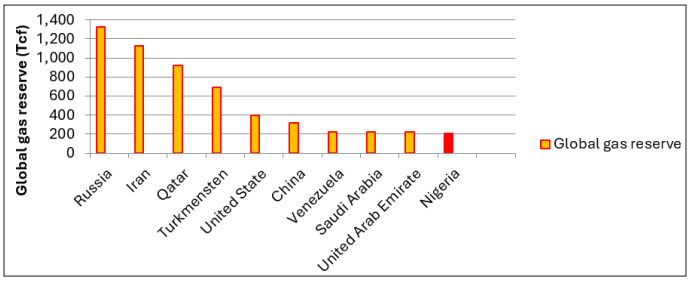

Figure 6: Top Ten Natural Gas Reserve in the World (Tcf)

Gas Utilization in Nigeria

The Nigerian Gas Master Plan was devised as a major intervention concept to move the gas sector from its essentially dormant status in 2006 to a market-based system with willing sellers and willing buyers, realizing the full potential of the sector for the benefit of Nigeria. 6.99 TCF of gas was produced in 2024 and a total of 6.9117TCF (92.26%) was utilized which is a slight uincrease of about 0.67% compared to the previous year 2023 (Table 1). Gas utilization by the players were for in-house gas consumption for fuel, gas lifting, injection for reservoir pressure maintenance or storage and sales to mostly export markets (Table 1). Export sales (39.5% gas produced) continue to offset domestic market (28.7% gas produced) which is indicative of the historical challenges confronting the domestic gas sector to facilitate the industrialization of the Nigerian economy. The details of gas utilization breakdown for the period are as shown (Table 1). Review of Gas resource utilization using applicable technologies was advanced to showcase new modern ways of value addition to gas production and utilization in Nigeria [4].

Table 1: Gas Utilization and Corresponding Volume for the Year 2023

Gas utilization	Volume (MMscf)	% Utilization
Fuel Gas	140738.0532	6.1
Gas Lift	110884.9623	4.8
Gas re-Injection	483476.518	20.9
Domestic Sales	665781.266	28.7
Export Sales	916167.2937	39.5
Total	2,317,048.093	92.263

Globally, in the industrial sector, the need to replace oil products (AGO and PMS) and coal with gas to meet up with industrial emission standards has led to the rise of the petrochemical industries that use gas as feedstocks. This further underscored the growing demand for gas in the industrial sector. In the power sector for example, gas and other renewable energy sources have been sought for as gradual replacement for coal and oil in the energy mix across key regions. As a result, many coal-fired and nuclear fired power plants are giving way to gas fired power plants, as well as other renewable energy sources such as solar and wind. In the transportation sector, the new policy by the International Maritime Organization (IMO), which puts a 0.5% cap on the sulphur content of bunker fuel used in the maritime industry has resulted in the search for alternative energy sources such as low sulphur diesel oil and Liquefied Natural Gas (LNG) that meets the international requirements.

At the core mandate of most countries, modern environmental policies is a deliberate shift towards low carbon energy society, such as natural gas and this is fuelling the growing appetite for natural Gas as an alternative energy source to oil and coal and its unique environmental qualities outlined below:

- Natural gas is relatively clean i.e. when combusted, it generates 45% and 30% less CO2 emissions than Coal and oil respectively.
- Natural gas is cheaper and available in abundance. As at the end of 2019, global proven reserves of gross natural gas stood at 7,019 trillion cubic feet (tcf).
- The versatility and efficiency of natural gas is another reason for its increasing preference as an alternative dependable energy source for the world economic growth.

Defined as the marketing and distribution of natural gas for domestic, value addition and commercial purposes and includes power generation, LNG, gas-to-liquid plants, fertilizer production and gas transmission and distribution pipelines. Current gas utilization in Nigeria favours the export market over the local consumption (Table 1 and Figure 3). Nigeria also adopted a gas transport network code in 2020, formalizing third-party access to critical gas infrastructure. Gas entrepreneurs are required to create separate companies for each segment and acquire the necessary licenses from the Commission or the Authority for their operations. This structure and other provisions of the Petroleum Industry Act are intended to promote natural gas production and its utilization.

Gas utilization trend in the month of June 2025 has vividly shown that NLNG exported the largest chunk (Figure 7) of the produced stock that stood at 72.718 BSCF of gas representing 39.21%, while domestic consumption in the country stood at 27.577 BSCF representing just 14.87% of total gas produced in the month. Furthermore, 9.589 billion SCF was used as fuel gas representing 5.17% of total gas produced for the month. Excravos gas to liquid (EGTL) used up 7.774 billion SCF, representing 4.19% and lastly, 2.263 billion SCFof gas, representing 1.22% of total gas produced in the month under review was used for natural gas liquid/liquefied petroleum gas (NGL/LPG). Review of gas resource utilization using applicable technologies was published to reveal the versality of utilizing technology to gas production [5].

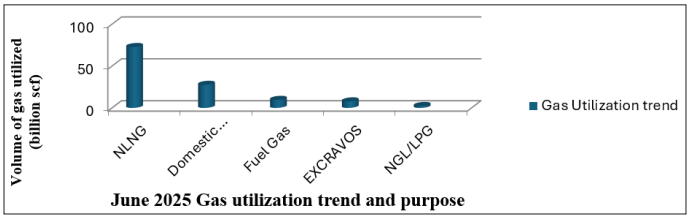

Figure 7: June 2025 Gas Utilization Trend in Nigeria

More importantly, associated gas stood at 111.602 billion scf accounting for 60.18% of total gas produced in June 2025, while 73.83 bscf of gas was non-associated gas (NAG) and accounted for 38.82% of total gas produced. Statistical record (NNPCL 2024) has also shown that Renaissance Africa energy that just acquired the onshore assets of Shell oil company produced the largest volume of gas to the tune of 54.374 bscf of gas (Table 2), followed by Seplat energy producing Nigeria Limited (Table 2). Moreover, other major players included Chevron Nigeria Limited 22.444 bscf, Total energies upstream 11.746 bscf, Star deep water 10.924 bscf and Esso exploration and production 9.400 bscf (Table 2).

Table 2: June 2025 Gas Output and Corresponding Producers in Nigeria

S/N	Companies	Gas Output (Billion scf)	% of Gas Output
1	Renaissance Africa energy	54.374	38.838
2	Seplat Energy Producing Nig. (SEPNU)	31.148	22.248
3	Chevron Nig. Limited	22.444	16.031
4	Total energies upstream	11.746	8.390
5	Star Deep water	10.924	7.802
6	Esso Exploration and Production	9.400	6.714

Field Development Plan

It is imperative to note that in 2024, the forty-one oil field development plans were granted with the aim to develop about 1,366.91 MMstb and 10.7 TCF of oil and gas reserves respectively, with an anticipated oil and gas production of about 572.74 kbopd and 4,113.78 MMscf/day respectively. On the other hand, seven FDP of NAG field development plans aim to develop 4.41 TCF of gas reserves with an anticipated gas production of 1,562 MMscf/day. In view of current energy realities, achieving the latter shall position Nigeria to meet growing energy demands that is expected from gas as its transition fuel coupled to newly introduced CNG market aside existing LPG utilization strong and existing market.

More importantly, same year, field development plans showed a bigger preference for land development with 64% for land terrain, while 6% developed fields in swamp terrain (Figure 8), 19% developed fields in offshore terrain and 11% developed fields in deep offshore terrain (Figure 8). Evidently, this shows a significant preference by operators to develop fields on land terrain which has a lower cost of development including its technological art compared to the other terrains.

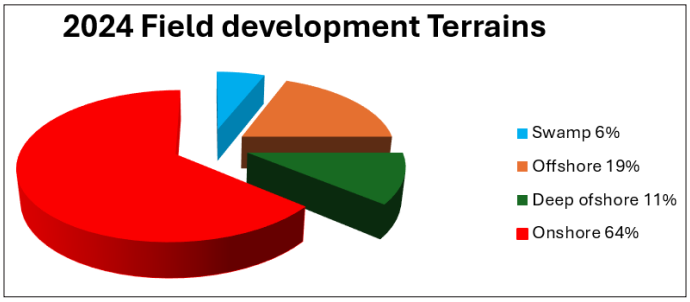

Figure 8: 2024 Field Development Plan by Terrain in Nigeria

Furthermore, one-hundred and seven (107) wells drilled in the year 2024 revealed 73% were drilled on land, 12% drilled in swamp terrain, 9% in offshore terrain and 6% in deep and ultra-deep offshore terrain. A clear decommissioning and abandonment schedules is expected to restore the ecosystem and immediate environment of operation. The 143 approvals granted to Indigenous operators in 2024 well re-entry facilitated the restoration/development of 370MMstb of oil and 2,087.04BCF of gas to production with an estimated daily output of approximately 143,869bopd and 585.48MMscf/d, respectively. This was made possible by both established and new entrants in advancing field development/optimization and production restoration to meet up with OPEC quota. The Environmental Impact Assessment of onshore and offshore wells is crucial to field development plans as was carried out for Non-Associated Gas Wells in Forcados-Yokri block, Burutu Area [1].

Gas Flaring

Gas faring occurs when upstream oil field operators opt to burn the associated gas that accompany oil production or simply release it into the atmosphere, rather than build gas tracking infrastructure and pipelines to capture it for economic and industrial growth. This is also called 'non emergency flaring and venting'. It results in the release of substantial volumes of potent greenhouse gases (GHGs) including methane, black soot and nitrous oxide to the atmosphere and this causes severe environmental damage to the communities including the well-being of inhabitants [6]. With natural gas prices at historic highs, the International Energy Agency (IEA) has stated that gas flaring has serious negative impacts on climate change and public health. Out of 2.511 TCF of gas produced in 2024, a total of 0.1918 TCF was flared (Figure 3). This represents 0.28% difference compared with the 2023 flaring recorded (Table 3). NPDC company recorded the highest flare rate of 8.25%, while ESSO oil company recorded the least flared gas in the year 2024 (Table 3). Total flared volume amounted to 114660.098 MMscf/Day. Others are companies whose flare is less than 2mmscf per day in 2024.

Table 3: Annual 2024 Company Gas Flare Performance

Companies	Gas Flared Volume (MMscf/Day)	% Flared
NPDC	109	8.25
MPN	66	8.11
CNL	15,039	7.57
ADDAX	14,379	7.58
SPDC	14,059	6.98
NAOC	14,416	7.11
ESSO	15,356	6.86
HHOC	15,808	7.44
FIRST Exp and Prod.	14,599	7.14
STAR-DEEP	17,145	7.78
SEPLAT	18,065	7.93
EROTAN	19,067	8.85
Total	114660.098 MMscf/ Day	

To initiate the Nigerian flare-free era, approval was granted for the Nigerian Gas Flare Commercialization Programme (NGFCP) to eliminate gas flaring through technically and commercially sustainable gas utilization projects developed by competent third–party investors invited to participate in a competitive and transparent bid process. Flare Gas (Prevention of Waste and Pollution) Regulations of 2018 (“the 2018 Regulations") was introduced to midwife the NGFCP. However, due to events like COVID-19 and the enactment of the Petroleum Industry Act 2021 (PIA), flare situations changed and there emerged new operational realities which necessitated the expediency for an optimized restructure of the programme.

The Nigeria Upstream Petroleum Regulatory Commission (the Commission) restructured the NGFCP in August 2022 with the renewed mandate to achieve the core objectives of flare gas monetization in Nigeria within an accelerated timeline to create end-to-end value for investors to drive the attainment of the FGN's 'Decade of Gas' policy. Recent data obtained (NUPRC, 2025) has shown that despite 229 billion scf average production in recent time, the production peaked in January with the highest output of 236.3 billion scf, while February had the lowest of 199.7 billion scf. Total volume of 1.26 trillion scf of gas was thus utilized and this represent 91.8% of total production. This comprised of 408.3 billion scf for field use, 370.7 billion scf for domestic supply and 481.1 bscf exported majorly through NLNG.

Effects of Gas Flaring

Gas flaring poses economic, health, environment and other challenges to the society. Gas flares emphasize the aphorism that Nigeria is rich in energy resources but poor in energy supply and its distribution. Gas flaring has declined to 7.2% of total production in 2025. The lowest level in more than a decade down from 7.6% in 2024 and 7.5% in 2022. In volumetric terms, daily flaring averaged about 0.55 Bscf/Day this year compared to 0.69 Bscf/Day in 2021, reflecting a 20% reduction in 4 years with a target to achieve zero routine flaring by 2030. The associated gas Re-Injection Act was made as an Act to compel every company producing oil and gas in Nigeria to submit preliminary agenda for gas re-injection and detailed plans for implementation of gas re-injection policy. It made it illegal after the set date. The target to stop gas flares moved from 1984 to 2008 and later 2011. But gas is still being flared up to date though at a lower rate. The water toxicity (Figs. 9 and 10) from acid rain and heating from the flare stacks has made lots of biodiversity go extinct, while the people eating the few surviving intoxicated fish in turn get poisoned. Other health issues associated with flared gas which have been reported in Niger Delta includes aggravated Asthma, Chronic Bronchitis, Cancer, Leukaemia, reduced lung function, Pneumonia etc. The noise and heat have become major causes of insomnia and heat rashes respectively. Gas flaring causes acid rain which eat through villagers roofing, deteriorate civil structures. Additionally it has a detrimental effect on soil fertility (Fig. 9) and linked to lower food yields thus can cause serious food insecurity for affected communities and nation at large.

Revenue Loss

In 2014 alone, about 295 bscf of natural gas was flared leading to a massive loss of about $1billion in revenue. 2024 flare rate has shown a significant reduction with 191834.6 mmscf of flared gas with a revenue loss of $133.716 million. In essence, 2014 to 2024 has revealed $877 million saved from gas flaring. Nigeria lost about millions of dollars as oil companies operating in the country flared a large proportion of the gas produced from January to September 2024. According to data from NNPCL about 295 billion standard cubic feet of natural gas was flared in the nine-month period, which is contrary to what was published by NUPRC ie main regulator recognized by law.

These estimates of gas flares are based on information supplied by IOCs and not independently computed by operating companies and verified by the regulatory agency. So, the likelihood that its either overestimated or understated to avoid due penalties or undue profits. Nigeria recently lost $133.716 million ie about N26.743 billion to gas flaring as oil and gas companies in the country could not convert such to beneficial use. In essence, it is important for NUPRC (the upstream regulator) to procure and deploy modern gas flare tracker/meter at every oil and gas production platform for accountability in the sector. This will ensure transparency and real flaring data that is currently conflicting with other major oil and gas players, especially that of NNPCL. A uniform, reliable data that emanates from the NUPRC and at every oil and gas production platform will give more credible, transparent, fair and unambiguous data that will also boost investors confidence in that sector of the economy.

Health Hazards

According to Ikoro (2003), the emissions from gas flaring contain smoke, soot, smog and other acidic particles which constitute serious health hazards mostly in the form of respiratory tract diseases. The presence of carbon and traces of nitrogen and sulfur in natural gas leads to the production of various oxides and sulphides. When these chemicals are inhaled through flaring, it settles in nostrils down to the lungs as thick carbon monoxide, which blocks the passage of oxygenated blood to the heart of humans and animals. The oxides and sulfides in hydrocarbon with gaseous chemicals when flared combine with water in the atmosphere to form various types of corrosive acids such as nitric and sulfurous acids that irritates the human skin and prevent plants chlorophyll from functioning. This also leads to cancer of the skin and corrodes galvanized roofing sheets around oil and gas production zones. HYPREP just concluded phase 1 clean-up of Ogoni area including restoration of mangrove and other shoreline protection and about to conclude the provision of potable water to affected communities. Gas Flaring in Nigeria: Opportunity for Household Cooking Utilization if harnessed [7]. More importantly, Geological gas flaring has caused various public health disorders showcasing the nexus of Geoscience and public health in our evolving Society [8].

Environmental Pollution

Every year, around 140 billion cubic meters of natural gas produced together with oil is wastefully burnt or flared at thousands of oil fields around the world. This results in more than 300 million tons of carbon dioxide being emitted into the atmosphere – equivalent to emissions from approximately 77 million cars. According to the Nigerian Minister of Environment, oil and gas companies are pumping nearly 17million tones of carbon dioxide emissions into the atmosphere yearly which endangers human health and environment. Other environmental hazards associated with gas flaring include; increased environmental temperature, heat-wave and global warming. These environmentally degrading conditions dehydrate surroundings, habitats, ecosystem, food chains, nitrogen cycle, oxygen cycle, flora and fauna, animals and vegetations and thereby cause their actual deaths or poor yields of environmental resources. Potable water bodies to sustain lives is lost. Gaseous acids like cadmium, benzene and calcium also pollutes streams, natural water ways like swamps, creeks, ponds, including arable farm lands, rivers, soil nutrients and thereby kill fishes, aquatic animals and plants.

Figure 9: Signature of Gas Flaring Polluting Soil and Potable Water Sources

The re-injection of natural gas would also be harmful, if the injected gas escapes to the earth surface and when it ignites, the result is wild fire and pollution, including destruction of lives and property. In the current global food shortage era, rising water levels, floods, erosion, rising warm temperatures and other adverse climate change effects, gas flaring should be stopped as penalties for flares have not discouraged continued flaring and has been traced to seriously aggravate food insecurity [8]. According to data from the gas flare tracker of the National Oil Spill Detection and Response Agency (NOSDRA) of Nigeria's Federal Ministry of Environment, from January 2013 to December 2021, the country flared 3.4 billion Million standard cubic feet (Mscf) valued at $12.0 billion. That resulted in CO_2 emissions of 182.3 million tones. Within the same period, 129.3 million Mscf was flared resulting in the emission of 6.9 million tonnes of CO_2.

Figure 10: Severely Oil and Gas Polluted Region of the Niger Delta

Experts say residents of communities where gas flaring takes place stand higher risks of experiencing medical complications like respiratory disorders and cancer. A 2017 study also found that persons living in gas-flaring host communities in the Niger Delta are 1.75 times more likely to be hypertensive than persons resident in communities without oil and gas exploration activities.

Domestic Gas Delivery, Obligation and Performance

This refers to the amount of gas budgeted for domestic consumption against the actual volume finally delivered for domestic use. In terms of the overall monthly DGDO performance (Table 4), the average monthly supply of gas to the domestic market and the

performance in respect to the allocated gas has not been too good. From the data available domestic gas allocation and delivery is still a big challenge in Nigeria with a shortfall of about 13% to 31%. This shortfall can be traced to significant preference to export market through NLNG (for revenue purpose) and the effect will be an abnormal increase of LPG and CNG price in the local Nigeria domestic market. Development of Gas Aggregation and Allocation Models in the Domestic Sector of the Nigerian gas Economy is another fair, practical model of gas allocation [9]. Development of Domestic Gas Supply Obligation Model for Efficient Gas Utilisation in Nigeria was presented at Society of Petroleum Engineers [10].

Table 4: 2023 Domestic Gas Allocation and Performance

Months	Allocated (Mmscf/d)	Delivered (Mmscf/d)	% Performance
January	2,261	1,629	72%
February	2,261	1,559	69%
March	2,261	1,693	75%
April	2,261	1,681	74%
May	2,261	1,721	76%
June	2,261	1,592	70%
July	2,261	1,795	79%
August	2,261	1,656	73%
September	2,261	1,847	82%
October	2,261	1,801	80%
November	2,261	1,917	85%
December	2,261	1,971	87%

The 2025 DGDO has shown some remarkable improvements. Domestic Gas Delivery Obligation performance record has shown 72.5% in July, up from 71.8% in June same year. 72.2% in January rose to 73.5% in February, dipped slightly to 70.8% in March, before climbing again to 73.7% and 73.0% in April and May respectively all of 2025.

Gas Processing

Gas processing hubs are springing up at a faster momentum in Nigeria, courtesy of the 2021 PIA and its effective implementation. Foreign and national investors are constructing processing plants to develop and distribute gas to customers locally and internationally. The regulatory framework investment ie Mid and Dowstream Gas Infrastructure Fund domiciled within the NMDPRA will need do more to expand this gas distribution in the downstream sector to realize the clean, low carbon energy target of 2030. In essence, the 0.5% levy on petroleum and wholesale gas sales will need be reviewed to 1% levy in no distant time to allow better participation to encourage investors (local and international) in the transition phase of the energy need of Nigerians. Most of the gas infrastructures are still in the South-south, south-east and south-western axes with little penetration into the North-central and virtually no attention in the North-west and North-eastern corridors. The huge population of North-western and eastern corridors is a big market for gas sales, but only if the infrastructure is available for its distribution to stimulate the industrialization of the region and Nigeria as a whole. Navigating the various complex Geologic terrains from the South to the Northern axis is another big task that is currently been overcome as recently typified by the AKK pipeline crossing of the main tributary of River Niger (GCEO of NNPCL). Evaluating Interdiction of Oil Pipelines at the River Crossings Using Environmental Impact Assessment ie feasibility study is crucial to prevent pipeline buckling and crampling in harsh water terrain [11].

More importantly, Nigeria is known to have built the West Africas largest Gas Plant for the processing of its (Figure 11) large gas reserve. This is an onshore processing plant built close to the well head translating to lower pipeline and transportation cost. This is called ANOH Processing plant along the Assa North-Ohaji south (ANOH) field axis, which is holding about 4.3-5 trillion cubic feet of natural gas. Exploration findings has also shown that Egbema, Obitti and Izombe have huge gas reserve in Imo state. The gas field is strategic for national gas distribution as it lies between the south-south, south-east and North-central axis for an efficient distribution for domestic and international market utilization. This can also conveniently connect to OB3 Gas trunkline to Edo/kogi and Abuja. It effectively supports Nigerias Energy Transition goals, thus the ANOH gas processing plant is a key part of Nigeria's Decade of Gas plan. It is expected to power industries, electricity generation, CNG hubs, LPG for cooking with numerous advantages its location has to easy access, friendly community, good onshore terrain with low cost of development. In essence, all these properties effectively qualifies ANOH in Imo state as a Gas Power House (Figure 11) and these are the obvious reasons its hosting the biggest gas plant in West Africa, ensuring a cleaner society, Gas Supply to Power Markets in Nigeria was similarly studied on how it can enhance the more stability of the power sector for the generation of electricity [12,13].

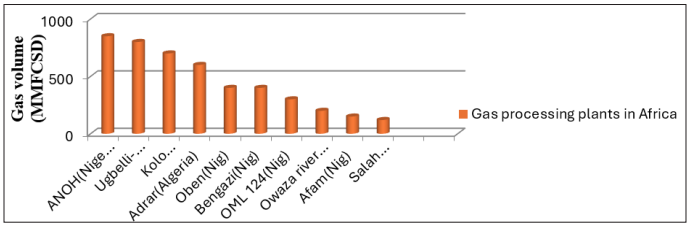

Figure 11: Gas Processing Plants in Africa

Existing Gas Pipelines for Adequate Gas Distribution

The network of pipeline to carry abundant gas as a major source of clean energy is still at its lowest ebb compared to gas reserve deposit of 210Tcf deposit and this can be traced to low investment in the mid and downstream gas infrastructure. The PIA 2021, new energy reforms and fuel subsidy removal which serve as official legislation and law in Nigeria is gradually changing the narratives as new investments are gradually creeping into the downstream oil and gas in Nigeria. P-CNG, AKK and Nigeria-Morocco gas pipelines are some of the fruits of this articulate law for gas expansion especially in the downstream sector. However, some of the existing gas pipelines (Figure 12) to carry and distribute gas in Nigeria for domestic and industrial growth are:

- The Aladja Gas Processing facility which supplies the Delta Steel Company Aladja gas, though production seems stalled but expected to be revived soon.
- The Oben-Ajaojuta-Geregu Gas Processing System, which will form the backbone of the future Northern Gas Processing System; supplies gas to Ajaokuta Steel Company, Dangote's Obajana Cement Company and PHCN Geregu Power Plant. Some sections are currently obsolete.
- The Sapele Gas Processing facility which supplies gas to the power station at Ogorodo, Sapele
- The Imo Rivers-Aba Gas Processing facility for Gas supply to the International Glass Industry Limited, Patterson Zochonis, Aba Textile Mills and Aba Equitable Industry.
- The Obigbo North-Afam Gas Processing facility caters for the power station at Afam.

- The Alakiri to Onne Gas Processing facility for supply of gas to NOTORE Chemicals (formerly National Fertiliser Company-NAFCON) for fertiliser production.
- The Alakiri-Obigbo North-Ikot Abasi Gas Processing facility for gas supplies to Rusal Industries (former Aluminium Smelting Company of Nigeria – ALSCON) plant in Ikot Abasi.
- The Escravos – Lagos Pipeline (ELP) Gas Processing facility supplies gas to Egbim Power station. Subsequent spur lines from the ELP supply the West African Portland Cement Plants at Shagamu and Ewekoro, PZ Industries at Ikorodu, City Gate in Ikeja Lagos, PHCN Delta IV at Ughelli and Warri Refining and Petrochemical Company.
- The Ibafo-Ikeja Gas Processing facility supplies gas to Ikeja City Gate from where Gaslink distributes to the Lagos Industrial Area (LIA).
- The Ikeja-Ilupeju-Apapa Gas Processing facility operated by Gaslink for gas supplies to greater Lagos Industrial Area.
- Ajaokuta- Geregu Gas Processing facility which supplies gas to Geregu Power Plant.
- Ajaokuta-Obajana Gas Processing facility which supplies gas to Dangote's Obajana Cement Plant

All these facilities and many more comprises of over 2,237 kilometers of pipelines ranging from 4" to 36" in diameter with total installed capacity of 2.5billion standard cubic feet of gas carriage per day (bscf/d) capacity, 16 Compressor Stations and 24 Metering Stations. The facilities represents an asset base of more than 29 billion dollar to the Nigerian government and potential investors. Invariably, the population of the country has grown tremendously that the need for more gas infrastructure expansion is crucial for the economic growth. The West African Gas Pipeline (WAGP) Project supplies gas from producing fields in Nigeria through the NGC ELPS and WAPCo's pipelines to Volta River Authority (VRA) in Accra, Ghana, industries in Togo and Benin Republics. The project includes supply of initial volume of 133mmscf/d to peak at 470mmscf/d in future. The project was commissioned with spur lines to Togo and Benin Republic completed. Mothballing, Manifold, Pipeline installation and Impact Assessment along the corridor is inevitable as similarly done in existing Saghara Gas solution Flowstation Facility, Warri, Niger Delta [14].

Investment in Downstream Gas infrastructure

The current structure for gas production and distribution in Nigeria is a franchising arrangement between the NGPTC, the gas transportation subsidiary of the national oil company, the NNPC Limited and third-party franchisees selected by the NGPTC to undertake gas distribution in certain geographic and geologic areas. The franchise includes a tying arrangement whereby gas owned by the NGMC, a gas marketing affiliate of the NGPTC and another subsidiary of the NNPCL, is sold by the local distribution company (LDC) to end-users at a discount to the price of an alternative or competing petroleum product. Under these gas distribution franchises, the distribution tariff is a blended commodity price and an infrastructure tariff. It incorporates a regulated commodity price in the sale between the upstream and the Nigeria Gas Marketing Company, the tariff payable to the NGPTC for gas transportation and a marketing margin to the NGMC, plus a cost recovery charge by the LDC for the recovery of the capital expenditure invested in the development of the gas distribution infrastructure. The end-user price is subject to adjustment to reflect changes in the price of petroleum products. Given the wide-ranging powers of commercial regulation granted to the Authority, including competitive regulatory powers, it is not unlikely that the Authority will invade the franchise arrangements even more as the PIA requires that gas distribution is a licensed activity under the Act and mandates third-party access to a gas distribution network.

Furthermore, the PIA provides that the pricing for gas distribution services should not exceed the sum of the domestic base price that is determined by the Authority plus US$0.50 per million British thermal units. In addition, it stipulates certain principles applicable to the prices to be charged by midstream license holders, such as gas distribution license holders. This includes the requirement that prices should reflect disaggregated costs across segments of the natural gas supply chain (ie, the cost of wholesale gas supply as well as the tariffs payable for gas processing and transportation), ensuring a reasonable return for the licensee on its investment, and non-discrimination in services and charges by license holders. It is obvious that investment in the upstream gas infrastructures is gaining traction mostly by international and national oil and gas companies through the Nigeria Liquefied Natural Gas (Figure 7) and most of such gas is currently exported to international market. The need for investment in the mid and downstream gas infrastructure will accelerate the rate of utilization of gas domestically. Most existing gas infrastructures are obsolete and will have to be refurbished with new gas pipelines laid for adequate distribution. Gas as the future of Nigeria's energy, industrial and economic development and has become more pressing, given the country's growing population and rising urbanization with the need for more revenue to improve the economy and ensure environmental eco-friendly energy.

Gas Expansion Infrastructure Network Beyond Nigeria

Regional pipeline projects such as the Nigeria–Equatorial Guinea Gas Pipeline, Trans-Saharan Gas Pipeline, and Africa Atlantic Pipeline will facilitate gas exports and industrial use. The Trans-Nigeria Pipeline Project plans to integrate all gas transmission systems in the country (Figure 12). It is planned that extension of the system would be made to far northern states including the industrial city of Kano. The resulting highly interconnected system is expected to provide full flexibility and better management of supply and demand throughout the country. The backbone of these future supplies will be the three proposed major pipeline projects namely the Obiafu-Obrikom-Oban (OB3), Calabar-Ajaokuta-Abuja (CAA) and Abuja-Kaduna-Kano (AKK) pipeline projects (Figure 12). There is also an export oriented plan to build the Trans-Saharan Pipeline to service the European Gas Market, but currently having serious challenges on the most suitable corridors to adopt for the gas to get to such markets (Nigeria-Morocco or Nigeria-Algeria pathway) both with unique rugged, complex geological terrains with diverse feasibility pipeline routes and robust financial need for all investors (Figure 13).

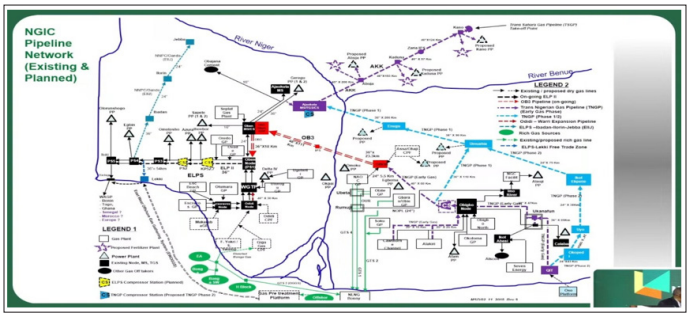

Figure 12: Existing and Newly Planned Gas Pipelines in Nigeria

The AKK Gas Pipeline Project constitutes the Phase 1 of the Trans-Nigeria Gas Pipeline (TNGP) Project that is driven by

availability of additional gas supplies from Assa Gas Plant and the need of gas supply to the Northern/Eastern States through Obigbo-Umuahia-Ajaokuta pipeline and Ajaokuta-Kaduna-Kano pipeline (Figure 12). The project development, fabrication and construction involve, surveying and clearing the Right Of Way (ROW), hauling and stringing of pipe(s), bedding of pipe(s), welding, digging of trench, lowering of pipe and backfilling, Installation of valves, special fitting and joint coating, Pipeline crossings of rivers (especially river Niger and its tributaries), road crossing, streams and other pipelines, Non-Destructive Testing (NDT) Surveying and ROW preparation will lead to vegetation clearing, loss of biodiversity and farmlands, crops, habitat and migration of wildlife, as such, it is highly recommended that a detailed Environmental and Social Impact Assessment will have to be robustly done to include remediation exercise to reclaim polluted areas including land, waterways, farmlands, airways and fully restore the ecosystem of all areas the pipeline will navigate and impact, including adequate compensation [15].

The AKK gas transmissions pipelines with a diameter of 40" is with a length of about 614km along the route. The pipeline has spur lines from the Abuja Node to the Abuja TGS, approximately 13.6km, from Kaduna node to Kaduna TGS approximately 200m and from Kano node to Kano TGS approximately 8.14km; respectively. The Abuja and Kaduna spurs has been sized for 500 MMscfd each measuring up to 2,250 MMscfd available at Kano for local distribution and export in the immediate future through the Trans-Saharan Gas Pipeline (TSGP) project mostly considered is the Nigeria-Morocco axis (Figure 13). Similarly, the project will be executed in three phases, with phase one covering the construction of a 200km-long segment between Ajaokuta and Abuja Terminal Gas Station. Phase two will comprise a 193km-long section to be built between Abuja and Kaduna. Phase three will involve the construction of a 221km-long section between the Kaduna terminal gas station (TGS) and Kano TGS. Other infrastructure planned for the development includes various associated valve stations, as well as intermediate and terminal facilities. The natural gas pipeline is expected to require the laying of approximately 51,200 steel line, 40 inch-diameter pipes featuring a total combined weight of 240,768tonnes. Indeed, it's a highly ambitious project that will facilitate an inclusive growth. Furthermore, the project will utilize 24in-diameter steel line pipes for spur lines, as well as 40in-diameter line break valves and future tie-in valves. The AKK natural gas pipeline is intended to boost Nigeria's electricity generation capacity by adding 3,600MW of power to the national grid and provide electricity in the northern part of the country with more revenue generation for Nigerian government. It will also strengthen the industrial sector and provide skilled and unskilled jobs within the country's eastern and northern corridors. The project is also expected to promote and increase the local usage of domestic gas and will significantly contain gas flaring in Niger Delta with an appreciable drop in gas price at the pump for the consumers and a massive reduction in deforestation.

The AKK pipeline project is slated to be the single biggest gas pipeline project to be executed in the history of Nigeria, Africa and the World, if it finally crosses to European gas market through Morocco. The first section of the TNGP is the AKK pipeline, which will connect Ajaokuta with Kano. The second section will link the Qua lboe terminal with Cawthorne Channel/Alakiri. It will also comprise a metering station, which is to be constructed in Obiafu/Obrikom. The third section of the TNGP will be laid between the Obigo gas compressor station and the Ajaokuta node to Morocco. The Trans-Nigeria Gas Pipeline has been designed to transport between 11 and 24 million metric cubic meters per day (Mm^3/d) of natural gas and will form part of the Trans-sahara Gas Pipeline (TSGP) system to Morocco and finally to Europe (Figure 13).

Figure 13: Upcoming Nigeria-Morocco Gas Pipeline

Gas Reserve and Market in Africa

Africa's reserves of 527 tcf account for 7.5% of the world's total proven reserves. Gas production in Africa increased marginally by 0.7% to 8.4 tcf (or 23 bcf per day) in 2019, which represented 6% of global production. Gas consumption in the continent also increased to 5.3 tcf (or 14.5 bcf per day) in 2019, an increase of nearly 1% from the previous year. Africa's gas consumption in 2019 represented 3.8% of global consumption value despite massive reserve deposit.

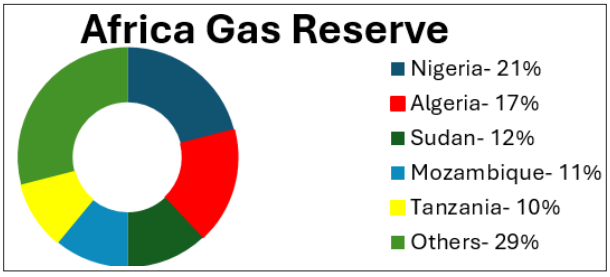

Figure 14: Chart Showing African Gas Reserve Deposit

Nigeria's gas reserve is estimated to increase to 230.8 tcf by 2030 from its current 210.564tcf due to ongoing aggressive exploration and production exercise. Moreso, developing Nigeria's Gas Industry for Regional Economic Integration can be championed by Nigeria through series of pipeline projects [16].

With adequate investment in gas exploration and production, Nigeria could become the undisputed gas production powerhouse of Africa by 2030. Gas production stood at an average of 2.53 tcf in nearly two decades, which is less than 1% of the nation's reserve. Optimizing natural gas assets from marginal fields in Nigeria is important to shore up the revenue base for infrastructure development. Indeed, Gas development is driving sustainable growth in Nigeria [17,18].

Gas Metering and Pipeline Vandalism

TNP delivers 180,000 liquid products to bonny export terminal and was totally shut down from June to October 2022, leading to huge revenue loss to Nigeria due to pipeline vandalism. Oil and gas pipeline vandalism is a major hindrance most operators and regulators claim is militating against gas distribution in Nigeria especially in the downstream sector. Resent Research conducted on this critical issue has shown that this problem is surmountable if there is adequate collaboration between the operators, investors, security apparatus and regulators in the upstream and downstream oil and gas to use what is called "Code and show technique (CST)" [8]. If this technique is adopted, Gas pipeline vandalism will reduce drastically by 65% within the first 3 years of introduction.

More importantly, community sensitization of members, youths, traditional rulers, security agencies etc will have to be carried out to properly educate inhabitants of these areas where Gas pipeline pass with their unique codes and symbol and need to protect them to prevent explosion. CST simply means Gas pipelines are coded with a conspicuous symbol with its massive symbol of explosion if tampered with. Gas is not a product anybody can steal in any country so, there is no basis tampering with it in the first place. They are largely mistaken as oil pipeline and when it has been established as a gas pipeline upon human intervention, the culprit flee only for the gas to be wasted causing severe harm to the environment and pollution of the community waterways, soil and quality air, For accountability, gas metering will be highly needed at flow stations for early detection of leakage and theft. PwC estimates that harnessing Nigeria's proven gas reserves can stimulate an estimated Gross Value Added (GVA) of US$18.3 billion annually to the domestic economy. In addition, optimizing the domestic utilization of gas could support 6.5 million Full Time Equivalent (FTE) jobs for the local economy.

Figure 15: Gas Metering and Stock Taking

New Downstream Investment Funding Model

The best funding model for gas exploration and production is that of the foreign direct investment. In essence, the risk of investing in the Nigerian gas should be almost zero for the investors to have that confidence to invest in gas development, storage, processing and marketing. More importantly, all regulatory activities will have to be highly transparent with strong judicial and regulatory systems to encourage investors that the rules will not be changed midway of investment drive. The internal NMDPRA alternative dispute has a crucial role to play to secure foreign investment flow into the country by ensuring fair judgment on all feuding investors if the need arise such that no party feels cheated irrespective of clime, ethnic or political affiliation.

The franchise includes a tying arrangement whereby gas from the NGMC, an affiliate of the NGC, is sold by the LDC to end-users. The LDCs enter into standard gas sale and purchase agreements with their end-user customers. The LDCs enter into gas transportation agreements for the transportation of gas produced from the upstream. However, this is not applicable to the use of gas transmission pipelines that are subject to the Nigerian Gas Transportation Network Code (Network Code) that governs the terms for the transportation of gas in certain pipelines. Shippers in those pipelines are required to have acceded to a framework agreement that makes the Network Code binding on such shipper. The operator of a facility delivering gas into the transmission pipeline system will be required to enter into a network entry agreement with the pipeline operator, while the operator of the facility taking gas off the pipeline such as the operator of a natural gas distribution network, will be required to enter into a network exit agreement with the transmission pipeline operator. This is indeed a very transparent procedure put together by the regulators for all investors irrespective of gender, race, political affiliation, and clime.

The PIA provides for the incorporation of a domestic gas aggregator as a not-for-profit vehicle, which will undertake all of the functions previously carried out by the GACN, including the implementation of the domestic gas delivery obligations of gas producers. In ensuring that the needs of the domestic market are met, the Commission may require producers of natural gas to carry out operations such as the drilling of new wells, completing and deepening existing wells or the construction of a gas transportation pipeline connected to existing pipeline or utilization facility. A penalty of US$3.50 per million British thermal units (which may be adjusted by the Commission by regulations issued under the PIA) is payable by a gas producer for failure to meet the DGDO allocated to such producer by the Commission. Also, any gas export project proposed by the natural gas producer will not be permitted by the Commission until it meets its DGDO. An offtaker that applies to and obtains a gas purchase order from the gas aggregator is entitled to negotiate a template gas supply and aggregation agreement (GSAA) issued by the aggregator with a gas producer that has been issued a DGDO by the Commission. With respect to pricing, the gas producer is required by law to be paid an aggregate price that is a weighted average of all payments under similar GSAAs for the sale of DGDO volumes received by the GACN, or successor gas aggregator pursuant to the PIA, in an escrow account established for that purpose.

A gas producer that has satisfied its DGDO may contract with any offtaker for the sale of natural gas on a willing-seller-willing buyer. The technical allowable rate (TAR) which is the optimized production capacity of all wells in-country that is determined by the Commission will be after the execution of the statutory bi-annual maximum efficiency rate test (MER) by all operators. The MER test serves as the first technical basis for hydrocarbon measurement and accounting. A total of 2.511TCF of Associated and Non-Associated Gas was produced at an estimated daily average production of 6.86BCF/D during the year 2024. This represents a slight increase of about 0.53% compared to year 2023. More importantly, cutting carbon emission from production using modern production technology is beneficial to the ecosystem [19]. The sustainable use of gas is inevitable as a critical role for economic development across different climes of the world as transition fuel. Gas utilization enhance clean environment and egalitarian society [12,20].

Evolving CNG in the Nigerian Energy Landscape

Natural Gas Vehicles (NGV) is a fuel vehicle for internal combustion engines gradually evolving in the Nigeria's energy landscape (Figure 16). This can be traced to the removal of fuel subsidy May 29, 2023 which is making Nigerians switch to safer, cleaner, cheaper and environmentally friendly CNG fuel, thereby reducing the carbon footprint in Nigerian ecosystem. A detailed assessment of the current progress on its adoption, utilization and future projection has just been published with the title: Compressed Natural Gas: The Geo-scientific and Technological Innovation shaping the Energy Landscape for a Cleaner and Eco-friendly Society in Nigeria [15]. More detailed information is provided on the scientific, Technological, Advantages, Environmental sustainability, Investment drive, present and even future utilization projection rates in Nigeria. CNG is basically composed of Methane gas and its use offers extraordinary advantages unlike gasoline vehicles. As its combustion is more complete, the contaminating effects of the exhaust gas emissions are reduced by approximately 80%. This gas is also less corrosive, thus increasing the duration of the exhaust system. NGV like CNG keeps the spark plugs clean, prolonging their use; it does not contaminate the engine oil thus prolonging its utilization lifespan hence doubling the time interval

required for oil changes and that of the filters and this in-turn improves lubrication because the cylinders are not washed by gasoline excess invariably avoiding premature wear of vehicles. Mitigating gas flare and emission footprints via implementing natural gas vehicles of PCNGI in Nigeria is an excellent step to further consolidate gas utilization in Nigeria.

Figure 16: Natural Gas Processing Plant to CNG

The Presidential Compressed Natural Gas Initiative (PCNGI) targets over 1,000,000 new CNG-enabled vehicles and 55,000 CNG conversion kits for existing Premium Motor Spirit (PMS)-dependent vehicles in Nigeria. In no distant time and as at the last statistical data available, the head of commercial at PCNGI made it clear that 590 CNG-compliant buses had been procured by the Ministry of Finance and distributed based on access to CNG fuel. This is an establishment set up to fasttrack the switch to the utilization of CNG in Nigeria ecosystem for clean, cheap and environmentally friendly energy. Furthermore, compilation of latest data on the subject issue of CNG utilization and future utilization projections in Nigeria's energy landscape has just been concluded and has just been published as earlier reported [15].

Conclusions

Nigeria is turning its vast natural gas reserve deposit into a national catalyst for economic growth using smart policy, local enterprise and expertise, strategic economic reforms and a highly ambitious infrastructure development to power homes, fuel industries, brighten numerous transportation network, busy our roads and re-define its place in the global energy map. Associated gas of 1.440.742.48 mmscf and Non-associated gas of 1.067.585.02mmscf in 2024 is highly explorative ambitious! More importantly, total gas production of 2.511,345 Trillion cubic feet recorded in 2024 signify its ongoing current gas expansion is huge and creates multifaceted economic opportunities at home and beyond for Africans and International community. With a total gas utilization of 2.312.926.16mmscf recorded in 2024 for in-house gas consumption fuel, re-injection for reservoir pressure enhancement and sales to domestic and export markets to serve as feedstock for industries, especially in petrochemicals, fertilizers, methanol production, manufacturing and agro-industries to grow its economy, the country is on a bigger trajectory to attain the target of a trillion dollar economy.

Regional pipeline network projects such as the AKK, Nigeria–Equatorial Guinea Gas Pipeline, Trans-Saharan Gas Pipeline and Africa Atlantic Pipeline will obviously fastrack gas exports and in-house industrial use such that domestic consumption and export markets that stood at 673.644.81mmscf and 905.341.94mmscf respectively in the year 2024 respectively will massively increase to 1.494.328.85mmscf and 1.930.730.22mmscf respectively by 2030. This forecast and projection will not only effectively position Nigeria as a trillion dollar economy, but will greatly showcase the country as the biggest producer of gas enhancing Africa and world economic growth, drastically reducing carbon footprint to net zero, shoring-up revenue, promoting sustainable and inclusive economic growth, curbing deforestation and promoting a clean, eco-friendly and egalitarian society [21].

Brief Biography of Lead Researcher (Author)

Dr. Ibrahim Olanrewaju Ibrahim is a versatile researcher, especially oil and gas expert with about 40 published articles in different national and international journals. He is an Environmental, Hydro, Engineering and Petroleum Geoscientist with published articles covering all the aforementioned skills. He is a book and several manuscripts reviewer with several Award of Excellence on reviewed manuscripts from numerous international journals to his credit. He has delivered several public lectures and attended several seminars and conferences locally and international arena. He has mentored several Students of Industrial Work Experience (SIWES) from different institutions of learning at Lower Niger River Basin Development Authority, Ilorin, Kwara state, Nigeria on Hydrogeology, Exploration Geophysics, Engineering Geoscience and Sedimentology, equipping them with different knowledgeable practical skills to create jobs. He earned a first degree in Applied Geology from Abubakar Tafawa Balewa University, Bauchi, Nigeria. He also attended University of Ilorin where he was awarded a Master and Doctorate degree in Geological Science. His area of current research is on Climate change, Carbon credit market, Natural Gas development and their impacts on economic growth in Nigeria and Africa.

Acknowledgements

We sincerely thank God for helping us complete this manuscript. We profoundly appreciate all listed authors for their individual contribution to bring out the best of this paper. More importantly, Authors appreciate our publishers and reviewers for their kind attention. All national and international sources of data are hereby duly acknowledged and adequately referenced.

Conflict of interest

No conflict of interest has been declared in this paper as contents have been put together to contribute to learning, knowledge acquisition and investment drive on the Gas potential in Nigeria currently grossly untapped.

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