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NATURAL GAS UTILISATION IN NIGERIA: CHALLENGES, EFFORTS AND PROSPECTS

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Abstract

The study examines natural gas utilisation in Nigeria: Challenges, efforts and prospects. It showcases an empirical investigation on the potential of the Nigerian gas industry; Past and ongoing gas utilisation efforts; factors influencing investment in the sub-sector and the constraints of gas development. It employed secondary data from the Central Bank of Nigeria (CBN), Nigeria National Petroleum Corporation (NNPC), Nigeria Gas Company (NGC) and Department of Petroleum Resources (DPR) from 1976 to 2015 and T Regression Models estimated using The Ordinary Least Square (OLS) technique. Based on the findings, it is recommended that an appropriate price structure be put in place to guarantee recovery of investment and a sound regulatory environment to ensure efficient utilisation practice.

Keywords: Natural gas; Utilisation; Challenges; Gas industry; Prospects, Nigeria

1.0 Introduction

The availability and efficient exploitation of natural resources within the territory of any country contributes to the economic, social and political well-being of such country. Revenue stream can be used in promoting development agenda such as education, industrialisation, health, infrastructure, favorable balance of payments, employment, stable currency etc. Nigeria with a population of over 200 million people, has substantial natural mineral resources. There are several of these natural mineral resources that serve as primary sources of energy which when transformed further can result in several economic benefits. Nigeria has advantage of crude oil and natural gas, due to its abundance in her territory.

Focus is on natural gas which Nigeria has proven reserves in excess of 187 trillion Square CubicFeet (SCF) according to the Department of Petroleum Resources (DPR) with a potential for new discoveries in the neighborhood of 75 Trillion SCF. 56% of these reserves exist in association with crude oil, while 44% exist alone.

Natural gas has unique qualities which makes it have variety of applications as premium fuel as well as feed stock in many industrial and domestic settings world over. It is a veritable partner for heating, locomotion and luminosity. Considering the importance of this natural resource, enough progress has not been made in its development and utilization in the country.

Expected progress include establishment of gas gathering and transmission systems, gas export-oriented structures and conversion of gas for industrial and domestic purpose. This is not commensurate with the quantity of gas available in Nigeria that is wasted by flaring which translates in 2bscf/d (NNPC/NAPIMS, 2006). This represents an enormous economic loss to Nigeria and adverse impact on the environment. This is in contrast to other natural gas rich countries like Malaysia, Qatar and Indonesia which have been able to spur the development of their domestic market through improved gas application.

1.2 Problem Statement

The demand beyond the domestic scale is externally controlled which has fallen in the international market arising from natural disasters, discovery of alternative sources and supply disequilibrium in recent times. The need to look inward becomes imperative as natural gas is still the future for its rare qualities, which include its intensity, second

to crude oil and a better environmentally friendly choice to others, coal especially.

The oil and gas sector has been a key contributor to the country's budget since its discovery. It contributes over 90% of our external reserve requirement and exchange earnings. With supply outweighing demand of the product and subsequent decline in price, to avert the ugly consequences, the need for strategic reserve through functional and adequate storage mechanism and market strategy become simperative. However, corruption is still highly perceived in the sector as most products are stored in third party facilities with the attendant costs weighing heavily on the economy. These storage vessels are mostly owned by people in authorityand their cronies. This phenomenon makes shutdown of production facilities inevitable when capacity is over stretched, resulting in decline in revenue with a reserve of over 187trillionscf, seventh largest in the world, it should be stated that Nigeria is blessed with the commodity. It has the potential to make the country great and prosperous. But with over 45% of this gas flared, the country should improve on its management, examine the constraints to the development of a viable gas sector and prospects for gas utilisation in Nigeria.

It is therefore pertinent to ask to what extent has revenue from gas influence investment in the sector, what are the constraints to output utilisation, what can be done to reduce wastage to its barest minimum and how can the country maximize its benefit through increase gas utilisation.

1.3 Objective of the Study

The broad objective of this study is to find out the various challenges being faced and prospects of the gas sub-sector. The specific objectives are to ascertain:

(i) The extent to which revenue from natural gas has influenced investment in the sector;

(ii) The extent to which natural gas output and revenue has impacted the growth of the economy.

1.4 Hypotheses of the Study

The following hypotheses were tested.

Ho1: The revenue from natural gas has no significant impact on investment in the sector.

Ho2: Revenue and output of natural gas has no significant impact on the growth of the economy.

2.0 Review of Related Literatures

2.1 Conceptual Issues

The production of gas entails very complex processes. As earlier mentioned, gas are exploited alone or in association with crude oil. The production process are almost similar, just that in gas alone exploitation and production, additional safety measures are required because of the behavior of some wells, in some cases up to 4000 pressure per square inch (psi), which is highly volatile, requiring "kill tools" to prevent blow out. Also, gas exploration require higher throughput (bigger diameter of pipes and tougher schedule).

Eventually, they both pass through 4- or 6-inches flow lines from wells to production facility. Oil and gas or gas alone hit the "knock out drum", a vessel in the production facility for stability, then to the "test and service separators" through intricate pipe arrangements, for proper separation of gas, crude oil and water. Where there are no storage for gas as in most cases they are flared out, except in situations when some wells are epileptic, gas is reinjected through gas compression to boost the performance of the well. It is worthy to mention that gas production is more expensive that crude oil production, while gas is cheaper in the market (Domestic and International) than crude oil, creating a disincentive for investors. Also, the regulatory environment in Nigeria supported by subsidy in the sector, which is gradually easing out is still a constraint.

2.2 Nigeria New Gas Policy at a Glance

With an expected life span of 144 years for Nigeria Crude Oil reserve and 88 years for gas base on 2001 production rate 1950mmscf/d with increasing domestic oil consumption, an economically optimal strategy to replace oil with gas is being put in place. The waste of a vital energy resource like gas and the consequent atmospheric pollution has necessitated the terminal date of flaring in January, 2008. Thus, the new gas policies as enunciated by the National Energy Commission and enclosed by the Presidency in April, 2003 are as follows:

a-Increase the reserve base by intensive exploration and development.

b-Put in place the right infrastructure and incentive to encourage local and foreign investment.

c-Put in place adequate infrastructure to ensure transmission and distribution of the product all over the country.

The above listed policies seek to achieve the following objectives.

(i) To eliminate gas flaring by 2008

(ii) To expand the utilisation of natural gas as domestic and industrial fuel for power generation.

(iii) To use gas to diversify the foreign exchange base of the nation.

(iv) To increase the use of natural gas as industrial feed stock for Petro-chemical and fertiliser plants.

(v) To determine the nation's actual gas reserve.

(vi) To accelerate the process of technological transfer in the gas industry.

As a measure to achieve the aforementioned policy objectives, various strategies was instituted:

(i) Encourage associated gas gathering by MOCs in order to end gas flaring at the stipulated time.

(ii) Encourage infrastructure building for effective gas gathering transmission and distribution.

(iii) Imposing appropriate sanctions for gas flaring

(iv) Put in place incentive to encourage industrial and domestic application.

(v) Establish the right infrastructure for the export of natural gas

(vi) Ensuring the right price regime for gas and the use of suitable appliances.

2.3 Current Gas Utilisation Regime

So far a total of 45% of produced gas is wasted through flaring with a corresponding loss in revenue to about $33,720 million monthly, (NNPC, 2014). Apart from such loss, gas flaring also shrink the economic space through its impact on the environment, leaving continuous agitation and poverty in the host areas.

The monthly utilisation value of gas produced stood at over $550,000million, monetary equivalent of 183.2billionscf. The utilisation is on gas re-injection, domestic and foreign sales and storage practice, which is inadequate. If properly managed, gas export can add more value in the financing of the country's budget. Logistics management activities of production, handling, packaging, transportation, storage and distribution in the sector covers precautionary, exigencies and actual activities take to ensure product gettothe desired destination or market. In the same vein, gas hydrocarbon logistics involves the needed support base to ensure production and transportation of gas to the end users. In the process, the key imperatives of social, economic and the environment

must be considered. This implies the social, economic impact of operations on the environment must not be undermined, bearing in mind the best global standards. Gas logistics involves the knowledge, right technology for efficient and effective value addition in the supply chain process. These activities must be aimed at reducing treats that can induce economic, social and environmental wastages.

In a situation where utilised gas are flared away with impunity, there is need for a systematic reversal of this trend. This is where storage activities becomes imperative as a strategic tool to address future demand. NNPC (2011) opined, the local gas demand may exceed 5millions cf in the next decade.

Out of this aggregate, the power sector is estimated to have a share of over 70%. The need for a robust gas infrastructure becomes necessary for efficient and effective gas supply in the country. The sector can only defile the resource curse fallacy argument and be a blessing to Nigerians if adequate logistics infrastructure, which include, but not limited to maintenance, monitoring of piping and storage facilities are put in place for effective supply and demand interaction. Currently, the sub-sector is bedeviled by gas flaring, environmental pollution, poor processing, pipeline issues (destruction and tenure rupture from untimely change out) and storage facilities.

Hydrocarbon gas remains the most environmentally friendly alternative in the energy mix. It is cleaner and may remain the cheapest source of energy for industrial purpose (Farmer, 2004).

Insufficient storage facilities, transmission and distribution network has hampered its utilisation in Nigeria. Also, there is need for an appropriate gas policy giving a direction in the sub-sector.

2.4 Gas projects as efforts to shore up utilisation capacity

1. Nigeria Liquefied Natural Gas (NLNG) project.

The project has been described as most practical, genuine and commendable effort towards harnessing the nation's gas resource and a foreign exchange earner. The project is a three-train philosophy consisting of gas liquefied plant; a gas transmission system linking the plant by pipelines to the gas supply field, associated utilities, storage/loading facilities, seven LNG vessels for LNG deliveries, residential quarters for its fixed term employees on the Island of Bonny

and other infrastructure (OPEC Bulletin. May, 1997).

The fifth train was completed in 2006, increasing annual production capacity to 17 million Tons per year of LNG. There are also future plans to expand the facility. The project is an NNPC, Gas BV, ELF Clegg Ltd and AGIP International BV Joint Venture with the corresponding shares 49%; 25.6%; 15% and 10.4% respectively. With an initial outlay of $3.8 billion, the LNG is exported to special customers in Europe. They are ENEL of Italy, ENAGAs of Spain, BOTAS of Turkey, Gas de France and TRANSGAS of Portugal. Its projected accrual is $1billion per annum for the first 22 years.

2. Escravos Gas Project (EGP)

This is an NNPC/Chevron Joint Venture Project. Built at a cost of $350 million to process 185mmscf/day, commence operation in May, 1997. Chevron pegged its flare out date at 2006/2007 aiming at trains 2 and 3, which will utilise 80% of the gas emanating from its operation in the area.

3. Shell Nigeria Gas (SNG) Limited

SNG Limited subsidiary of the Shell Petroleum Development Company (SPDC), incorporated in March, 1998. It aimed at transmission and distribution of gas in Nigeria. It is a response to adequate utilization and flares out in Nigeria. Their main target are factories that use boiler fuel, industries that use gas as feed stock for manufacturing and transporting vehicle that compress natural gas. Their real destination are industrial hubs like Agbara, Otta and Aba. Other attempts by the SPDC are the Forcados Yorkri integrated project (FYIP), South Swamp Associated Gas gathering (SSAGG). They are to serve as feeder to the NLNG, also with the sole aim of capacity utilisation and flares out.

4. Mobil's Oso Natural Gas Liquids (Oso NGL) Recovery Project.

Jointly owned by NNPC-49% and Mobil-51%. If commence contractual agreement in February, 1995 with an initial outlay of $855 million, and a life span of 25-30 years. The Associated Gas from Oso and nearby fields are re-injected to maintain reservoir pressure

5. West African Gas Pipeline Project (WAGP)

The WAGP project is a 620 kilometer offshore regional pipeline project linking Nigeria, Benin Republic, Ghana and Togo. The companies involved in the project are Chevron Nigeria Limited, Shell Petroleum Development Company of Nigeria, NNPC

(represented by the Nigeria Gas Company – NGC), Society Beninese de Gas, Ghana Petroleum Corporation and Society, Togolese de Gas, with Chevron Nigeria Limited on the project manager. The project was to be completed in 2002, but commenced that year due to administrative bottlenecks as expected when giants fight for supremacy. With an outlay of $590 million, it is designed to export 120mmscf of gas per day from Nigeria to the other West African Countries (This Day. January 25, 2005).

6. Ajaokuta – Kaduna – Kano (AKK) Gas Pipeline Project

This is a 40inch by 614km trans-Nigeria gas pipeline project linking Ajaokuta, Kaduna and Kano from the East/West/North section of the country's gas network. It is the single largest gas utilization project in the countryto date with huge local content at a cost of $2.8billion. Launched on 30th June, 2020 and expected to be completed in 24 months. It is to deliver 2.2BCF/day of gas and boost domestic utilisation of gas in the areas. The Companies involved in the construction are NNPC and OilServe Nigeria Limited, an indigenous company.

2.5 Gas Storage Facility

The relevance of gas cannot be over emphasised. This had made the government desirous to commercialize its productions for local and foreign markets. However, this effort is been hampered by poor and inadequate logistics infrastructure, which includes storage facilities for effective demand response. Just like a warehouse for drybulk goods and storage vessels and tank farms for wet bulk products, a gas storage facility is a logistics infrastructure developed for proper storage of gas resources to avoid volatile consequence, risk leakage and wastage. The need for storage is important to avert environmental pollution, supply disequilibrium and disincentive for earning.

2.5.1 Types of Gas Storage Infrastructure

The idea behind gas storage is to prevent either its immediate use or wastage. However, produced gas can be re-used by the process gas re-injection. It is a process whereby produced gas is sent back to the specific wells where the gas comes from to avoid wastage through flaring, which serves to protect the environment. The re-injected gas into reservoirs add pressure to lift crude oil from viable wells. Gas storage is a strategic security endeavor. It is the conservation of gas for future use. It becomes

imperative due to uncertainties in supply, equipment failure, civil invest, natural disaster and market disequilibrium in the area of production. Gas storage can also be realized through the bridging of areas high in gas demand to areas high in gas reserves for easy evacuation through pipelines as in the case of the West African Gas Pipeline Project (WAGP). That is the gas is delivered sealed till it gets to its destination. Some of these gasses eventually end up in reservoirs of countries where it is demand and produce for immediate and future use.

Other form of gas storage facility are dead or depleted wells. Here, such wells have outlived theirusefulness in oil production and could serve as storage facility for gas lifted or delivered from producing reservoirs. The conversion of former producing reservoir to storage facility in the existing fields comes with an advantage. In such circumstance dead wells had oil and gas gathering and treatment facilities existing, as well as pipeline routing to evacuate produced gas. Depleted oil and gas reservoirs enjoy more patronage for strategic storage. Natural water bearing reservoirs can also be converted to gas storage facility.

From the petro-physical data analysis some wells can only produce water, such well are term aquifers. When water is evacuated from such wells, it can serve as storage for gas. Salt mines, termed Salt Carven can also be used to store gas. Its advantages when used provides very high injection and withdrawal rates relative to gas capacitor availability. Also, other mines of elements such as gold and diamond can be used.

However, the construction of cavern for natural gas storage can be more expensive, as against depleted fields converted to storage facilities. Technology has helped this process with increasing commercial viability. The characteristics of storage mines are important to guarantees safety and easy retrieval of stored gas when needed.

Generally, the storage adaptation will depend largely on the existing geological features of the chosen areas. Salt carven are beneficial for the storage of small volumes of gas, unlike the Aquifers and depleted reservoirs used in storing large volume of gas. Salt carven is popular for storing Liquefied Petroleum Gas (LPG) than Liquefied Natural Gas (LNG). Its advantage include short filling time, reliability, high deliverability and total recovery of cushion gas.

The establishment and operation of gas storage facilities is very crucial to the Nigeria

economy as the demand for Nigerian gas by importers is not yet at equilibrium. The need for strategic storage requirement becomes imperative to address future needs than wastage through flaring. The future for gas is bright. With more discoveries, the potential of gas to drive the economy cannot be disputed. The estimated gas reserves for Nigeria grew from 153trillions cf in 2001 to 165trillionscf in 2009. Current statistics indicate that the country's natural gas reserve stood at 185trillionscf, an enviable resource rating in the world.

2.5.2 The Key Functions of a Gas Storage Infrastructure

All products usually deal with the problem of production and consumption disequilibrium and natural gas is left out currently gas supply outweighs its demand, the need for the excess to be stored for future demand becomes imperative if we must sell at reasonable price for survival as a nation. The product may suffer seasonal, long- or short-term business cycles. The problem of seasonal peak demand in winter or higher demand by industries are reasons why gas storage facilities are necessary.

Considering its volatility and value, it must be safeguarded from loss through leakages. Such measure entails cost saving and environmental protection. The liquefied natural gas plants and other plants store gas which forms their inventory of raw material, should plant shutdown occur due to unforeseen circumstances. A gas storage facility adds time and place utility to producers. By time utility, gas is stored for future demand rather than wastage as experienced in Nigeria. Place utility is achieved as the commodity in placed near the consumers for usage guarantee.

2.6 Determinants of Investment in the Gas Sector

From economic stand point, economic agents generally have the primary motive of making profit; hence Entrepreneur will seek to invest where profit motive is guaranteed. Besides economic motive, other structural factors had been known to influence investments decision in the gas sub-sector. They include:

2.6.1 Government Policy: Government being a major regulator of the oil and gas sector hasencouraged investment in infrastructure that will enhance the production and processing of associated gas. It has provided fiscal incentive that view any cost incurred on capital investment to deliver AG in usable form to customers as part of

field development cost as contracted with what obtained in production and processing of NAG in where such cost are treated separately.

With this policy, it means the Federal Government which hold 49% equity share in the upstream sub-sector of the oil and gas industry will also be responsible for 49% of the cost of production and delivery to end users.

This policy also encourages increased utilisation of gas resources. It also provide that income tax on AG and NAG should not exceed 45%. Firms involve in the production, transmission and distribution of natural gas are exempted from paying tax for 5 years from the date of commencement of business. For producers, they are given 5-7% reproduction on payment of royalties, for the firms involved in transmission and distribution, payment of duties on imported materials for the maintenance and operating of such plant after 2 years commission of plant are waived. For distributors, income tax should not exceed 30%. The use of compressed gas like in the transport sector, should not pay more than 80% of the prevailing price of fuel. With these incentives, government had made investment in every phase of the gas sector worthwhile. These factors have motivated the many gas utilisation projects in recent times.

2.6.2 Expected Rate of Return over Cost on Gas Project:

The decision to embark on new gas utilisation project still depends on whether expected rate of return over cost on new investment is lesser or greater than the rate of market interest, which has to be paid on barrowed capital. Thus every rational investor will ensure that the rate of revenue will cover every cost of investment, maintenance of equipment and also guarantee reasonable profit. Because of its cost effectiveness for example, it is cheaper to transport natural gas through pipeline than any other fuel such as gasoline, diesel, kerosene etc. Also, gas is directly supplied to customers from well to gas plant and does not require storage like other fuel. Most of these cost that is conserved to ensure high profit margin, had underscored the high expectation on the rate of returns on new investment in the sector.

2.6.3 Investment Opportunities in the Nigeria Gas Industry:

Besides government partnership with OMCs in the upstream sector of the industry. There is scarcely private investment in the downstream sector. This does not mean there

are no opportunities in the downstream. Investigation had shown that investment opportunities are available in the following areas.

a - The establishment of mini petrochemical plants that uses natural gas as feed stock for manufacturing varieties of product.

b - Establishment of mini fertilizer plant that also utilise natural gas as feed stock.

c - Plant for the production of LPG and its accessories

d - Plants for compressed natural gas (CNG) to run vehicles.

e - Plants for Natural Gas Liquid (NGLs)

2.6.4 The Avoidance of Fine on Gas Flaring: Gas flaring has been of great concern to the government for a long time not due to the economic loss, but the social displacement and environment impact of the practice. This has forced the government to come up with measures to discourage gas flaring. One of such policies is the Associated Gas Re-injection Decree of 1979 and others mentioned earlier. One of such policies specified that every One Million Standard Cubic feet of gas flared, the producer shall pay to government of the 1st, 2nd, 3rd, 4th and sequent years 10%, 15% 20%, 25% and 30% respectively of the average price of gas delivered to industrial users. The penalty for flaring 1000scf of gas in 1990 was 50Kobo and N3.10 in 1998. The 1999 budget review, proposes further increment form N3.10to N20.00. In addition to these penalties, government also directed that gas flaring of whatever sort should end by 2008. Despite concerted efforts, the practice is still on unabated.

2.6.5 The Demand for a more Cost-Effective Energy Resources: Since the Oil and Gas Industry provides various alternative energy resources like premium motor spirit (PMS), fuel oil, kerosene, Aviation Turbine Kerosene (ATK) and natural gas with each of these products being sold at different prices per unit, each product user purchase that which is more cost effective. In energy terms 1000scf of natural gas is equivalent to a liter of diesel. A litter of diesel will cost four times to the cost of 1000scf of Natural Gas.

2.7 Constraints of Gas Development

Achieving maximum gas development and utilisation in Nigeria comes with obvious challenges. These clogs include:

2.7.1 Capital Intensive Nature of Gas Investment: Natural gas production, transmission and distribution require network of pipelines and facility including compressors to maintain flow pressure, stations for processing, treatment to ensure either dry or wet gas free from impurities and metering to account for quantities and pricing to ensuring gas moves from the point of production to the end users. The Nigeria gas being more of Associated Gas is more expensive to produce than Non-Associated Gas. Reason being the separation process with different orientation of facility. Thus, raising the initial capital outlay required in addition to high and unstable interest and exchange rates, inflation and other macroeconomic gyrations has been a problem.

2.7.2 Policy Change by Government: the rapid turnover of policies of government has not helped matters. This usually characterised by poor or inadequate regulation and leaving most projects abandoned.

2.7.3 High level of indebtedness: one major challenge is the delay or inability for most consumers to pay for what is demanded. Most of the Federal government owned organizations such as power generation companies (GENCOS) and the Comatose Aluminum, Steel and Fertilizer companies are heavily indebted to the Nigeria Gas Company (NGC), hampering its operations and other gas development projects due to financial difficulties arising from these debts.

2.7.4 Inappropriate Gas Pricing: of great concern is the issue of gas pricing. Given the pivotal role of energy to economic development, adequate gas pricing becomes important. It has been argued that the dynamics of demand and supply should determine the actual price of the product.

Briefly stated, some techniques and principles in pricing energy resources.

a. Marginal cost pricing: This approach equates the price of energy to the marginal cost (MC) of providing such services. This is a welfare approach that recommends very low prices for energy consumed.
b. Profit Maximising Techniques: This method equates Marginal cost (MC) to Marginal Revenue (MR). This technique exists in a perfect market competition of free entry and exist.
c. Average cost pricing technique: The method equates the cost of supplying such energy with the price paid by the

consumer i.e. a zero profit pricing method (AC = P).

However, whatever pricing regime adopted, the principle of financial soundness, economic efficiency and equity must be considered. The principle of financial soundness aim at recovering cost of investment. The economic efficiency principle emphasizes financial principle in addition to the concept of opportunity cost of the resources employed in energy supply. The principle of equity emphasizes the ability of consumers to pay (NACEMA, 1999).

2.7.5 High interest rate: like earlier mentioned, the gas sector is capital intensive, requiring funding from the capital market and other sources. High cost of capital as experience in Nigeria services as a major deterrent to investors, especially domestic investors.

2.7.6 Poor funding/Management: Maintenance of existing structures and the building of new ones require adequate and timely funding to ensure uninterrupted supply of gas. The poor funding has been identified as a factor stunting the growth of the sector. The lack of maintenance culture and accountability that has crippled the nation's refineries has also caused the collapse of steel, fertilizer and aluminum companies which are major consumers of natural gas in the country and still continuing unabated.

2.7.7 Non-Existing National Gas Grid: Another challenge of gas utilisation is absence of national gas or pipeline network to link areas of production with potential demand centers. The three segments of the gas chain i.e., production, transmission and distribution need to operate effectively for widespread use of gas in the country. The transmission phase is the most critical determinant of gas infrastructure development. The current grid being operated by the Nigeria Gas Company, need real expansion for the reserve of natural gas to be utilised and to also encourage the development of the domestic gas market towards eliminating gas flaring.

2.7 Empirical Literature on Natural Gas Utilisation

Development has been linked with per capita energy consumption or the contributions of the energy sector to Gross Domestic Product (GDP) of any nation. This fact has become more evident in the developed economies of

Japan, Australia and Western Europe which has the highest per capita energy demand in the world, in contrast with developing or emerging economies. A World Bank report states Nigeria and most African nations have per capita energy demand of about 10 percent below World average, (Iwu, 1998). The United States of America alone accounted for a third of the world's energy demand.

The role of a well harnessed energy sector to national development cannot be overemphasized with its multiplier effects on other sectors of the economy, which include, industrialization, infrastructural capital and general improvement in socio-economic activities. Also, a proper developed energy sector can adequately boost the earning capacity of the nation through Taxes, Royalties such as Rent, Petroleum Profit Tax (PPT), Income tax, signature bonuses and fines on gas flaring on the cause of production.

Several studies have been carried out in the area of energy and national development. Odidi (1987) wrote on the imperative of a National Energy policy, and the socio-economic implications of such policies. Simple statistical methods was employed in the analysis. Finding reveals that petroleum remain the key energy source of Nigeria.

Ayodele (1998) was concerned with the perennial energy crises, especially in the power sub-sector of the economy. Simple statistical techniques was used in evaluating data. Findings revealed poor gas supply, hydrological inadequacies and frequent breakdown due to excess carrying capacity. Agbon (1986) wrote on the role of energy utilisation and Nigeria's economic development process. He established the technical criterion for efficient energy utilisation. The inter-relationship of the productivity of energy, capital and labor are highlighted using mathematical models, graphs and inference analysis. He opined that technical efficient energy system would be uneconomical if the cost of increasing the system's efficiency is more than the benefit obtained from the energy saved. However, a technical efficient energy system is economically efficient if the net present value (NPV) of benefits is greater than zero.

Synage (1986) is bothered about efficient management of the energy sector of the Nigeria economy. He observed the sector lacks effective management structure and central direction. He suggested the Nigeria National Petroleum Corporation (NNPC), Nigeria apex manager of the sector has to be restructured to enable it live to expectations.

Also the organisation should be more proactive in developing Nigeria's natural gas resource which for decades has been wasted though flaring.

Ukpong (1998), assessed the policy measures adopted by government to develop Nigeria energy resources, factors that contributed to energy crisis and mitigating measures. Statistical averages and percentages were used in analyzing data. Finding reveal that the major cause of the energy crisis is the inefficient performance of petroleum refining and marketing infrastructure. On irregular power supply, the author observed deteriorating power generating plants, pre-loading, illegal connection and lack of equipment maintenance and destruction of power infrastructure as major contributors. As a remedy, the need for urgent rehabilitation of power infrastructure, funding of the sector and privatisation of the refineries without delay.

Moro (1985) took a critical look at the National Development Plan from the first to the fourth, stressing implementation as the major problem. He noticed that despite the huge investment in the sector during these periods, the policy objectives are yet to be met. Adewoye (1998), wrote on the environmental hazard of energy production and utilization of Nigeria. The study centered on hazards of exploration of petroleum and gas on the air, land, water and bio-system as well as governments effort at protecting the environment. Okoroji and Chikwendu (1990), wrote on the future prospects and potentials of the Nigeria Gas sub-sector. They estimated an increase energy demand at a growth rate of 0.53 million barrels of oil per day, and by the next decade, Natural gas share of total primary energy would be expected to surpass 35% against the sector's share of 16.9%, 13% in 1979 and 24% in 1989. This was to be in view of gas utilisation projects like Delta Steel Company, Aladja, National Fertilizer Company of Nigeria, Onne and Aluminum Smelting Company of Nigeria, Ikot-Abasi. All moribund now.

Tiratsoo (1979) wrote on the advantages and uses of natural gas. Statistical inferences are used in analysing data. He observed that natural gas provides a clean and very flexible source of heat and fuel for domestic and industrial concerns. It burns with minimal pollution, with a higher overall efficiency than other fuel. It can also be used to fuel engines. It also have an advantage of cost, it is cheaper, displacing coal and oil in power generation. Also, in oil field operations, gas

is used for well reinjection to boost production. Knott (1993) is worried about the surge of demand for Natural gas by European consumers. Despite the fact that natural gas is viewed as a clean gas. However, the demand may increase in the next few years, but cautioned against competition.

Watts (1999) wrote on Nigeria's gas development within the world's LNG market. By investing in Liquefied Natural Gas (LNG) export business, a significant change may arise in gas utilisation in Nigeria. He observed that the safety, reliability and security of supply are the hallmarks of the LNG trade as customers seek the lowest cost and more efficient fuel to add value to their investment. Though the investment capital outlay on LNG is high, the advantages are numerous. For example, gas-fired combine-cycle power plants are less capital intensive, quicker to build, take up less land, and are more efficient to operate than say coal operated plants and could provide early return on investments. The NLNG currently takes about 1200 million standard cubic feet (1200mmscf) of gas daily with a steady increase when future expansion is achieved. Thus, the present 120 trillion feet are enough for the current NLNG project for 200 years.

Obanubi (1999) wrote on the creation of additional wealth by current gas for the future development of Nigeria. He observed that Nigeria's gas reserve stands at 187 billion SCF which in energy terms equivalent to 46 billion barrels of crude hydrocarbon oil. Also, 45% of the gas produced which is equivalent to 500,000 barrels of oil per day is flared, as the country lacks the consumptive capacity to utilise the magnitude of gas. He suggests the need for more investment in utilisation. Onukwe (1985), was worried about national energy policy for self-reliance. He analysed this through the use of ratios, statistical average and percentage. The author observed after a critical examination of the energy profile in Nigeria, that the sector is marred by scandalous wastage, ridiculous contradiction, policy inconsistency and poor management. A situation he suggested stunted the growth of the sector, poor output, importation of energy and poor power supply.

Gas utilisation/conservation policies began with a command-and-control approach by the military government of Olusegun Obasanjo in 1979, when the Associated Gas Re-injection decree was promulgated. This was followed in 1984 by the Associated Gas Re-injection (continued Gas flaring Regulation, and 1985 Associated Gas Re-injection

(Amendment) Decree (Orubu, 2005). These three pieces of legislation provided the initial statutory basis for the conservation and efficient utilisation of the country's gas resources. The Associated Gas Re-Injection Decree 1999 required operators to submit to the Minister in charge of petroleum proposals for the utilisation of natural gas not later than 5 years after the commencement of production as entrenched in Drilling and Production Regulation, 1969.

The 1979 Associated Gas Re-Injection Decree requires operators to re-inject the gas they produced without planned utilisation into the earth's reservoirs as a means of conserving such important economic resource. The gas reinjection was also to increase reservoir pressure to recover marginal oil wells. January 1984 was the deadline for flares out or with permission from the Minister with a prescribe fee to flare. Violation may attract cost of concession. The operators were more interested in the payment of fines rather than embark on gas utilisation program. The association gas reinjection (amendment decree No. 7) of 1995 came into effect. The decree increased the penalty for flaring 28.317scf of gas from 2kobo to 11kobo. By 1998 the penalty for flaring 1000scf of gas had moved to N10.

Some reasons had been advanced for why oil multinationals companies (OMCs) could not implement these gas utilisation programs they are:

1. They came to explore for oil and not gas. This made them to be laid back on extensive gas utilisation program.
2. The current regulation makes gas flaring an option, for its cheap fines.
3. Gas utilisation is capital intensive.
4. The country's industrial base in not strong enough to utilise the gas locally.
5. The inability of the federal government to meet its joint venture financial obligation and the absence of appropriate incentive by government to OMCs to promotes large gas gathering projects.

3.0 Research Methodology

3.1 Research Design

The study basically used secondary data from the Central Bank of Nigeria (CBN), Nigeria National Petroleum Corporation (NNPC) and its subsidiaries, Nigeria Gas Company (NGC) and Department of Petroleum Resources (DPR) for a period of 40 years from 1976 to 2015. Econometric technique of

Ordinary Least Square (OLS) was employed to investigate the impact of revenue from Foreign Direct Investment (FDI) on natural gas, effect of gas output and revenue on Gross Domestic Product (GDP).

3.2 Model Specification

Stated functionally as follows:

Model 1: RNG = f(GDP, FDI, MS)

.....eq. 1

$RNG = a_0 + a_1GDP + a_2FDI + a_3MS + u_t$.....eq. 2

$a_1 > a_2 > a_3 > 0$

Model 2: FDI = f(RNG, QNG, GDP).....eq. 3

$FDI = b_0 + b_1RNG + b_2QNG + b_3GDP + u_t$.....eq. 4

$b_1 > b_2 > b_3 > 0$

Model 3: GDP = f(RNG, QNG, FDI, MS).....eq. 5

$GDP = c_0 + c_1RNG + c_2QNG + c_3FDI + c_4MS + u_t$.....eq. 6

$c_1 > c_2 > c_3 > c_4 > 0$

Where

GDP = Gross Domestic Product

RNG = Revenue from Natural Gas

QNG = Quantity of Natural Gas

FDI = Foreign Direct Investment

MS = Money Supply

U = Stochastic or Random variable(s) which may influence the Dependent variable in the models.

Positive (+) sign between any of the Explanatory variables and Dependent variable confirms the *apriori* hypothesis.

4.0 Data Presentation and Analysis of Results

This section aims at discussing the results of empirical analysis of the various models.

Model 1

RNG = -301.80 + 7.626GDP + 1.584FDI + 1.402MS

T-Cal. -1.051 1.471 4.064 3.750

R^2=0.95; R^{-2}= 0.94; F-Cal. = 74.96;F-Crit. 4.02; DW = 1.973; n = 40T-Crit. = 2.001; @ 5% Significance level.

The variable used in the model has right signs. GDP, FDI and MS have positive linear relationship with RNG. With FDI and MS constant, as GDP increases by a unit, RNG increases by 7.626 units. Also, with GDP and MS constant, an increase in FDI by a unit will increase RNG by 1.584 units. Similarly, with GDP and FDI constant, a unit increase in MS will increase RNG by 1.402 units.

Model 2

FDI = 324746 + 31.016RNG + 1.594QNG - 4.545GDP

T-Cal.2.831 8.844 0.280 -0.177

$R^2 = 0.89$; $R^{-2} = 0.86$; F-Cal. = 30.566; DW = 0.599; n = 40; F-Crit. = 4.02; T-Critical = 2.001

@5% Significance level

The variables used in the model has positive signs. RNG and QNG has positive relationship with FDI. With QNG and GDP constant, a unit increase in GDP will increase FDI by 4.545 units.

DW Test (0.599) < 2, indicates positive serial correlation. However, no need to worry, as model is not designed for forecasting.

Model 3

GDP = 6493.74 + 40.75RNG + 1.410QNG - 3.362FDI + 0.928MS

T-Cal. 0.431 2.170 1.517 -1.029 2.229

$R^2 = 0.377$; $R^{-2} = 0.128$; DW = 2.334; F-Cal. = 1.515; n = 40; F-Crit. = 4.02; T-Critical = 2.001; @5% Significance level

The variables used in the model have right signs. With FDI and MS constant, RNG and QNG have positive linear relationship with GDP. A unit increase in QNG will cause an increase in GDP by 1.410 units. DW Test (2.334) > 2, indicates negative serial correlation. Needless to worry as model is not for forecasting.

5.0 Summary of Findings, Conclusion and Recommendations

5.1 Summary of Findings

Nigeria currently ranked number one is gas flaring in the world. The need to convert this avoidable loss to economic advantage becomes imperative. The demand for gas is on the increase domestically and globally because it is viewed as a clean, cheap, abundant, versatile and because of eroded confidence in oil. Natural gas is likely the choice fuel to replace oil as a leading source of energy. However, in quantitative terms, the impact of gas revenue on the economy is currently low since the bottlenecks in the sector such as adequate utilisation, high-cost outlay, pricing and storage are still a challenge.

5.2 Conclusion and Recommendations

Considering Nigeria's abundant gas reserved, there is urgent need to make implementable

policies that would enable the sector generate much economic value. Since the flares out expected target of 2008 has fallen short of realisation and another set for 2020, which is here and almost overtaken by the global Covid-19 pandemic, the need for a new national policy on gas wastage through flaring becomes crucial not only its economic benefits, but also for the impact it has on the environment. The expected petroleum industry bill (PIB) should incorporate incentives to the oil and gas companies to establish and operate gas storage facilities and overhaul of transmission and distribution networks for effective reach out to end users. The gas market is highly globalised and if well harnessed could compete with oil and take an enviable place in our budget proposal, contribution to GDP and foreign exchange earnings. There is need for the establishment of large-scale storage and pipe network systems.

Despite its abundance, most households and firms cannot easily access this product because of distribution shortfall, making the price to be out of reach. An average 12kg of LPG goes between N4000 – N4500 depending on season and location, making it an elite commodity. Policy instruments should stimulate entrance by local investors to ease the burden of utilisation.

Nigeria's gas supply potentials clearly outweigh its demands. Strategies that could conserve the product for economic, social and environmental sustainability should be pursued. The gradual unbundling, deregulation of the sector and partial withdrawal of subsidy for the product could encourage local and international participation.

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