Natural Gas Logistics, Utilization And Impact On Nigeria's Economic Health: A Simple Empirics

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ABSTRACT
The Study Examines Natural Gas Logistics, Utilization and Impact on the Nigerian Economy. Past and Ongoing Gas Utilization efforts, Storage, Factors influencing Investment in the Sub-Sector and the Constraints of Gas Development. It adopted Ex-Post Facto Design through Secondary Means from The Central Bank of Nigeria (CBN), Nigeria National Petroleum Corporation (NNPC), Nigeria Gas Company (NGC) and Department of Petroleum Resources (DPR) Statistical Bulletins from 1981 to 2020. Econometric Regression Technique of Ordinary Least Square (OLS) was employed to investigate the Impact of Revenue from Foreign Direct Investment (FDI) on Natural Gas, and Effect of Gas Output and Revenue on Gross Domestic Product (GDP). Findings reveal that, Gas Revenue on the Economy is currently Low since the Bottlenecks in the Sector such as adequate Utilization, high Cost Outlay, Pricing and Storage are still a Challenge. It is recommended that for Commercial reasonability, an appropriate Price Structure should be put in place. Also, a robust Regulatory Environment to ensure Sound Utilization Practice. It is expected that with the recent Commercialization of the NNPC through the Petroleum Industry Act (PIA 2021), these Recommendations should be accommodated to guarantee Efficiency, Expansion and Recovery on Investment in the Sector.
Keywords: Natural Gas; Logistics; Utilization; Investment; Economic Growth

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, Industrialization, Health, Infrastructure, favorable Balance of Payments, Employment, stable Currency among others (Isik, 2010). Nigeria with a Population of over 200million 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 Petroleum Oil and Natural Gas, due to its abundance in her Territory.

Focus of this Study is on Natural Gas which Nigeria has proven Reserves in excess of 187 Trillion Square Cubic Feet (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 Feedstock 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 purposes. This is not commensurate with the Quantity of Gas available in Nigeria that is wasted by flaring which translates in 2bscf/d (NNPC, 2021; Adelegan, 2018). 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 harness the Development of their Domestic Market through improved Gas Application (Songur, Muratoglu & Muratoglu, 2016).

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 Environmental friendly choice to others, Coal especially.

The Oil and Gas Sector has been a key Contributor to the Country's Budget since its Discovery in Commercial Quantity. 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 becomes imperative. 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. It is therefore pertinent to ask to what extent has Revenue from Gas influence Investment in the Sector; what are the constraints to output Utilization; what can be done to reduce wastage to its barest minimum and how can the Country maximize its benefit through increase Gas Utilization.

Empirical Literature on Natural Gas Utilization

Development has been linked with per capita Energy Consumption or the Contributions of the Energy Sector to Gross Domestic Product (GDP) of any Nation (Adamu & Darma, 2016). 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 Economies. The United State of America alone accounted for a third of the World's Energy Demand. A World Bank Report states that Nigeria and most African Nations have per capita Energy Demand of about 15% below World Average, (Abdulkareem & Odigure, 2010; Eludinni, 2004).

According to the Federal Ministry of Budget and National Planning (2020), 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 in the cause of Production. Several Studies have been carried out in the area of Energy and National Development.

Lee & Chang (2007) wrote on Energy Consumption in Developed and Developing economies, the imperative of a National Energy policy, and the Socio-Economic implications of such Policies on GDP. Panel Analysis was employed. Finding reveals the importance Petroleum and Gas to Developing economies. Madueme (2010) wrote on Wastages, the perennial Energy Crises, especially in the Power Sub-Sector of the Economy. He employed Simple statistical techniques in his Analysis. Findings reveal poor Gas Supply, Hydrological inadequacies and frequent breakdown due to excess carrying capacity.

Also, Odumogbo (2010) wrote on Natural Gas Utilization, Challenges, Prospects and Nigeria's Economic Development process. He established the Technical criterion for efficient Energy Utilization. The inter-relationship of the productivity of Energy, Capital and Labour 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. In the Work

of Ojide, Salami, Fatimah, Gazi & Oke (2012), on the Impact of Efficient Management of the Gas Sub-Sector on Sustainable Economy in Nigeria. He observed the Sector lacks Effective Management Structure and Central Direction. He suggested the Nigeria National Petroleum Corporation (NNPC), the Apex Manager of the Sector has to be restructured to enable it live to expectations. Also the Organization should be more proactive in developing Nigeria's Natural Gas Resource which for Decades has been wasted though flaring.

Pibowei & Marei (2021) in a recent Study, evaluated the Impact of Gas Exploration Tax on Economic Growth, Policy measures adopted by Government to develop Nigeria Energy Resources, Factors that contributed to Energy Crises and mitigating measures. Statistical Averages and Percentages were used in analyzing Data. Finding reveal that the major cause of Energy crises 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 Privatization of the Refineries without delay. Adelegan (2018), took a critical look at the Role of Natural Gas, National Development Plan from the First to the Fourth in Nigeria using simple Empirics. He observed that despite the huge Investment in the Sector during these periods, the Policy Objectives are yet to be met.

Abdulkareem & Odigure (2010), conducted a Study on the Benefits accrued from Gas Utilization, and Environmental hazard of Energy Production in Nigeria. The study concentrated on the Hazards of Exploitation of Petroleum and Gas on the Air, Land, Water and the Biosphere, as well as Government's effort at protecting the Environment. Adamu & Darma (2016), wrote on the Gas Consumption and Potentials of the Nigeria Gas Sub-Sector using ARDL Co-integration Test. They estimated an increase Energy Demand at a Growth rate of 0.53million 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 Utilization Projects like Delta Steel Company, Aladja, National Fertilizer Company of Nigeria, Onne and Aluminum Smelting Company of Nigeria, Ikot-Abasi. All moribund now.

Adenikinju (2008), wrote on the Advantages and Uses of Natural Gas and its Competitiveness on the Nigerian Economy. Statistical inferences were used in the Analysis. He observed that Natural Gas provides a better alternative Energy due to its Quality. Austvik (2000), wrote on the Economics of Natural Gas Transportation, he was worried about the reach and experienced in the 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. Eludinni (2004), reviewed the Benefits from 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 Utilization 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 1500million Standard Cubic Feet (1500mmscf) 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. Obaseki (1999) and subsequently Obasi (2015), wrote on the creation of additional Wealth by Natural Gas for the future Development of Nigeria. He observed that Nigeria's Gas Reserve stands at 187trillion SCF which in Energy terms equivalent to 40billion Barrels of Crude Oil. Also, 45% of the Gas produced which is equivalent to 500,000Barrels of Oil per day is flared, as the Country lacks the consumptive capacity to utilize the magnitude of Gas. He suggest the need for more Investment in Utilization. Osakwe (1985), was worried about National Energy Policy for Self-reliance. He analyzed 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 Utilization/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).

Conceptual Clarifications
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 Exploitation involves higher Throughput requiring larger diameter of Pipes and higher Schedule (Barnes, Hayes, Jaffe & Victor, 2006).
Eventually, they both pass through 4 or 6 inches Flow-lines from Wells to Production facilities. 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 Piping arrangements, for proper Separation of Gas, Crude Oil and Water. Where there are no Storage for Gas as in most cases in Nigeria, they are flared out. In some 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 than Crude Oil Production, while Gas is cheaper in the Market (Domestic and International) than Crude Oil, creating a disincentive for Investors.

Nigeria Gas Policy at a Glance
With an expected Life span of 134 years for Nigeria Crude Oil Reserve and 85 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 from 2008 to 2020.
Thus, the New Gas Policies as enunciated by the National Energy Commission and endorsed by the Presidency 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 2020
(ii)   To Expand the Utilization of Natural Gas as Domestic and Industrial Fuel for Power Generation.
(iii)   To use Gas to diversify the Foreign Exchange base of the Nation.
As a measure to achieve the aforementioned Policy Objectives, various Strategies was instituted:
(i)   Encourage Associated Gas Gathering (AGG) by MOCs in order to end Gas flaring at the stipulated time.
(ii)   Encourage Infrastructure building for effective Gas Gathering, Transmission and Distribution.
(iii)   Put in place Incentive to encourage Industrial and Domestic Application.

Gas Projects as Efforts to Shore up Utilization Capacity in Nigeria
 1.   **Ajaokuta – Kaduna – Kano (AKK) Gas Pipeline Project**
      Currently on-going is the 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 Country to 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 Utilization of Gas in the Areas. The Companies involved in the Construction are NNPC and Oil-Serve Nigeria Limited, an Indigenous Company.

2. **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 as the Project Manager. 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)

3. **Shell Nigeria Gas (SNG) Limited**
   SNG Limited, a 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 Feedstock for Manufacturing and Transporting Vehicle that compress Natural Gas. Their real destination are Industrial Hubs like Agbara, Otta and Aba. Also on-going by the SPDC are the Forcados-Yorkri Integrated Project (FYIP) and Southern Swamp Associated Gas gathering (SSAGG) Project. They are to serve as Feeder to the NLNG, Capacity Utilization, and Flares out.

4. **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).

5. **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 Utilize 80% of the Gas emanating from its Operation in the area.

6. **Mobil's Oso Natural Gas Liquids (Oso NGL) Recovery Project.**
   Jointly owned by NNPC-49% and Mobil-51%. It commenced Contractual Agreement in February, 1995 with an initial Outlay of $855 million, and a Life span of 25-30years. The Associated Gas from Oso and nearby Fields are re-injected to maintain Reservoir Pressure

RESEARCH METHODS
Research Design
Research design provides the bond that held the Study together. Ex-post facto Research Design was therefore applied, relying on 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) Bulletins for a period of 40 years from 1981 to 2020. Econometric Regression 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).

Model Specification
The models employed in the study is presented in its functional and econometric forms below as:
Model 1: RNG $= f$ (GDP, FDI, MS) ……………………………….eq. 1

RNG $= a_0 + a_1$GDP $+ a_2$FDI $+ a_3$MS $+ u_t$……………………...eq. 2

$a_1 > a_2 > a_3 > 0$

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

FDI $= b_o + b_1$RNG $+ b_2$QNG $+ b_3$GDP $+ u_t$……………….……eq. 4

$b_1 > b_2 > b_3 > 0$

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

GDP $= c_o + c_1$RNG $+ c_2$QNG $+ c_3$FDI $+ c_4$MS $+ u_t$…………..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 *a-priori* Hypotheses.

RESULTS PRESENTATION/DISCUSSION

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 = 40 T-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.

Nigeria currently ranked number one in Gas flaring globally. The need to convert this avoidable loss to Economic Advantage becomes imperative. The Demand for Gas is increasing on the Domestic and Global fronts, because it is viewed as Clean, Cheap, Abundant, and Versatile. Due to the eroded confidence in Oil, Natural Gas is likely to be 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 Utilization, high Cost Outlay, Pricing and Storage are still a challenge.

CONCLUSION AND RECOMMENDATIONS

Considering Nigeria's abundant Gas Reserve, 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 realization and another set for 2020, which is here and almost overtaken by events. The need for a new National Policy on Gas Wastage through flaring becomes crucial not only for its Economic Benefits, but also for the Impact it has on the Environment. The Petroleum Industry Act (PIA) should incorporate Incentives to the Oil and Gas Companies to Establish and Operate Gas Storage Facilities and the overhaul of Transmission and Distribution Networks for effective reach out to end Users.

The Gas Market is highly globalized 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 12.5kg of LPG goes for about $20 equivalent depending on Season and Location, making it an elite Commodity. Policy Instruments should stimulate entrance by Local Investors to ease the burden of Utilization.

Nigeria's Gas Supply potentials clearly outweighs 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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